Reconstructive Techniques in Melanoma for the Surgical Oncologist

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KEYWORDS

• Flap • Graft • Melanoma • Skin cancer • Skin graft • Reconstruction • Cancer • Oncology

KEY POINTS

- Goals of reconstruction include restoration of form, function, and aesthetics while minimizing donor site morbidity without compromising the effectiveness and safety of oncologic melanoma treatment.
- Reconstruction of defects associated with wide local excision for the treatment of melanoma should take into consideration patient variables; disease factors; and anticipated defect location, dimension, characteristics, and surroundings.
- Reconstructive options include primary closure, healing by secondary intention, skin grafts, random-pattern flaps, and/or axial-pattern pedicled or free flaps of locoregional or distant origins.
- Multidisciplinary collaboration between the ablative and reconstructive teams in the preoperative, intraoperative, and postoperative periods provides comprehensive and safe treatments for melanoma patients undergoing surgical treatment.

INTRODUCTION

As the standard of care for primary cutaneous melanoma, wide local excision minimizes the risk of locoregional recurrence by including margins with tissue harboring local micrometastases, genotypically abnormal cells, and disease-free tissue.[1] Current guidelines recommend 1-cm lateral margins for lesions with Breslow thickness less than 1 mm and 1- to 2-cm lateral margins for melanomas thicker than 1 mm.[2]

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Deep margins should extend to, and sometimes include, the underlying deep fascia. Resultant defects may have significant functional and aesthetic implications, particularly in the head and neck and extremities. A multidisciplinary team with early involvement of a reconstructive surgeon allows for appropriate planning and execution, and ensures optimal results with low local recurrence rates.

Wounds resulting from wide local excision vary in size and complexity, and require individualized solutions to achieve functional and aesthetic closures. Optimal reconstruction relies on an in-depth understanding of the defect, locoregional anatomy and vasculature, available donor tissues, and basic wound healing and surgical principles and techniques. This article provides a broad overview of preoperative patient, timing, and wound considerations; various surgical techniques; and postoperative care and complication management.

PREOPERATIVE CONSIDERATIONS

Patient Factors

The success of reconstructive surgery depends on preoperative consideration and optimization of patient-related risk factors that should be elicited through a comprehensive history and examination. It is imperative to screen the patient for comorbidities that may complicate wound healing or preclude prolonged surgery, such as obesity, diabetes mellitus, chronic obstructive pulmonary disease, hypertension, cardiovascular or peripheral vascular disease, renal disease, coagulopathies, rheumatologic disorders, or immunocompromised and malnutrition states.[3,4] Medications, such as anticoagulants or steroids, may complicate the surgery or postoperative course.[5] Prior history of radiation at the site of surgery or tobacco use may decrease tissue vascularity and perfusion.[4,6] Actively smoking patients should be counseled on smoking cessation and, if timing allows, encouraged to discontinue smoking at least 4 weeks before surgery.[7] Age and preoperative functional and ambulatory capacity may inform the type of reconstruction a patient may be able to tolerate. Patient expectations, reconstructive options and their possible complications, and anticipated functional and cosmetic outcomes should be addressed preoperatively.

Reconstructive Timing

The optimal timing of reconstruction after melanoma excision remains a topic of debate. Although Mohs micrographic surgery is widely used in the excision of nonmelanoma cutaneous malignancies, frozen section analysis of melanoma has not been shown to be reliable or accurate enough for routine use.[8,9] Because negative margin status cannot be confirmed intraoperatively, surgeons have traditionally delayed reconstruction or limited immediate reconstruction to skin grafts while awaiting permanent pathology. Skin grafting facilitates continued ease of surveillance without distorting the local anatomy or masking recurrent disease. Although this traditional approach is safe oncologically, it inconveniences the patient, requires further anesthetic episodes, and increases health care costs.[10,11] Whenever possible, patients prefer a single procedure with immediate reconstruction to avoid a prolonged period of disfigurement.[12]

Although there are a small number of studies exploring the optimal timing of reconstruction, recently, immediate reconstruction following wide local excision of melanoma has been performed with safe and reassuring outcomes.[10,11,13] A recent systematic review by Quimby and colleagues[13] concluded similar rates of positive margins and local recurrence between delayed and immediate reconstruction. Furthermore, locally recurrent, ulcerated, thicker melanomas (T4), melanoma in situ with ill-defined borders, and desmoplastic melanomas have been identified as high-risk for positive margins; delayed reconstruction may be more prudent in these cases.[10,11] More complex reconstructions with adjacent tissue rearrangement and locoregional flaps have been shown to be safe because they often allow for larger excision margins and they do not impede re-excision in the case of positive margins.[6,10,11,13] More high-quality studies are needed to further define guidelines for reconstructive timing.

DEFECT ASSESSMENT

An optimal reconstruction provides adequate and safe coverage of a given defect, restores tissue composition, and preserves form and function while minimizing donor site morbidity. Reconstruction begins with thorough assessment of the wound, surrounding tissues, and a survey of available donor tissues. The location, size, depth, tissue quality, skin thickness and laxity, vascularity, and any lost or exposed underlying critical structures must all be described. Adjacent functional structures or organs should be noted to avoid their disruption. If delayed reconstruction is performed, viable, desiccated, and necrotic tissues must be differentiated, and any slough, eschar, or signs of infection must be addressed. Although these basic principles can guide general wound assessment, there are special considerations unique to each body part that inform the required reconstruction.

Head and Neck

The head and neck region is a particularly challenging area for reconstruction because the delicate aesthetic and functional demands are extensive. Minor reconstructive flaws are readily evident. Within the face, there are static and dynamic structures with several special function organs, including the orbit and its contents, nose, ears, lips, and mouth.[14,15] To guide wound assessment and reconstruction, facial anatomy is divided into various aesthetic subunits determined by skin quality, thickness, color, texture, contour, and function.[5,16,17] Delimiting the reconstruction by aesthetic subunits may yield superior results, because scars may be concealed at the boundaries between these topographic subunits. Favorable incision design allows for eventual scar camouflage within Langer lines of tension. One should aim to replace lost tissues with "like" counterparts that exhibit similar color and thickness. Given the density of critical anatomy in this region, specific potential complications should be discussed preemptively, and intraoperative measures should be undertaken to limit such morbidity. Preservation of facial nerve motor branch function is important during the ablative and reconstructive procedures. Forehead reconstructions should consider hairline disruption. Periocular reconstructions should avoid designs that may predispose to ectropion, especially in elderly patients with lower lid laxity at baseline.

Extremities

The upper extremity poses its own reconstructive challenges. As the upper extremity tapers in circumference from proximal to distal, skin laxity and donor tissues diminish and bones are located in a more superficial subcutaneous plane, making reconstructions more complex. The surgeon must consider the complex functionality and extensive range of motion of the numerous joints, avoiding any options that may limit motion or cause stiffness, because these can result in long-term disability. Durable coverage of vital structures, such as exposed muscles, tendons, vessels, and nerves, should also allow for muscle and tendon gliding while maintaining neurovascular integrity of the upper extremity.[17,18]

The lower extremity poses many of the same challenges, because it has diminishing amounts of skin laxity, subcutaneously positioned bones and vital structures, and high functionality with extensive range of motion. Additionally, the lower extremity is a weight-bearing structure that withstands significant pressure and shearing forces and requires intact sensory innervation. Wound reconstruction should be robust and durable. The sensory function of the plantar foot should be preserved. Even small wounds can result in bone exposure in the distal third of the leg, which may require reconstruction with free flaps. Underlying peripheral vascular disease should be recognized and optimized to enhance healing potential.[17,18]

Trunk

The chest, abdomen, and back are generally forgiving because there is ample tissue laxity amenable to primary closure. The groin, which harbors important neurovascular structures, does require durable and well-vascularized coverage that obliterates the existing dead space and minimizes the risk of infection and compromise of critical structures.[17]

SURGICAL TECHNIQUE

To help the reconstructive surgeon conceptualize all the surgical options in a systematic approach, Mathes and Nahai introduced the metaphor of the reconstructive ladder.[19] This concept allows the surgeon to consider various wound closure options in a stepwise fashion from the simplest to the most complex, tailoring each solution to a patient's specific reconstructive, health, and functional needs. Over the years, the ladder has been adapted to include newer modalities of wound care and closure and now includes: closure by secondary intention, direct primary closure, skin graft, dermal matrices, local flaps or tissue rearrangement, regional flaps, tissue expansion, and free flaps (**Fig. 1**).[20] Negative pressure wound therapy can serve as an adjunct to every

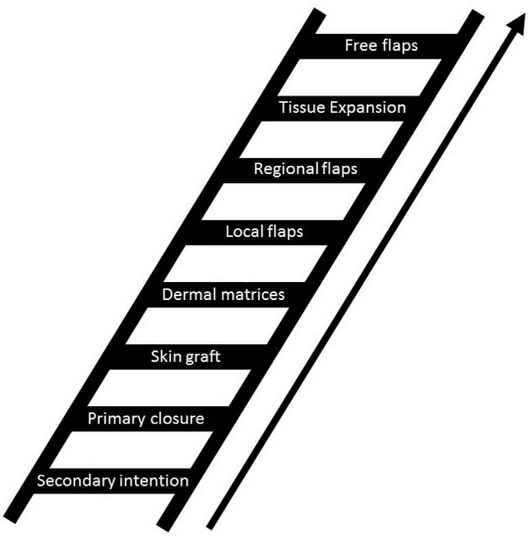

Fig. 1. Reconstructive ladder. (*Adapted from* Janis JE, Kwon RK, Attinger CE. The new reconstructive ladder: modifications to the traditional model. *Plastic and reconstructive surgery.* 2011;127 Suppl 1:205s-212s.)

possibility. The ladder should not be adhered to in a strict order where the best option is the simplest option. Rather, it should serve as a simple framework to consider all the available options and the final solution should be tailored to the patient.

Primary Closure and Secondary Intention Healing

Simple closures can generate favorable aesthetic and functional results. Primary closure outcomes may be optimized by placing incisions for ablative procedures along the boundaries of aesthetic subunits or along the relaxed skin tension lines. Linear closure over a joint surface should preserve sufficient laxity to accommodate full range of motion. Closure by secondary intention may be appropriate in locations where wound contraction would not cause undue morbidity, such as on the trunk, proximal extremities, or scalp. Wounds on facial concavities, such as on the inner canthus, alar crease, and within the helical rim, are known to heal successfully with good cosmetic and functional results. However, management requires regular wound care. The aesthetic outcomes are unpredictable and may require revisionary surgery.[21]

Skin Grafts

Skin grafts have been used traditionally to close melanoma defects because they allow for continued surveillance without anatomic distortion. By definition, grafts are tissues that are harvested from one part of the body, completely devascularized, and then replaced at the wound, where they survive via a three-stage process of imbibition, inosculation, and neo/revascularization. During the initial imbibition stage, which lasts about 24 to 48 hours, the graft, which is held in place by a thin and delicate fibrin layer, survives by diffusion of nutrients from the wound bed. Following this phase, the end capillaries from the recipient wound bed and graft begin to align in a process known as inosculation, and, over the course of several days, become mature arterial and venous vessels. The success of this process depends on the presence of a healthy, well-vascularized wound bed; prevention of seromas, hematomas, or infections; and minimizing shearing forces on the graft.[22]

Depending on the depth of harvest and the amount of dermis included, skin grafts are classified as split-thickness or full-thickness. Split-thickness skin grafts (STSG), which are harvested at a depth of 0.012 to 0.020 inches, contain varying amounts of dermis. By contrast, full-thickness skin grafts (FTSG) contain the entire dermis and are harvested down to the underlying subcutaneous tissue. The variable amount of dermis confers several important graft characteristics. First, FTSG exhibit greater degrees of primary contraction, because the elastin fibers within the dermis cause an immediate recoil following harvest. However, secondary contraction, which occurs in delayed fashion within a healed graft, is greater for an STSG. FTSG have the ability to regenerate sweat glands, grow hair, and become reinnervated because epithelial appendages and neurilemmal sheaths are transferred within the dermis. Finally, FTSG have an increased risk of failure or partial take, because their metabolic requirements are greater.[22]

The donor site for graft harvest may be chosen based on the color, texture, thickness, and size of graft required. STSG are harvested from the lateral thighs, buttocks, trunk, or even scalp. By contrast, FTSG are harvested from the groin, preauricular or postauricular regions, the supraclavicular regions, and the gluteal crease. FTSG sizing is limited by the capacity for primary donor site closure. Although a graft can be meshed to increase its size and allow for drainage of underlying fluids, it does result in a more unsightly result.[22]

Although skin grafts provide a technically simple and quick reconstructive option and allow for continued easy surveillance, there are several disadvantages. STSG donor sites are painful, heal by secondary intention, and are ultimately unsightly. Hypopigmentation or hyperpigmentation, texture and contour irregularities, and contracture may compromise recipient site appearance. Finally, in the long-term, skin grafts do not tolerate trauma or repetitive forces well and can break down easily, requiring further revisions. Although skin grafts are an indispensable technique for reconstruction, advances in surgical technique and evolving knowledge of flap anatomy and physiology may make these complex reconstructions more appealing solutions.[22]

Flaps

Flap surgery, whether from locoregional or distant tissues, provides a more sophisticated means of reconstruction with the aim of improving functional and aesthetic results and minimizing donor site morbidity. In contrast to grafts, flaps maintain their own blood supply and do not depend on the recipient wound bed vascularity for survival. Therefore, flaps can be used for defects with poorly vascularized or devascularized wound beds. Locoregional flaps are classified by their blood supply into random or axial pattern flaps.[23] Random-pattern flaps are supplied by the subdermal plexus, whereas axial pattern flaps are supplied by a specific named and identifiable cutaneous artery within the longitudinal axis of the flap. Traditionally, the dimensions of these flaps are limited to a length-to-width ratio of 2 to 3:1 for random pattern flaps to 6:1 for axial pattern flaps. As this ratio increases, the risk of flap necrosis increases.[24] When the locoregional tissues are not apt for defect closure, more extensive and larger pedicled or free flaps can be performed. In the following sections, several fundamental random- and axial-pattern flaps used to reconstruct defects throughout the body are described.

Random pattern flaps

Advancement flaps Advancement flaps recruit adjacent tissues to close the defect in a linear fashion. The skin edge moves unidirectionally forward without any rotation or lateral movement.[25] There are various iterations of the advancement flap. The single advancement flap is designed as a square or rectangular flap in which two parallel incisions are made along tangents to the wound edges. The flap is then elevated at a depth to match the contour of the defect. Flap advancement distance is increased by excising Burow triangles laterally at the base of the flap. If a single-pedicle advancement flap does not suffice, two opposing single-pedicle advancement flaps can be performed to provide additional tissue to achieve wound closure (**Fig. 2**).

The V-Y advancement flap is designed as a triangle with two divergent incisions from a point of origin to opposing edges of the wound (**Fig. 3**). The angle between these diverging lines should be about 30°, because this allows for the length of the triangle to be about two to three times larger than the defect diameter. The width of the triangle should be equal to the defect diameter.[25] The resultant triangular skin island must not be undermined to preserve vascularity. Instead, undermining of the wound edges and island flap perimeter should be performed to allow for tension-free closure. The final suture lines create a Y-shape.

The keystone flap has recently emerged as a novel and versatile solution that finds particular applicability in distal limbs.[26] The design and movement of this flap draws on the foundation of the more classic advancement flaps. Flap design begins with excision of a lesion within an ellipse along the longitudinal direction. The flap is then performed over the area of most tissue laxity. Two incisions are planned at proximal and distal ends of the defect at 90° angles to the wound edge. From these incision end

Fig. 2. Advancement flap. (*A*) Circular defect involving left forehead immediately adjacent to eyebrow. (*B*) Medially based forehead advancement flap. (*C*) Intraoperative flap inset and closure. Additional lateral V-Y advancement was performed for additional coverage. (*D*) Final results at 6 months.

points, a curvilinear arc parallel to the wound edge is designed to connect to these two end points. An islandized flap is created by making full-thickness incisions without beveling. Along the greater arc, a fasciotomy is performed to maximize mobility. The skin island should not be undermined. After dissection is completed, closure should begin at the proximal and distal edges in a V-Y fashion with the goal of providing enough tissue laxity centrally to close the defect (**Fig. 4**).[26]

Larger defects are amenable to closure with double keystone flaps. In the lower extremities, keystone flaps have allowed for fast recovery times, short time to ambulation, reduced postoperative pain, and improved cosmetic results with minimal donor site morbidity.[27] Furthermore, the flap allows for appropriate excision margins and does not complicate re-excision in the event of positive margins.

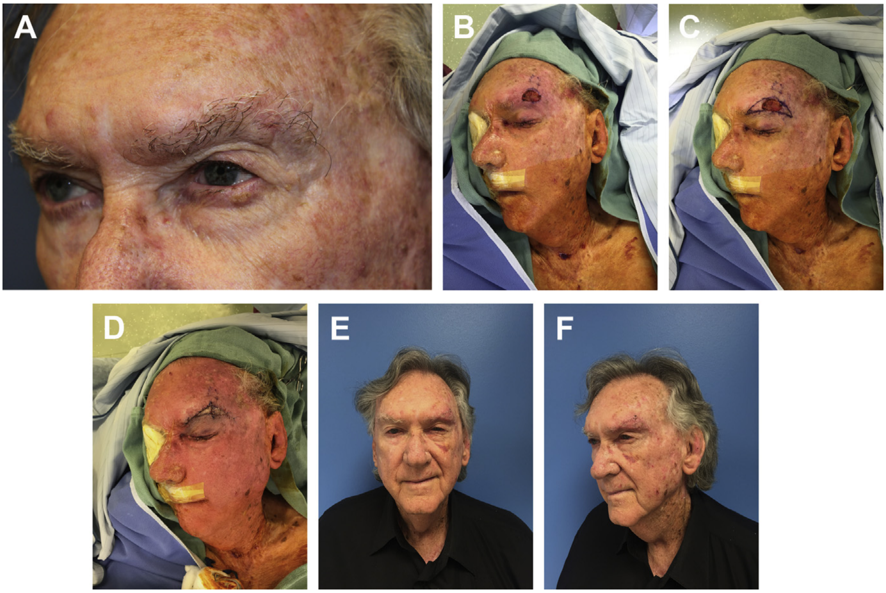

Fig. 3. V-Y advancement. (*A*) Preoperative melanoma involving the left eyebrow. (*B*) Left eyebrow defect following wide local excision of melanoma. (*C*) Double opposing V-Y advancement flaps designed along natural eyebrow curvature. (*D*) Intraoperative tension-free flap inset with viable flaps. (*E*, *F*) Postoperative results at 4 weeks.

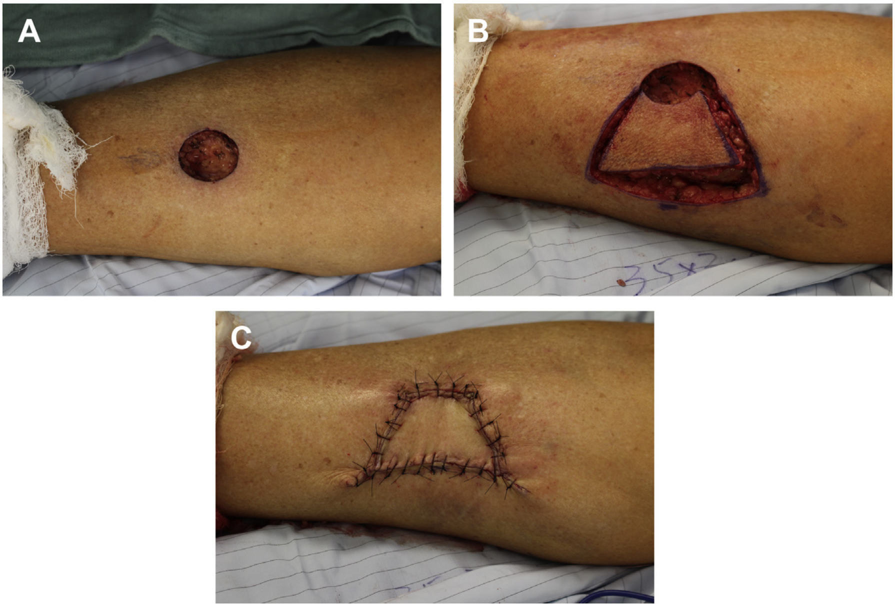

Fig. 4. Keystone flap. (*A*) Full-thickness circular defect involving the medial leg. (*B*) Keystone flap is incised down to the underlying fascia. (*C*) Intraoperative flap inset and closure with V-Y closure at proximal and distal edges.

Rotational flaps When defects cannot be closed along a single tension vector by primary closure or with advancement flaps, rotational flaps are used to turn a semicircular flap of lax adjacent skin and subcutaneous tissue about a pivot point. An arc is drawn extending from the base of the defect onto the adjacent lax tissues. The flap and its surrounding tissues should be widely undermined. When planning these flaps, the arc length, degree of curvature, and expected degree of rotation should inform flap design to ensure adequate wound coverage.[28,29] The effective length of a flap decreases as the degree of rotation about its pivot point increases. Thus, the arc length should be longer than the defect itself. To maximize movement, the optimal arc of rotation should be from 90° to 180°. If rotation is hindered at the pivot point, a back-cut extending into the base of the flap may be performed to allow for greater arc of rotation. The appropriate back-cut strikes a fine balance between flap mobility and vascular compromise. After the flap is rotated into place, a secondary donor site defect is created, which can usually be closed primarily or with a skin graft. This scenario most commonly occurs on the scalp, where flap coverage over denuded calvarium may be achieved while preserved pericranium at the donor defect is amenable to skin graft coverage (**Fig. 5**).

Rotational flaps are commonly used for large defects in the scalp, cheeks, and trunk. The cervicofacial rotational flap is a workhorse option for cheek defects within the suborbital and preauricular regions because it provides tissue with appropriate color, texture, contour, and hair match (**Fig. 6**). The flap may be based anteriorly or posteriorly. The variable extent of the incisions typically course along the nasolabial fold, the cheek-lid junction toward the outer canthus, the temple and temporal hairline, preauricular skin, and the retroauricular scalp or neck skin.[30] The incision extent depends on the exact defect location and dimensions. Widely versatile, this flap elegantly exploits the generous cutaneous lower face and neck laxity typically accumulated with age. However, the most distal aspect of the flap has a tenuous blood supply. In smokers, a deep-plane cervicofacial rotation advancement flap, which has a more robust blood supply because of inclusion of the platysma, may reduce the risk of partial flap necrosis.[31] Design should avoid downward tension vectors against the lower lid, which may result in ectropion. In at-risk patients, preemptive canthopexy may be prudent. Careful planning of any necessary cervical nodal dissection incisions with the ablative surgeon, especially in staged surgeries, preserves optimal cervicofacial flap incisional design. The skin flap may even be undermined and elevated in part by the reconstructive surgeon first to facilitate neck access.

The ying-yang flap is another rotational flap variant, consisting of two double opposing rotational flaps. The arcs are designed in opposing sides of a wound in either a clockwise or counterclockwise fashion, which allows for both flaps to be rotated in opposite directions into the defect. This closure technique is particularly helpful within the scalp, because the extensive vascular network can supply various rotational flaps and the patient's hair will conceal the incisions. Extensive undermining of the rotational flaps is required for closure because scalp tissue is inelastic, and tension-associated alopecia should be minimized.[5] The addition of multiple additional rotation flaps around a circular defect creates the "pin-wheel" flap.

Transposition flaps Transposition flaps are rectangular or square pedicled flaps that are recruited from adjacent tissues and rotated about a pivot point into a defect.[32] Many of the same principles that dictate rotational flap design also govern transposition flap planning. Typically smaller than rotational flaps, the donor sites can usually be closed primarily. There are numerous types of transposition flaps that are used throughout the body.

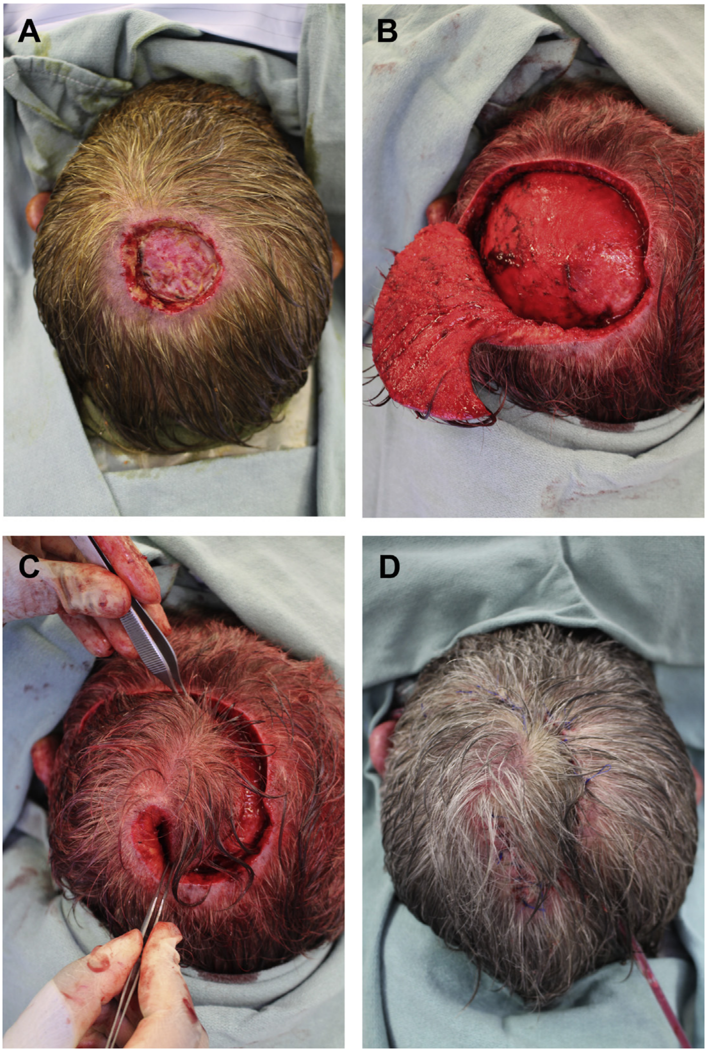

Fig. 5. Scalp rotational flap. (*A*) Circular vertex scalp defect with intact pericranium following excision of melanoma. (*B*) Adjacent rotational scalp flap elevated in a subgaleal plane with underlying pericranium intact. (*C*) Flap rotated into defect. (*D*) Intraoperative tension-free flap inset without distortion of hair direction.

The rhomboid flap was first described by Limberg.[33] The key initial step is to convert the defect into a rhombus, or a four-sided parallelogram with equal sides (x) and opposing 60° and 120° angles. From the vertex at one of the 120° angles, an outward incision of length x is made and, from this incision end point, a second incision parallel to the sides of the rhombus is made, forming a 60° angle (**Fig. 7**). Because there are four possible flap configurations for any rhomboid defect, the expected donor site should be placed over the site of maximal tissue laxity. Once the flap and donor sites are reapproximated, the resulting suture line should resemble a question mark. These versatile flaps are applied to defects throughout the body, but are especially popular in the trunk and extremities.

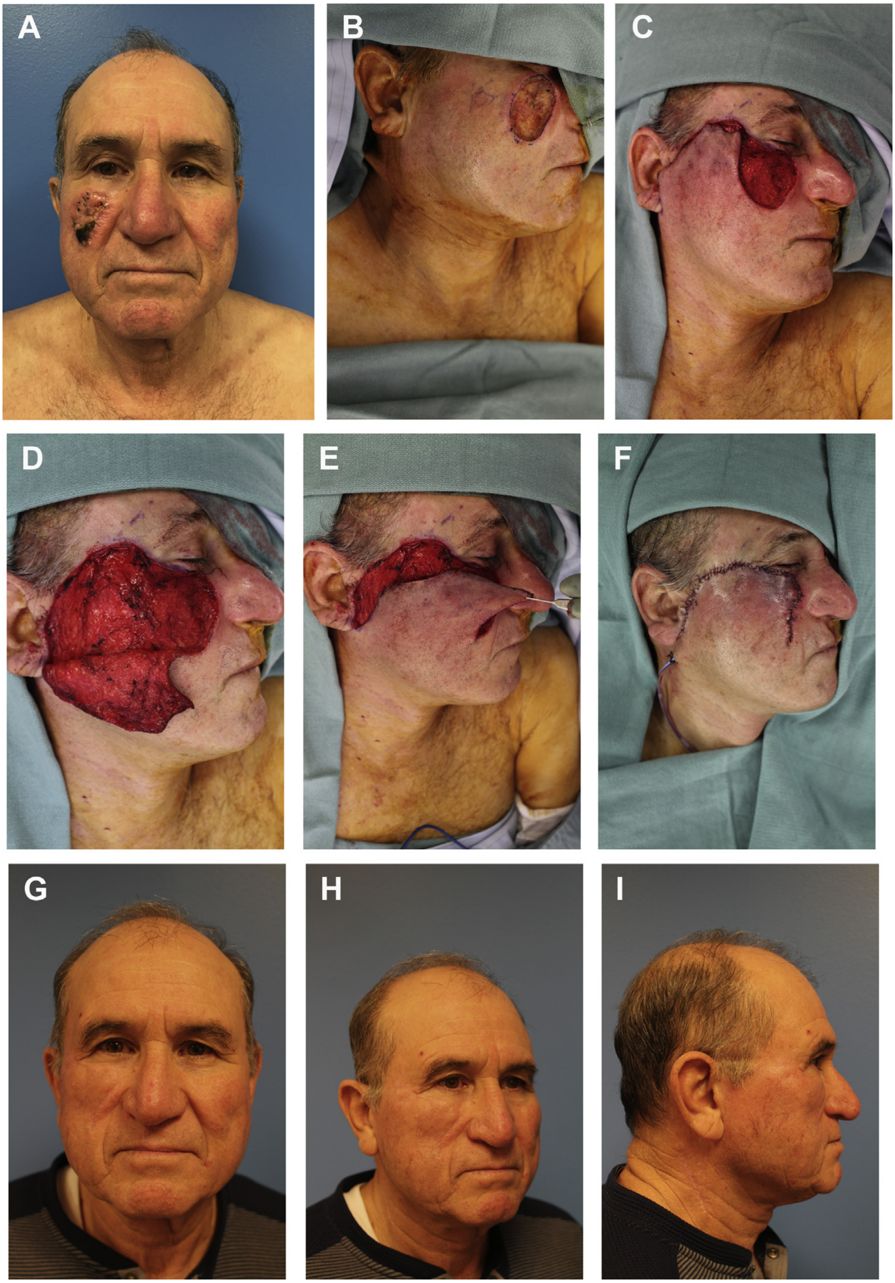

Fig. 6. Cervicofacial flap. (*A*) Melanoma of cheek status post margin-positive excision and full-thickness skin graft. (*B*) Full-thickness circular defect involving the right cheek. (*C*) Inferiorly based cervicofacial flap incised along the cheek-lid junction toward the outer canthus, the temple and temporal hairline, and the preauricular skin inferiorly to the tragus. (*D*) Flap elevated in subcutaneous plane and reflected. (*E*, *F*) Flap is rotated and inset into the defect over a drain. Distal flap tip ischemia related to local vasoconstrictive agent injection resolved spontaneously. (*G–I*) Postoperative results at 6 months.

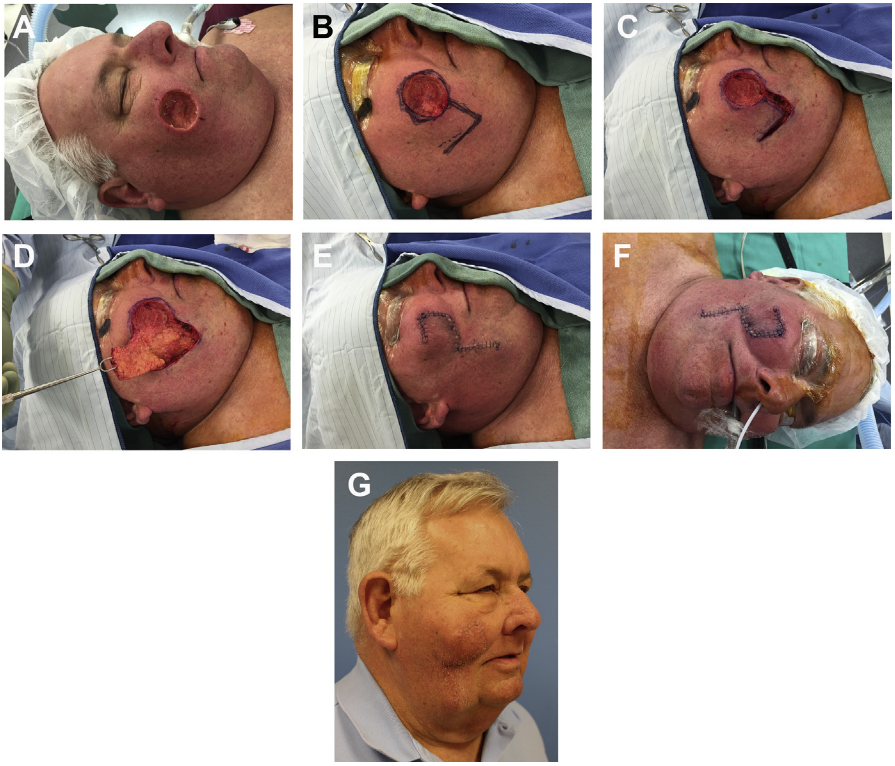

Fig. 7. Rhomboid flap. (*A*) Full-thickness circular defect involving the right cheek. (*B*) Design of inferiorly based rhomboid flap. (*C*, *D*) Flap incised, elevated in a subcutaneous plane, and reflected. (*E*, *F*) Flap inset and closure. (*G*) Postoperative results at 4 weeks.

The bilobed flap is yet another transposition flap that is particularly useful in nasal reconstruction, because lax tissues from the upper two-thirds of the nose are used to reconstruct defects in the less mobile lower-third (Fig. 8). The bilobed flap is a double transposition flap consisting of two lobes based on the same pedicle designed along a circular arc. First, the arc of rotation for the entire flap is marked from the distal edge of the wound. Next, a pivot point is placed about one radius away from the opposing wound edge and a Burow triangle is designed from this point to excise the intervening tissue between the pivot point and the defect. The first lobe is then designed identical in size to the defect at a 45° angle from the pivot point along the circular arc. The second lobe, which is designed narrower, longer, and with a triangular tip, is then placed at a 90° angle from the pivot point.[34,35] After flap design is completed, the Burow triangle is excised and the flap is raised in a subcutaneous or submuscular plane and rotated 45° into the defect.[35] The defect is closed with the first lobe, the primary donor site is closed with the second lobe, and the secondary donor site is closed primarily.

Axial flaps

An exhaustive description of all flaps with axial pattern, or named, blood supply exceeds the scope of this article. A sampling of common and pertinent pedicled axial flaps for oncologic cutaneous reconstruction follows.

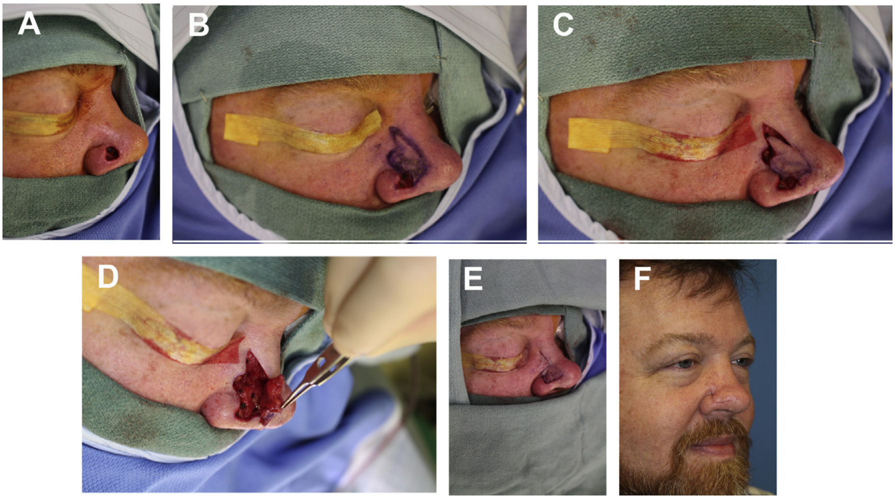

Fig. 8. Bilobed flap. (*A*) Full-thickness circular defect involving the right nasal ala. (*B*) Design of bilobed flap with anteriorly based pivot point. (*C–E*) Flap incised, elevated in a subcutaneous plane, and transposed into the defect without effacement of alar crease. (*F*) Postoperative results at 6 weeks.

Forehead flap The paramedian forehead flap, as described by Menick,[36] is a reliable flap to reconstruct nasal tip, lobule, and ala defects, or for even larger subtotal or total nasal reconstructions (Fig. 9). The flap provides large amounts of tissue with favorable color and texture match. Its blood supply is the supratrochlear pedicle, which originates deep to the medial brow about 1.7 to 2.2 cm from the midline and travels superiorly at varying tissue depths.[37] Preoperative assessment of vertical forehead dimensions, hairline position, defect size, and exposed or missing nasal structures is paramount. The length of available forehead tissue should be measured from the pivot point at the medial brow through the arc of rotation. The templated defect may be traced at the superior forehead along the path of the Doppler-confirmed vascular pedicle. The flap is elevated in the subcutaneous, subgaleal, and subperiosteal planes sequentially from distal to proximal. After inset, the flap remains pedicled for 3 to 4 weeks. Donor defects are partially left to heal by secondary intention with good cosmesis.[5] Patients should be counseled about postoperative wound care, multiple surgical stages, and the temporarily unappealing appearance before pedicle division. Secondary revisions for flap thinning are not uncommon.

Nasolabial flap The nasolabial flap is another reliable option for the reconstruction of smaller nasal defects of the sidewall and ala with intact lining (Fig. 10). Suitable candidates include patients with sufficient cheek laxity and well-defined nasolabial folds.[38] The superiorly based nasolabial flap is based on retrograde flow through the angular artery. In designing the flap, the medial edge overlies the nasolabial fold and the lateral extent is dictated by the width of the defect. The flap length is determined by assessing the arc of rotation from the intended pivot point. The flap may also be based inferiorly off of the facial artery.

Propeller flaps Emerging over the last decade, the propeller flap was originally conceived for reconstruction of defects in the distal one-third of the leg, a region with scant amount of lax tissues usually requiring free flap reconstruction.[39] It is a

Fig. 9. Forehead flap. (*A*) Circular defect involving multiple nasal aesthetic subunits, including the right nasal tip, soft triangle, and ala. (*B*, *C*) Contralateral forehead flap based on right supratrochlear vessels elevated at various depths and inset into defect with primary closure of donor site. (*D*) Second-stage procedure at 3 weeks for pedicle division. (*E*) Post-operative results at 6 months. Additional procedure for flap thinning was performed 3 months after second stage.

locoregional island fasciocutaneous flap based on a single off-center perforating branch that branches off of a main named pedicle. The off-center perforator, which serves as the pivot point, splits up the flap tissues into two blades of unequal length. The longer arm is placed more proximally, so that when the flap is fully elevated and rotated 180°, the longer arm covers the defect. The shorter arm covers the donor site, which sometimes requires adjunctive skin grafting (Fig. 11).

Although propeller flaps are appealing alternatives to free flaps, they are technically difficult surgeries with high rates of partial flap loss (11.3%) and venous congestion (8.1%), and represent an advanced form of reconstruction.[40] As technical refinements have been made with increased experience, propeller flaps have become more popular and the indications have expanded to include upper extremity and truncal reconstruction.

Pedicled and free muscle, myocutaneous, and fasciocutaneous flaps

Larger and more complex three-dimensional defects after wide local excision require early involvement of a reconstructive surgeon. These complicated cases often require either larger pedicled flaps from regional tissues or free flaps from distant sites. Although uncommon in the context of reconstruction for melanoma-related defects,

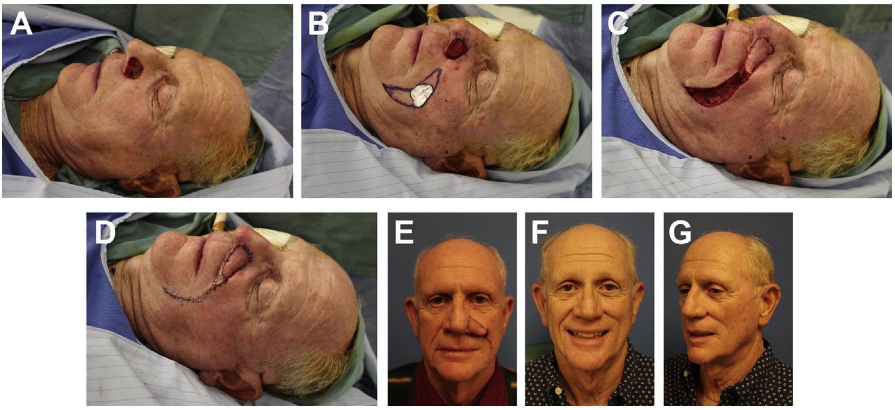

Fig. 10. Nasolabial flap. (*A*) Full-thickness defect extending from the left nasal ala to the medial cheek. (*B*) Nasolabial flap designed extending laterally from the nasolabial fold using a suture foil template of the defect. (*C*, *D*) Flap incised and inset into defect with primary closure of donor site. (*E*) Two weeks postoperative appearance with skin bridge intact. (*F*, *G*) The skin bridge was divided at 2 weeks and flap inset completed. Additional flap thinning procedures were undertaken. Postoperative results at 6 months after index procedure are depicted.

Fig. 11. Propeller flap. (*A*) Full-thickness circular defect extending down to denuded patella. (*B*) Superomedially based thigh propeller flap incised and elevated in subcutaneous plane down to fascia. Perforator dissected for adequate length to facilitate rotation. (*C*) Flap inset and donor site closure following 180° rotation of the flap. A small full-thickness skin graft was used for adjunctive donor site closure.

the use of these advanced techniques may become necessary in scenarios that involve recurrent disease, reoperation where local options have been exhausted, radiated fields, and loss of or exposure of critical anatomy. Reconstructive considerations are not limited to primary melanoma resection sites, but also at locations of regional lymphadenectomy. Patient comorbidities and functional status should be taken into account.

There are various types of pedicled and free flaps, including muscle, fascial, fasciocutaneous, bony, and composite flaps. Many of these flaps can be transferred as pedicled or free flaps, depending on the reconstructive needs and the location of the defect. Some common examples include the pectoralis major, latissimus dorsi, rectus abdominis, radial forearm, and anterolateral thigh flaps.

POSTOPERATIVE CARE

Meticulous postoperative care and follow-up is an invaluable adjunct to thorough preoperative planning and successful intraoperative execution. Skin graft postoperative care aims to ensure appropriate graft adherence to the recipient bed. Although various postoperative care regimens are described in the literature, most aim to facilitate compression of the graft against the recipient bed to prevent seroma or hematoma. A bolster dressing may be used to secure the graft. Negative pressure wound therapy is useful in exudative, irregular, or mobile and functional recipient sites to promote graft adherence.[41] As an adjunct to graft healing, wound vac therapy has been shown to provide a secure dressing that decreases bacterial counts, improves graft survival, and minimizes the need for repeat grafting.[42]

Postoperative activity is an important consideration, especially in extremity reconstruction. Traditionally, postoperative extremity immobilization for 5 to 7 days has been standard. However, immobilization is associated with increased morbidity, such as decreased range of motion, deconditioning, increased rates of thromboembolism, and longer hospitalizations. Recent studies have shown similar rates of skin graft take with early or even immediate ambulation.[43] The postoperative activity regimen should be tailored to the specific reconstruction, because certain body parts, such as the sole of the foot, benefit from immobilization.[44]

A high incidence of postoperative lymphedema has been reported following sentinel lymph node biopsy and completion or therapeutic lymph node dissection after melanoma wide local excision.[45] As such, having a general understanding of lymphedema consequences and management is essential to treating patients with melanoma. The main risks associated with lymphedema are increased rates of skin and soft tissue infections; lymphangitis; and rarely, lymphangiosarcoma. Furthermore, it can have negative psychological and social impacts on patients.[46] Preventive measures, including weight management and supervised exercise programs, have been shown to decrease the risk of lymphedema development.[47] For those who develop lymphedema, prompt referral for decongestive therapy is the gold standard.[48] In refractory cases, surgical intervention, such as volume-reduction procedures, lymphovenous bypass, and node transfers, may be considered.

The indications for adjuvant therapies in melanoma are extensive and evolving as new modalities are developed. Although the guidelines for radiation therapy are not well-defined, it is generally reserved for high-risk histopathologic features. Radiation consequences on reconstructions are well-described and include delayed wound healing issues, scar contractures, volume loss, and decreased skin integrity and tissue vascularity.[49] Furthermore, when adjuvant radiation is directed at the nodal basins, there is an even higher risk of lymphedema.[50]

SUMMARY

Wide local excision of melanoma remains the standard of care. In addressing the resultant complex defects, there is a wide range of tools within the reconstructive armamentarium. Each reconstruction should aim to restore form and function while minimizing donor site morbidity and preserving oncologic treatment efficacy. By working alongside surgical and medical oncologists, the reconstructive surgeon serves as an integral member of the melanoma multidisciplinary oncologic team.

DISCLOSURE

The authors have nothing to disclose.

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