SKIN GRAFT TECHNIQUES

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The role of skin grafting in lower extremity surgery is gaining in importance. The dilemma of inadequate skin for wound coverage has always been a challenge. The indications and contraindications for grafting are numerous and only the skill and ingenuity of the surgeon are limiting factors. Concepts of skin grafting and the fundamental techniques necessary for success will be reviewed.

Skin Anatomy

The epidermis represents approximately 5% of total skin thickness whereas the dermis occupies nearly 95%. The sebaceous glands actually lie within the dermis. However, the hair follicles and glandular components of the sweat glands lie within the superficial layer of the subcutaneous tissue. Circulation is supplied to the skin by blood vessels running parallel to the skin just above the superficial fascia. Branches from these vessels divide at right angles into the subcutaneous tissue below and the dermis above. Dermal branches continue to divide superficially ending in capillary tufts between the dermal papillae. Accordingly, as the skin becomes thinner a greater number of blood vessels will be cut during incision.

Classification

Split thickness grafts include the epidermis as well as varying amounts of dermis. The epidermis plus the thickness of the dermal layer divides the graft into the following types:

Thin:	.008-.011 inch
Intermediate:	.012-.014 inch
Thick:	.015-.024 inch

Skin thickness varies depending on anatomic location. Thus an intermediate split thickness graft from the lateral thigh, where the skin is thick, may be full thickness where the skin is thinner, such as the medial thigh.

A full thickness graft includes the epidermis as well as the entire dermis. No element of subcutaneous fat should exist on the graft since this acts as a "vascular parasite" and a barrier for ingrowth of new vessels.

Graft Physiology

Three definite stages exist during the take of a graft.

1. Plasmatic Stage

For the first 24 to 48 hours the graft is adhered to the recipient bed by a fibrin layer which forms immediately after graft placement. The nutritional requirements of the graft during this period are supplied by plasma transported to the graft from the recipient bed by capillary action.

2. Inosculation

At the end of 48 hours a fine vascular network is produced by capillary budding from the recipient bed blood vessels. These capillaries will then connect with vessels in the graft restoring blood flow. The graft will obtain a pink hue at this stage.

3. Capillary Ingrowth

During and after inosculation, capillaries from the recipient bed will actually penetrate into the graft, establishing a vascular network. Controversy exists concerning this stage. However, firm venous, arterial, and lymphatic channels do result. Sympathetic nerve supply does not exist until much later in the maturation process.

Indications

The most common application for skin grafts are skin ulcerations, burns, and wound dehiscence. Other indications include: biological dressings, traumatic loss of tissue, i.e., digital amputation, and surgical excision of neoplasms.

Contraindications

Sufficient vascularity is necessary for graft take. Accordingly, a graft will not survive on poorly vascularized tissue such as bare tendon, bone, or cartilage. However, it should be understood a graft will take when placed on periosteum covered bone, paratenon covered tendon, or pericondrium covered cartilage.

The concept of bridging, however, will allow for coverage of small non-vascularized areas. Although vascular supply of the graft is primarily supplied by capillary ingrowth from the recipient bed some capillary penetration occurs from the host sides. This phenomenon will occur where there is satisfactory approximation of the graft edge and adjacent normal skin margin. Up to 5 mm of capillary ingrowth can be ideally expected from each side. If surrounding vascularity is ideal, an approximately 1 cm in diameter graft may survive if placed over an avascular area.

Split thickness grafts should not be used over areas of chronic pressure due to their thinness and lack of subcutaneous padding. Generally, one should not consider the plantar aspect of the foot and the anterior tibial prominence as appropriate recipient sites. However, Wolering and associates documented the successful use of split thickness skin on the plantar aspect of the foot after wide incision of skin neoplasms.

Recipient Bed Preparation

All efforts must be made to remove necrotic tissue, chronic, infected granulation tissue, and fibrotic tissue from the wound. Without sufficient vascularity graft failure is predictable. Surgical debridement of all necrotic tissue is recommended where extensive preparation is necessary. Small amounts of non-viable tissue may be sharply debrided with a scissors or scalpel at bedside under sterile conditions. Extensive amounts of secondarily infected granulation tissue may be avulsed in the operating room with the back end of a knife blade or a tongue depressor blade.

Daily wound care is performed most successfully with either wet to dry dressings or NU-gauze packing material to promote mechanical debridement.

A preferred wet to dry dressing involves eight to twelve layers of gauze placed directly on the wound and moistened with normal saline. The dressing is allowed to dry by evaporation usually taking approximately four hours. The dressing is changed every four hours and then removed dry carrying necrotic tissue with it. One must remove the dressing dry and resist the temptation of wetting the gauze so as to ease removal.

Absolute hemostasis is essential. Hematoma and seroma will separate the graft from the vascular structures of the bed. If hemostasis cannot be obtained after surgical debridement, a compressive dressing should be applied for 48 to 72 hours followed by delayed graft placement.

Donor Site

Cosmetic as well as functional needs must be considered in the selection of the donor graft site. The buttocks as well as the lateral thigh above the bikini line make excellent donor sites for lower extremity recipient regions.

Harvest Techniques: Donor Site

A variety of methods have been described over the decades including the pinch graft, razor blade, and Humby knife grafts. The above methods are technically difficult and usually produce a graft of variable thickness.

The development of the dermatome enabled the taking of a uniform, split thickness graft without extensive experience. Variations include the Padgett-Hood, Reese and Brown modifications. Earlier types were electrical powered whereas most modern dermatomes are gas driven allowing a faster, more uniform graft. Technical pearls of dermatome use involve even, uniform pressure, proper lubrication of skin surface with mineral oil, and appropriate skin tension.

Meshing of the graft may be performed either with manual "pie-crusting" of the graft surface or by using a commercial mesh device which creates numerous, uniformally scattered perforations in the graft. Advantages of the commercial device include stretching of available graft tissue for coverage of large defects as well as decreased seroma and hematoma formation." Pie-cresting" yields little advantage as no increase in size is obtained and scattered perforations epithelize too rapidly to allow drainage of hematoma or seroma. A poor cosmetic result is produced by commercial meshers and one should avoid their use for other than life threatening situations.

Donor Site Care

The donor site heals by epithelization from the epithelial linings of the ducts of sweat glands, sebaceous glands, and hair follicles as well as bordering skin margins. Promotion of wound epithelization is the goal of donor site care. Absolute avoidance of infection is necessary as a once partial thickness skin loss may progress to full thickness loss. Initially the wound should not be disturbed to promote epithelization.

A petrolatum gauze or Xeroform dressing should be placed directly against the wound followed by layers of gauze sponges or abdominal pads. Even compression should be applied to assist hemostasis of the wound. The dressing should be left undisturbed for approximately seven to ten days since earlier dressing changes may disrupt epithelization. Once complete epithelization has

occurred, a dressing is no longer necessary.

Graft Application

Prior to application, the graft should be maintained moist with saline and spread on a curved surface (basin bottom) to prevent raveling. Since the graft material may be difficult to control, a saline soaked gauze can be placed on the exterior surface of the graft to establish a temporary backing and thus make handling easier.

The traditional dressing is the tie-over or stent dressing and is the author's procedure of choice. A stent dressing involves the possible use of a variety of soft dressing materials, i.e., gauze, dry or wet cotton balls, or foam. In our experience, neomycin ointment impregnated cotton balls are the favored material since there is little adherence to the graft's surface. Once the graft is sutured in place, the sutures are left long and tied over the stent material to apply an even compressive force.

A graft will take without suturing to the recipient bed. In many cases where a pressure dressing can be applied, an adequate take can be expected. However, since movement of the graft is detrimental to its success most surgeons choose to suture it in place. Interrupted sutures are desirable as they may be utilized for stent dressing application. The suture needle should be passed from the graft to the recipient bed to avoid continually disrupting the fibrin layer between graft and bed edge. Additionally, the recipient bed margin gives a firm layer to suture into versus the unstable graft border.

Graft Failure

Movement of the graft on its recipient bed will result in disruption of the fibrin clot necessary to allow a successful plasmatic stage. Thus inosculation and capillary ingrowth will be diminished.

Hematoma and seroma act to decrease the growth of ingrowing vessels as well as lift the graft from its recipient bed. A graft may survive 24 to 48 hours from the plasma of the hematoma, however, capillary ingrowth is essential to survival.

Obviously infection will result in graft failure. Purulent exudate acts in a similar fashion to hematoma by lifting the graft away from the recipient bed. Furthermore, proteolytic enzymes of various bacteria can easily digest the fragile graft tissue.

Postoperative Care

Since the primary source of graft failure is seroma and hematoma, it is essential to closely observe the graft postoperatively. Because a graft with hematoma formation may still be salvaged at 48 to 72 hours postoperatively, it is critical for inspection to occur no later than 72 hours to allow evacuation of a hematoma. Fluid collections may be removed from beneath the graft either by direct needle aspiration or by a fish-mouth incision directly over the hematoma. Even pressure may then be applied to the graft by rolling a cotton applicator tip over the graft to assist either needle aspiration or drainage from an incision site.

The extremity must be completely immobilized to avoid graft movement. This may be accomplished by sandbagging the involved limb for the first 48 to 72 hours postoperatively. Proper identification of the graft site should be labelled on the dressing to alert nursing personnel. A Jones compression dressing affords excellent compression as well as immobilization properties.

Of prime importance concerning postoperative care is the maintenance of compression on the graft until its maturation is complete. Since the ingrowth of sympathetic nerve supply is slower than the ingrowth of new capillaries, there is total absence of sympathetic vascular tone. When the extremity becomes dependent these vessels will dilate rapidly due to hydrostatic pressure resulting in graft cyanosis and congestion. Graft failure may occur as late as two to three weeks after a total take. Since a graft does not mature for two to three months postoperatively an elastic compressive stocking should be dispensed to maintain compression at the graft site.

Summary

The essentials of split thickness graft use, operative technique, and management have been presented. Split thickness skin grafting offers the podiatric surgeon an alternative source for wound coverage. The precise nature of graft technique and management should be appreciated to ensure a satisfactory result.

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