Skin Grafting

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Knowledge of the indications, techniques, donor site considerations, and complications of all types of skin grafting is invaluable for the dermatologic surgeon who performs soft tissue reconstruction on a regular basis. With proper defect assessment, reconstructive planning, and attention to detail pre-, intra-, and postoperatively, optimal cosmetic and functional results using skin grafting techniques can be achieved.

ALTHOUGH SKIN GRAFTING originated 2500 to 3000 years ago, it was not until the 19th century that this technique was again introduced as a reconstructive option. While nineteenth century surgeons used grafts to repair their most difficult cases, skin grafting has since evolved into a modality that is routinely and sometimes preferentially used for the surgical repair of skin defects.[1-5] A thorough understanding of skin grafting is therefore essential for all physicians performing reconstructive surgery.

Free skin grafts are pieces of skin that have been severed from their local blood supply and transplanted to another site. They can be divided into 4 types: full thickness skin grafts (FTSG), split thickness skin grafts (STSG), composite grafts, and free cartilage grafts.[6-8] FTSGs are composed of epidermis and the full thickness of dermis, including adnexal structures such as hair follicles and sweat glands. STSGs are composed of epidermis and partial thickness dermis. Composite grafts are composed of at least two tissue types, usually skin and cartilage. Free cartilage grafts consist of cartilage with its overlying perichondrium.

WOUND HEALING CONSIDERATIONS

The first 24 hours following graft placement are termed the stage of "plasmatic imbibition" or the "ischemic period." During this time, fibrin attaches the graft to its bed, allowing it to remain hydrated and to obtain a supply of nutrients.[9-11] The patency of graft vessels is thereby maintained until revascularization begins. The fibrin beneath the graft is then replaced by granulation tissue, which attaches the graft permanently to its bed.

Vascular anastamoses begin to form within 48 to 72 hours after grafting, a process known as inosculation, after which proliferation of vessels in the graft and the recipient bed occurs.[9,12,13] Vascular connections arising from the recipient bed allow blood to percolate through pre-existing vessels, enabling nutrients to reach portions of the graft overlying small avascular areas through a process termed the bridging phenomenon. Full circulation is restored within 4 to 7 days. While degeneration of adnexal structures may occur initially, subsequent regeneration may allow partial function to be maintained.[9] Return of nerve function may begin as early as 2 to 4 weeks after grafting, although patients do not usually regain full sensation for months.[8,14,15]

If extension of the ischemic period occurs, decreased graft survival may result. Causes of graft failure include: insufficient recipient bed vascularity, hematoma, seroma, infection, excessive tension, mechanical shearing forces, and improper postoperative care.[6,8] These complications tend to affect FTSGs, which have a greater surface area to nourish and support, more than STSGs. The most common infectious agents associated with graft failure include coagulase-positive staphylococci, beta-hemolytic streptococci, and pseudomonas. Even after the ischemic period is past, other factors may decrease the blood supply nourishing the graft, including cigarette smoking, diabetes mellitus, protein deprivation, and severe trace element or vitamin deficiencies.[6-8,14,16,17] Certain systemic medications, such as corticosteroids, chemotherapeutic agents, other immunosuppressive drugs, and anticoagulants may also interfere with wound healing. For all of these rea-

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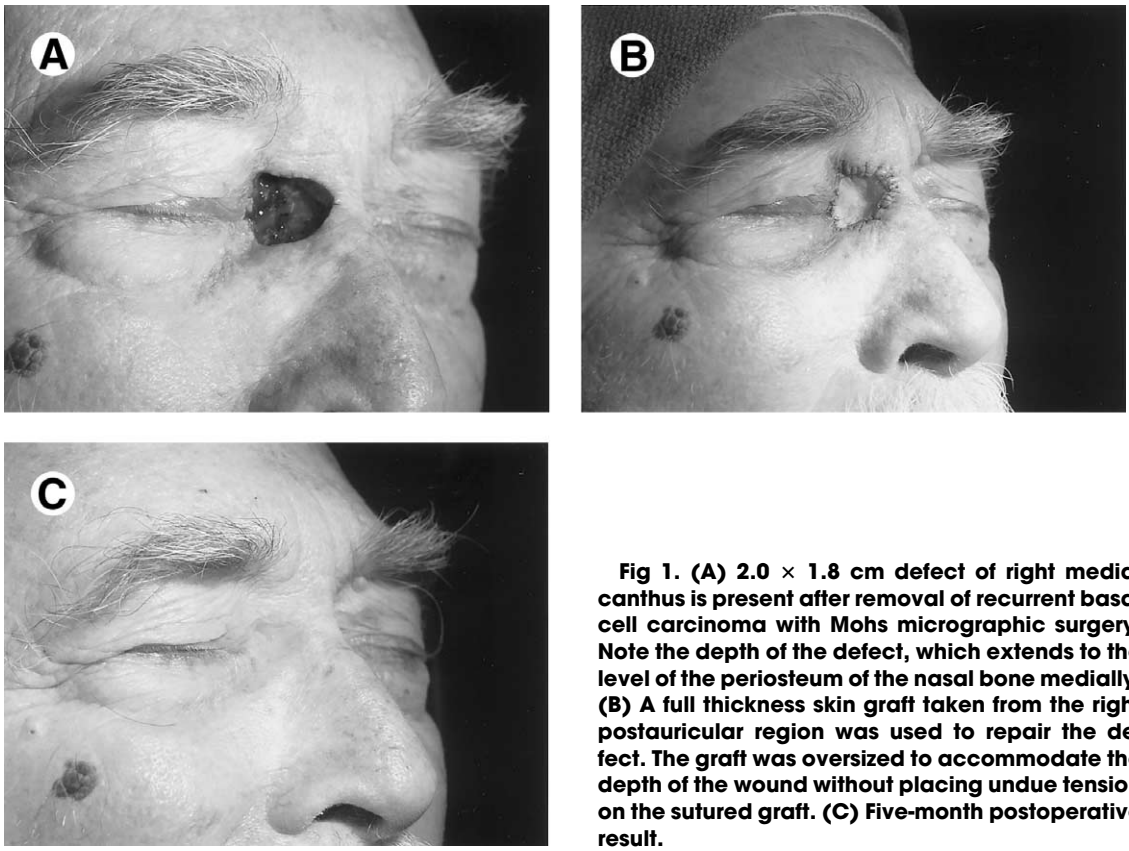

Fig 1. (A) 2.0 × 1.8 cm defect of right medial canthus is present after removal of recurrent basal cell carcinoma with Mohs micrographic surgery. Note the depth of the defect, which extends to the level of the periosteum of the nasal bone medially. (B) A full thickness skin graft taken from the right postauricular region was used to repair the defect. The graft was oversized to accommodate the depth of the wound without placing undue tension on the sutured graft. (C) Five-month postoperative result.

sons, a thorough preoperative evaluation, meticulous intraoperative technique, and good postoperative care are essential to optimize graft survival.

FULL THICKNESS SKIN GRAFTS

FTSGs are most commonly used to repair facial defects resulting from removal of skin cancers.[6-8,18,19] They may be used to repair defects on virtually any site, as long as the recipient bed has a sufficiently rich vascular supply. Under proper circumstances, FSTGs can provide excellent color, texture, and thickness matches for facial defects, and may be especially useful for the repair of defects of the nasal tip, dorsum, ala, and sidewall, as well as the lower eyelid and ear.[8,20-23] Large areas of avascular tissue, including patches of exposed bone, cartilage, tendon, or nerve devoid of periosteum, perichondrium, peritenon, or perineurium, are unable to support full thickness grafts, although small (< 1.0 cm) avascular areas may be grafted due to the bridging phenomenon.

Selection of a donor site for a FTSG depends on the color, texture, thickness, and sebaceous qualities of the skin surrounding the defect.[6,8,14,20,21] Most FTSGs are taken from sun exposed areas above the shoulders, whose color, vascular pattern, texture, thickness, and density and distribution of adnexal structures best match the tissue surrounding facial defects.[24,25] Because donor skin quality, irrespective of site, will vary from one patient to another, it is important to examine all sites carefully to find the best possible tissue match. This approach will ensure the best choice of donor tissue for each individual defect.

A regional approach may at times be used to obtain the best possible donor site match. Grafts taken from redundant upper eyelid skin may be used to repair lower eyelid defects, providing comparable color, texture and thickness as well as a camouflaged donor scar. Postauricular skin may be useful as a donor site for canthal and other eyelid defects, as well as for auricular defects (Figs 1A-C). Because post-auricular skin is relatively nonsunexposed, grafts harvested from this region may not provide a good match for other facial sites. Preauricular skin is more versatile, and can

be used to repair many nasal defects, because the thickness and degree of sun exposure of these areas tend to be comparable.[26,27] The suture line in this region can be easily camouflaged, as in face-lift surgery, to provide a minimally perceptible scar. Because the quality of preauricular skin may vary, it is important to assess which portion of the donor site best matches the recipient site. Care must be taken not to harvest hair bearing skin, as accidentally including mature follicles may produce undesirable hair growth within the graft. Skin from the nasolabial fold, glabella, or the conchal bowl can also be used to repair small nasal defects requiring grafting with thick, sebaceous skin.[25,28,29] Enough laxity may be present in some areas of the nose or forehead to allow for partial defect closure, with use of the adjacent Burow's triangle as a FTSG, providing an excellent tissue match.[30,31]

For larger defects of the forehead or scalp requiring full thickness grafts of sun-damaged skin, the supraclavicular region or lateral neck can be used as donor sites.[24] These donor sites can be more difficult to camouflage, and must be carefully placed, especially in areas that might not always be covered by clothing. Although the color and texture match may not be ideal, areas below the neck with thin, redundant skin, such as the inner upper arms, forearms, and inguinal creases, can be used as donor sites for these larger defects, or for defects of the hands, feet, or lower legs.

Many techniques for harvesting and placing FTSGs have been described.[6-8,18,19,32] Prior to performing a FTSG, a template of the defect is often made, using a flexible material, such as a telfa pad, which can be bent to conform to the defect. The periphery of the recipient site is marked, and the template material is pressed against the defect. The resulting outline of the margin serves as a guide to cut out a perfect template. The template is applied to the donor site, and inking material applied around it to indicate the exact size of the donor tissue required. The graft should be 3% to 5% larger than the template to allow for shrinkage of the graft after harvesting. Grafts used for eyelid defects may even be oversized by as much as 100% to 200% both to allow for contraction and to minimize the risk of ectropion.[18] Marking the donor site prior to local anesthesia prevents incorrect sizing due to tissue stretch from lidocaine infiltration.

After the donor site is marked, local anesthesia may be injected into the donor and recipient sites. Epinephrine may be used without compromising graft survival.[33] The donor site and recipient beds are prepped and draped sterilely. The donor skin is excised with a scalpel to the level of the subcutaneous fat. The graft is typically placed on a moist environment such as a saline-soaked gauze or in a sterile bowl or Petri dish containing normal saline, where it may remain for up to 1 to 2 hours. Grafts have been reported to be used up to 24 hours after harvesting if refrigerated or kept on ice. Before the graft is sutured into place, defatting should occur, since adipose tissue is poorly vascularized and does not adequately support vessel growth. The graft is then placed dermis down in the recipient bed, and rotated and trimmed if necessary, to ensure a perfect fit. Graft contouring often requires multiple trial placements within the graft bed, as well as multiple trimmings, to obtain an optimal aesthetic result.[22,34]

Perimeter sutures, basting sutures, support dressings, or a combination of these can be used to anchor the FTSG. Skin graft fixation using cyanoacrylate adhesive has also been described.[35] Depending on the size of the graft, several interrupted 5-0 or 6-0 absorbable or nonabsorbable sutures may be placed at opposite edges of its periphery (eg, at 12, 3, 6, and 9 o'clock) to tack down its four quadrants. Simple interrupted sutures or a running suture may then be placed around the graft perimeter. The cutaneous suture is placed so as to achieve perfect epidermal approximation, passing the needle first through the graft and then through the surrounding skin. Placing the suture slightly higher in the dermis of the graft and deeper in the dermis of the surrounding skin may help prevent tenting of the graft edges and maximize graft-recipient bed contact. All sutures should be snug, but not strangulating, so as not to compromise graft survival. Basting sutures, usually simple interrupted sutures, may be used to secure the graft and minimize shearing forces that may disrupt early vessel formation in the graft. These sutures can be useful in anchoring large grafts to provide extra support against movement, as well as grafts placed on a concave surface where tenting could possibly occur.

Immobilization of the graft over its bed can be maximized by the use of bolsters, or tie-over dressings, which stabilize the graft and help to

prevent hematoma or seroma formation during the critical period of revascularization.[8,14,36,37] The simplest bolster consists of Xeroform gauze (Xeroform, Sherwood-Davis & Geck, St Louis, MO), which is molded and placed to apply pressure to the graft. One end of a nonabsorbable suture is cut long, to a length of approximately 3 to 6 cm, and its opposing suture is left uncut. The suture ends can then be tied over the bolster two at a time (i.e. 12 o'clock to 6 o'clock and 3 o'clock to 9 o'clock) to secure it. Although sutures are usually used, adhesive wound closure tapes can also be placed to exert even pressure over the bolster.[38] A light dressing consisting of telfa and hypafix (Hy-Tape Corporation, Yonkers, NY) may then be placed over the graft. The donor site is dressed with a pressure dressing for 24 hours.[39] The bolster is not disturbed for one week, at which point the bolster and tie-over sutures are removed. Patients should be counseled that the vascular supply of the graft remains fragile for weeks. For this reason, trauma, such as direct shower water to the area, and excessive activity should be avoided for 1 to 2 additional weeks.

The ideal graft is pink when the bolster is removed, although its color may vary from pink to dark purple, depending on the extent of revascularization. Patients should be cautioned about color changes before bolster removal so that they will not be alarmed if they occur. A bluish tinge may represent ecchymosis rather than graft failure. A black graft signals necrosis and is undesirable. A white graft may also signal necrosis, although epidermal maceration may produce a whitish color change. The entire epidermal aspect of the graft may become necrotic and slough without adversely affecting the dermal portion, as reepithelialization can still proceed from adnexal structures and the surrounding epidermis, with an acceptable cosmetic result. Eschars should not be debrided, since they serve as natural dressings under which healing will progress.

Deep postsurgical defects, particularly on the nose, may pose a challenge for repair. Delaying grafting for 7 to 14 days may allow granulation tissue to fill a deep defect so that a better contour may ultimately be achieved.[40-43] If a depressed defect is anticipated, dermal grafts harvested from the dog ears of FTSG donor sites may also be used to fill deep defects prior to graft placement with little risk of resorption, eliminating the need for a more complicated repair.[44] Care must be taken to remove the epidermis completely from dermal grafts to minimize the risk of epidermoid cyst formation.

The complications of FTSGs can be divided into short-term problems of graft failure, and long-term functional and cosmetic problems.[8,14] Short-term problems include infection, hematoma, seroma, and mechanical shearing forces. These problems are significant when they occur, but can be minimized with careful preoperative evaluation, intraoperative technique and postoperative care.[45,46] It is important to be gentle when handling tissue intraoperatively, and to minimize debris generated by electrocautery to minimize the risk of infection. Because infection after grafting of facial defects is not often encountered, oral antibiotics are not routinely given. However, oral antibiotics covering for staphylococcus and streptococcus may be indicated postoperatively in patients with diabetes mellitus, immunosuppression, or a prolonged intraoperative time.

Long-term complications of FTSGs consist of cosmetic and functional problems. It is imperative to stress to the patient preoperatively that FTSGs take months to look natural. Such counseling may help to alleviate fears concerning the graft's appearance during the first weeks after bolster removal. FTSGs may be depressed during their first 2 to 4 weeks, but this depression usually corrects itself. Although careful donor site selection will minimize color, texture, and contour mismatch, patient and physician satisfaction with the aesthetic result may not be complete even after healing has finished. Spot dermabrasion or laser resurfacing may be performed after 6 weeks to correct discrepancies in elevation between the graft and its surrounding skin, and to improve color and texture mismatch.[47-49] Resurfacing of the entire cosmetic unit may be helpful in optimizing the cosmetic result. Hyperpigmentation of the graft may be treated with a brief course of hydroquinone and/or topical tretinoin without altering the course of healing.[50]

Functional complications of FTSGs occur primarily from graft contraction due to centripetal movement of unapposed elastic fibers. A variable amount of shrinkage may result, depending upon the thickness and elasticity of the donor site.[7,51] Complications due to FTSG contraction are usually minimal. If contraction does result in func-

tional or cosmetic abnormalities, revisional surgery may be required.

SPLIT THICKNESS SKIN GRAFTS

Split thickness skin grafts (STSGs) consist of epidermis and a portion of the dermis. These grafts vary in thickness, and are classified as thin (0.005 to 0.012 inches), medium (0.012 to 0.018 inches), or thick (0.018 to 0.030 inches), depending on the amount of dermis included. STSGs have less tissue requiring revascularization than FTSGs, and are therefore likely to survive on almost any recipient bed, including those with a limited vascular supply. STSGs are used to repair large defects, including those that cannot be covered by a flap or would heal too slowly by secondary intention.[6,7,10,51] They may also be useful to cover post-surgical defects at risk for tumor recurrence, since recurrent tumor is usually visible beneath split thickness skin. If the tumor does not recur after 1 to 2 years, the graft can be removed and a definitive reconstruction performed later.

Advantages of STSGs over FTSGs include: an improved chance of survival under conditions of vascular compromise, ease of application, the ability to cover large defects, and the ability to act as a "window" for recurrence of high risk tumors. Disadvantages of STSGs include their suboptimal appearance, the presence of a granulating donor site wound requiring postoperative care, greater graft contraction, and the special equipment required to harvest larger grafts. STSGs tend to be pale or white, hairless, and smooth, with impaired sweating since adnexal structures are not harvested in their entirety with the graft and do not survive. The contrast between a STSG and its surrounding skin can therefore produce a cosmetically inelegant "tire-patch" appearance. Because of their relative thinness, STSGs may be less durable than FTSGs, necessitating regrafting or partial healing by secondary intention if healing is incomplete.

Cosmesis of the donor site scar, ease of postoperative donor site care, and the type of instrument used for harvesting should be considered when selecting a STSG donor site.[52] The most common donor sites include the anterior, medial, and lateral portions of the upper thigh, the inner and outer aspects of the upper arm, and the inner aspect of the forearm. The anteromedial thigh is most frequently used, as harvesting and wound care are convenient, and wounds in this location do not interfere with ambulation. Donor site wounds on the buttocks tend to require assisted postoperative care, although the scars are hidden from view. Power driven dermatomes and large freehand knives require broad flat donor surfaces, which may limit donor sites to the thighs, abdomen, and buttocks, while smaller grafts can be harvested freehand from the forearm or upper arm.

Many techniques for harvesting and placing STSGs have been described.[6,7,19,53-55] Instruments used to harvest STSGs can be classified into freehand and electric dermatomes. Freehand dermatomes include scalpel blades, double-edged razor blades, and knives, such as the Weck blade. Although acceptable grafts can be obtained using freehand devices, considerable technical expertise is required to harvest them. Standard #15 or #15c blades may be especially useful in harvesting small medium-thickness STSGs for repair of auricular and retroauricular defects. Several blades may be required for harvesting, as blade sharpness diminishes quickly with multiple passes. Power driven Brown and Padgett dermatomes were until recently the instruments of choice for harvesting large STSGs of varying thicknesses and widths, while Davol-Simon dermatomes were used to harvest smaller STSGs of fixed width and thickness.[14] Although STSGs can be obtained with any of these devices when properly used, irregularity in graft thickness and width may at times occur. The newer Zimmer dermatome, originally powered by compressed water-pumped nitrogen, and modified into an electrically powered version, tends to harvest uniform grafts of predetermined width and thickness such that consistent graft quality tends to be less dependent on the technique of the operator.

After the dermatome is prepared, the donor and recipient sites are anesthetized, and prepped and draped sterilely. If chlorhexidine surgical scrub is used, a saline wash is employed to remove excess scrub. The donor site is sterilely lubricated to ease travel of the dermatome over the skin. The handpiece is held on the donor site at a 30 to 45 degree angle. A throttle control is pressed to start the cut, and the unit is guided forward to ensure that the cutting edge remains in contact with the donor site. An assistant applies traction around the donor area to create a flat, even surface. As the der-

matome glides over the skin, the graft emerges and is lifted away from the machine with tissue forceps or hemostats. Once a sufficiently large graft has been obtained, the dermatome is pulled away from the skin and the graft is placed in sterile saline.

As in the case of FTSGs, STSGs should be secured to minimize the risk of infection, hematoma or seroma formation, and mechanical shearing forces, as well as to maximize the potential for nutritional support. However, the edges of STSGs need not be as closely approximated to the surrounding wound edges as those of FTSGs, since overlapping skin will slough without affecting the cosmetic result. Meshing with scalpel slits allows for drainage of accumulated blood or serosanguinous material that could inhibit graft-bed contact. After the graft has been placed with the dermal side adherent to the recipient bed, its perimeter may be secured with sutures or staples. Basting sutures may also be helpful in ensuring good central apposition. Once the graft has been secured and its bolster sewn into place, a pressure dressing may be applied as an additional precaution. Sutures or staples are removed after 7 to 10 days.

Harvesting STSGs creates a second wound, the donor defect, which often causes more postoperative discomfort than the graft itself. This partial thickness wound heals by secondary intention. While STSG donor sites were once treated with bulky occlusive dressings left in place for 10 to 14 days, transparent, vapor-permeable dressings such as Opsite (Allerderm Laboratories, Inc, Petaluma, CA) have revolutionized donor site care.[56] These dressings allow the drainage that accumulates at the donor site to collect, keeping the wound moist and shortening healing time. Their use is associated with faster healing rates, lower infection rates, less pain, and minimal cost when compared with other dressings.[57] Because these dressings are transparent, the wound can be also observed for complications as it heals. Depending on the thickness of the STSG, the donor site should fully reepithelialize in 7 to 21 days.

Complications of STSGs may be divided into early complications, stemming from failure of engraftment due to hematoma, seroma, infection, or shearing forces, and late complications, which can be divided into cosmetic and functional problems.[6-8,53] Color and texture mismatch of STSGs with the surrounding skin is usual. STSGs may remain erythematous for months to years after placement, but more importantly, they may develop significant hyper- and hypopigmentation. Darker skinned patients are especially prone to graft hyperpigmentation, even with sun avoidance and the use of sunscreens. The absence of adnexal structures can also predispose to xerosis and a build-up of keratinous debris, although these symptoms can be minimized with liberal use of emollients.

Functional complications of STSG are important to recognize since STSGs, unlike FTSGs, can create forces of contraction powerful enough to produce contractures if placed over or near joints.[58,59] Graft contraction near free margins, including the nasal ala, the eyelid, the helical rim, and the vermilion border, may produce ectropion, alar rim retraction, helical rim distortion, or eclabium. Hypertrophic scarring of the graft or donor site can occur, and may be treated with steroid impregnated tape or intralesional steroids. Graft fragility and breakdown may also occur, particularly over sites with little underlying soft tissue support, such as the lower leg or scalp. Forewarning patients about these possible complications may reduce the risk via avoidance of trauma to these sites.

COMPOSITE GRAFTS

Composite grafts are modified FTSGs, consisting of 2 or more tissue layers. In dermatologic surgery, these grafts are usually composed of skin and cartilage, although they may be composed of skin and fat, or skin and perichondrium.[58-64] Auricular composite grafts may be useful for single stage repair of small full thickness alar defects and nasal tip defects with cartilage loss.[65,66] Full thickness nasal mucosal defects can also be repaired using auricular composite grafts to provide mucosal lining and structural support, with a nasolabial or forehead flap performed subsequently to reconstruct the overlying soft tissue defect.[6,7] Composite grafts taken from the earlobe have also been used successfully to repair defects of the alar rim.[62,64-66]

Reestablishment of circulation in composite grafts is thought to occur through establishment of anastamoses between the subdermal plexus of the graft and its surrounding wound edges. Since these grafts are dependent on the bridging phenomenon for survival, they must be limited in

size, with no point more than approximately 1 cm from a vascular source. The risk of central necrosis increases significantly at graft diameters greater than 2 cm.[67] After placement, the graft passes through four stages.[68] Initially, it blanches completely. By 6 hours, it becomes pale pink, signifying anastamosis of its vessels with recipient bed vessels. At 12 to 24 hours, the graft appears dusky blue, reflecting venous congestion, and by 3 to 7 days, it should again be pink, indicating graft survival. Composite grafts, like FTSGs, are threatened by shearing forces, which hinder revascularization.

Donor sites for harvesting composite grafts include the helical crus, the helical rim and the conchal bowl.[62,65,66,69,70] Small alar defects with cartilage loss can be repaired using the crus as donor site, while more substantial defects may require tissue from the helical rim or conchal bowl to obtain sufficient nasal lining. Composite grafts used for full thickness nasal defect repair may be obtained from the triangular fossa, scapha, conchal cavum, or cymba. The most appropriate donor site is that which best matches the contour of the defect. Most auricular donor sites can be allowed to granulate, while wedge excisions are usually necessary to repair helical donor sites for optimal cosmesis.

The technique for performing auricular composite grafts to repair full thickness nasal alar defects has been previously described.[63,66,71,72] A reverse tongue-in-groove technique is recommended to maximize graft stability and survival.[66,69] Cartilaginous wings are marked out on both sides of the donor site prior to harvesting. After the graft is harvested, the skin overlying the wings is removed, leaving cartilage with its overlying perichondrium. The wings are then inserted into pockets undermined in the soft tissue on either side of the defect, thereby interlocking the graft with its bed, helping to minimize shearing forces and providing a larger surface area for revascularization. The graft is then sutured into place, taking small tissue bites to minimize vessel strangulation and to maximize the number of vessels available for reanastomosis. The cartilage does not need to be sutured, as it will heal on its own. A vaseline gauze or Xeroform dressing can be placed in the nasal vestibule for support, with antibiotic ointment and a nonstick dressing applied to the external suture line. Oral antibiotics are advisable because of high bacterial colonization around the nares and the higher risk of failure with composite grafts. Sutures are removed after 1 week.

Advantages of composite grafts in the repair of full thickness defects of the alar rim relate mainly to the presence of cartilage, which provides structural support and stability, and prevention of alar distortion during inspiration and at rest.[66,69] Disadvantages include a higher risk of graft failure and substantial graft size limitations due to the increased number of tissue layers, as well as limited donor tissue availability. When properly applied, however, composite grafts can yield outstanding results.

As with other types of grafts, there is a risk of necrosis and infection in the early stages of healing, and a risk of contraction, textural changes, atrophy, and contour irregularities thereafter. Cleaning the ear with dilute vinegar solution, applying topical gentamycin ointment, and use of oral quinolone antibiotics are all measures worth considering after harvesting auricular cartilage to prevent infection with Pseudomonas, which resides in the external auditory meatus. If infection is suspected, oral quinolone antibiotics should be started immediately, and therapy guided thereafter by the results of cultures and sensitivities. If the infection does not resolve, fungal infection should be excluded. If the graft survives, but the cosmetic result is suboptimal, dermabrasion or laser resurfacing may be performed 6 weeks to 6 months postoperatively to correct color and textural differences between the graft and the surrounding skin. In the event of graft failure, a two-stage revision with placement of a cheek interpolation flap may be performed or, alternatively, a second composite grafting procedure may be undertaken.

FREE CARTILAGE GRAFTS

Free cartilage grafts, which consist of cartilage and its overlying perichondrium, are used to restore the architecture of a site that has undergone significant cartilage loss, such as the nasal ala, tip, sidewall, the ear, or the eyelid.[63,73-77] These grafts are useful in maintaining the position and contour of free margins against forces of contraction during healing, providing a rigid but flexible framework that braces against collapse.[78] Free cartilage grafts may be used in conjunction with flaps or

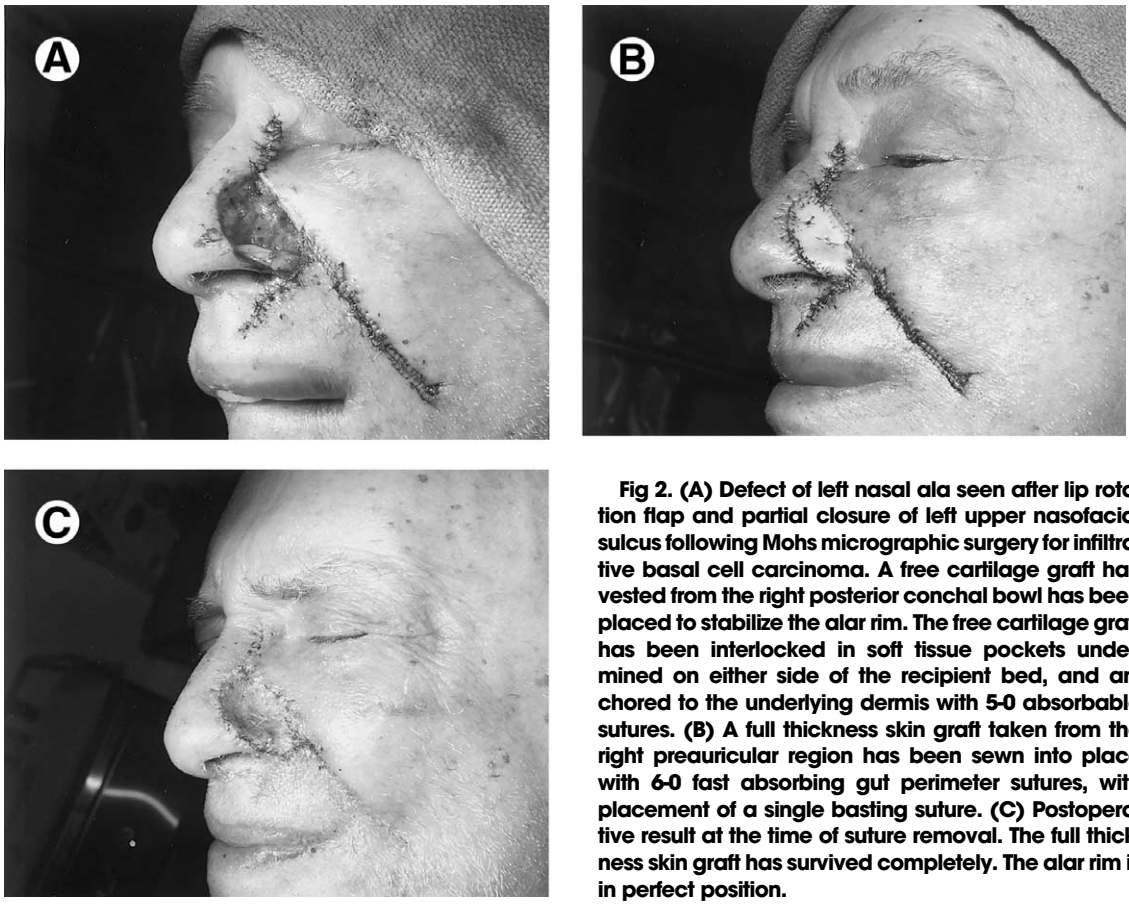

Fig 2. (A) Defect of left nasal ala seen after lip rotation flap and partial closure of left upper nasofacial sulcus following Mohs micrographic surgery for infiltrative basal cell carcinoma. A free cartilage graft harvested from the right posterior conchal bowl has been placed to stabilize the alar rim. The free cartilage graft has been interlocked in soft tissue pockets undermined on either side of the recipient bed, and anchored to the underlying dermis with 5-0 absorbable sutures. (B) A full thickness skin graft taken from the right preauricular region has been sewn into place with 6-0 fast absorbing gut perimeter sutures, with placement of a single basting suture. (C) Postoperative result at the time of suture removal. The full thickness skin graft has survived completely. The alar rim is in perfect position.

FTSGs to maintain airway patency and to minimize the risk of alar retraction during wound healing (Figs 2A-C).[76]

Partial thickness nasal defects extending into deep soft tissue or approaching the alar rim may lead to alar collapse, resulting in a functional as well as a cosmetic deficit.[71,76] Deep sidewall defects may at times involve loss of the lower lateral cartilage, thereby similarly producing nasal valve obstruction, which becomes noticeable with inspiration and resolves on expiration. Loss of cartilage at the distal nasal tip also necessitates replacement of structural support for optimal functional and cosmetic results.[73-75] Last, delayed nasal valve obstruction can occur if unresisted scar contracture collapses the remaining cartilaginous structure of the nasal vault. Replacement of lost cartilage at the time of reconstruction can avert these potential problems.[21,63]

The techniques for alar cartilage grafting have been well described.[63,71,76,77] Free cartilage grafts used for nasal sidewall and tip reconstruction are harvested in much the same way as cartilage grafts for alar reconstruction.[63] Sidewall grafts tend to be wider and broader than alar grafts, since they must brace a broader surface area against the forces of inspiration. Cartilage grafts may also be used as braces along the rim of the ear to minimize the risk of contracture, and may be used in the conchal bowl to facilitate hearing aid placement.[63]

Donor sites for free cartilage grafts include the conchal bowl, the helix, the antihelix, nasal septum, and ribs.[63] Since conchal cartilage is elastic, has a high degree of memory, and has varied contours that can be matched to the desired nasal contour, the conchal bowl is frequently used by dermatologic surgeons.[66,71,77] Although an anterior approach may be used, the posterior approach results in better camouflage of the donor site scar and preservation of the shape of the ear. After scalpel incision of the conchal bowl, the skin overlying the cartilage is undermined to expose the

perichondrial surface. The desired length of cartilage is incised with a scalpel, and a second incision is made parallel to the first to create a strip that is 3 to 6 mm in width, depending on the desired thickness of the graft. Alternatively, a larger disk or oblong shaped piece may be harvested. The cartilage and its overlying perichondrium easily separate from the anterior skin with scissor dissection. The graft is placed in a sterile moist environment while the donor site is reapproximated with nonabsorbable sutures.

The cartilage graft may be secured by several different techniques. If a narrow strip is to be used, the soft tissue of the recipient bed is undermined medially and laterally, and the ends of the graft inserted such that the graft interlocks with its recipient bed. The graft may be sutured to the underlying dermis with one or two absorbable sutures for additional security. A disk or oblong shaped cartilage also requires suturing for secure placement. Alternatively, multiple cartilaginous strips can be aligned parallel with one another and secured with sutures to brace the side of the nose against collapse. After the cartilaginous framework is in place, a flap or FTSG may be performed to cover the remaining cutaneous defect.

If conchal cartilage is used to repair a large auricular defect, the cartilage graft should match the defect as closely as possible in size, shape, and thickness.[63] Harvesting and placing a narrow strip of cartilage matching the helical defect alone may result in rim collapse under the forces of wound contraction. If necessary, partial wedge closure of the defect may be performed prior to graft placement to decrease the portion of the defect requiring replacement of structural support. The cartilage graft is secured by sewing it to the intact cartilaginous framework with 6-0 absorbable or nonabsorbable sutures, and is then generally covered with a pedicled retroauricular flap.

Postoperative complications following free cartilage grafting are rare. Regardless of the site of grafting, care must be taken postoperatively to minimize graft movement. There is a risk of infection at the donor site, particularly with gram negative bacteria. Appropriate cultures of any exudate should be obtained if infection is suspected. Empiric therapy with quinolone antibiotics should be initiated, and modified as sensitivities dictate. Postoperative tenderness, swelling, and erythema may herald chondritis, which should be treated with cool compresses and nonsteroidal inflammatory agents for several weeks or even months postoperatively. Later complications may include graft resorption, displacement or deformation, and extrusion. Surgical revision may be required if these complications occur. Recipient sites may be subject to trauma and are therefore at risk for graft displacement and resorption. Every effort should therefore be made to utilize cartilage grafts of sufficient thickness and stiffness to resist the forces of trauma and wound contracture, and to anchor the grafts so as to maximize their stability.

CONCLUSIONS

Knowledge of the indications, techniques, donor site considerations, and complications of all types of skin grafting is invaluable for the dermatologic surgeon who performs soft tissue reconstruction on a regular basis. As the incidence of skin cancer continues to rise, increasing numbers of patients are likely to require reconstructive procedures to repair their defects. With proper defect assessment, reconstructive planning, and attention to detail pre-, intra-, and postoperatively, optimal cosmetic and functional results using skin grafting techniques can be achieved.

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