Skin Grafting Basics

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1. Introduction
Skin grafting is generally reserved for wounds that have a very large skin defect that would not heal functionally or cosmetically with standard wound therapy intervention. Skin grafts not only cover granulation tissue and result in a more cosmetic end result, but they also have been shown to encourage wound contraction and epithelialization while decreasing exuberant granulation tissue. Skin grafting in itself is not a difficult procedure. Most of the effort involves appropriate preparation of the wound bed and skin graft prior to placement and effective immobilization of the grafted area after skin graft placement. The wounds should be treated with moist wound healing concepts to prepare the wound bed to receive the skin graft (see the presentation on wound care dressings). The most common circumstances that will lead to failure in skin grafting are infection, poor granulation tissue, and excess movement at the graft site. Consequently, the wound bed must be free of infection and have a healthy granulation tissue bed prior to grafting. If a previous graft has failed, quantitative bacterial analysis should be performed prior to placing a second graft. If the wound is over a site of excess movement, some type of wound immobilization, such as splinting or casting, should be performed. Regardless of the location of the wound, it is recommended to leave the original dressing in place for 7 days prior to changing. This will reduce the chance of dislodging the grafts. There are three main types of skin grafts used in the horse: autografts, allografts, and xenografts. Autografts come from the same animals, allografts are from the same species, and xenografts are from other species. Xenografts, such as porcine skin and fish skin, are not really integrated into the host animal; they are really just used as biological bandages.

2. Healing Stages of Skin Grafts
The healing stages of skin grafts are generally broken into four major categories: adherence, plasmic imbibition, revascularization, and final organization. Adherence occurs on day 1 before any other healing stages can occur. This is generally created by fibrin between the graft and the wound bed. Movement at this stage will often lead to graft failure. Plasmatic imbibition occurs from days 1 to 4 where nutrition for the graft comes from the fibrin clot around the graft. Cyanosis of the grafted tissue is expected during this phase. Revascularization occurs between days 3 and 7. There are at least three different methods for revascularization. Inosculation occurs when vessels in the graft anastomose with vessels in the recipient bed and is the most rapid method of revascularization. Capillary buds can penetrate from the recipient bed into the graft vessels, using them as a conduit to revascularize the graft. Capillary buds may penetrate the graft in areas other than old vessels to revascularize the graft. This is the slowest method.
of revascularization since the growth rate of capillary buds is approximately 1 mm/day. The greater the distance between the graft and the recipient bed, the more likely that capillary buds will have to form an entirely new vascular network and the greater likelihood of graft failure. The final stage of healing is organization where fibrous tissue replaces the fibrin of the original clot to hold the graft permanently in place. Fibroblasts are responsible for laying down the collagen during organization. The collagen fibers and neovascularization provide a firm attachment of the graft to the recipient bed within 9 days of grafting.  

3. **Graft Thickness**

Full-thickness grafts are composed of both the dermis and epidermis. Partial-thickness grafts are composed of the epidermis and part of the dermis. Both full-thickness and partial-thickness grafts can be used in horses. Full-thickness grafts tend to give more cosmetic end results because they have all of the adnexal structures such as hair follicles and skin glands. However, they are more difficult to apply successfully because they are thicker and take longer to vascularize. Partial-thickness grafts tend to have a better success rate but have a less cosmetic end result. When choosing the donor site, it is best to select a site that will not leave a significant cosmetic blemish. Either the side of the neck under the mane or the ventral abdomen or pectoral region where there is redundant skin are the common sites. A secondary consideration is the hair color.  

4. **Graft Types/Techniques**

Grafts can either be harvested manually or by using motorized equipment. Most practitioners will harvest using manual techniques. The benefit of even graft thickness when using motorized equipment is often outweighed by the cost of motorized equipment. No matter the method, the grafted tissue must have adequate capillary exposure by keeping the graft in close approximation to the granulation bed to allow in-growth of blood vessels. The recipient bed must have adequate capillary supply, and the practitioner must provide protection from mechanical disruption, hematoma formation, and infection. Skin grafting can be performed using many different techniques. The techniques will be listed in order of easiest to most complex.  

Pinch Grafting

Pinch grafting requires the least amount of equipment of the listed techniques. The grafting can be performed with a number 12 scalpel blade, a thumb forceps, and a mayo scissors. The skin is tented with the thumb forceps and cut off with the scalpel blade. The grafts should be no larger than 8 to 10 mm in diameter. The subcutaneous tissue is removed with scissors. Pockets, approximately 1 cm apart, are made in the granulation tissue with the scalpel blade, and the grafts are placed into the shallow pockets. The graft site is dressed with a nonadherent dressing or petrolatum impregnated dressings and a pressure bandage applied. This technique can be performed in the standing horse.  

Punch Grafting

Punch grafting requires similar instrumentation as does the pinch grafting as well as 6-mm and 8-mm skin punches. The 8-mm punch is used at the donor site to cut through the epidermis and dermis. The subcutaneous tissue is trimmed from the graft and the graft placed on saline-soaked gauze. It is best to maintain normal orientation of the hair on the grafts for the most normal cosmetic result at the wound site. The 6-mm punch is used at the wound site to remove a granulation tissue plug. The granulation tissue plugs are removed, cleaned of blood, and filled with skin. The graft site is dressed with a nonadherent dressing or petrolatum impregnated dressings and a pressure bandage applied. This technique can be performed in the standing horse.  

Tunnel Grafting

Tunnel grafting requires removing long narrow strips of skin from the donor site. A long forceps is tunneled under the granulation tissue and used to grasp the skin graft. The skin is pulled (taking care to maintain normal orientation) through the granulation tissue, and the ends are sutured to the surrounding skin. The wound is dressed as described above. Approximately 6 to 10 days later, the granulation tissue is surgically removed over the skin grafts. More skin is placed into the wound than with pinch or punch grafts, but less specialized equipment is necessary when compared to sheet grafting. This technique generally requires general anesthesia.  

Sheet Grafting

Full-thickness sheet grafting will generally give the best cosmetic result. However, it requires the most specialized equipment and has the greatest chance for failure. The biggest reason for failure is movement of the graft over the wound bed inhibiting the ingrowth of capillaries. One way to reduce the problems with graft movement is to “mesh” the graft. Graft meshing is beneficial for two main reasons. It allows evacuation of exudate from between the graft and the wound bed, and it allows coverage of a larger area without having to remove as large of a graft from the donor site. Sheet grafting is best performed with a dermatome that will remove a similar-thickness sheet from the donor site. The dermatome can be set to remove a partial-thickness or a full-thickness graft. The harvested graft can then be placed through a mesher to “mesh” the graft for
the reasons previously described. The graft is sutured into place around the periphery of the wound and then dressed as previously described. This technique requires general anesthesia. “MEEK” micrografting, which uses multiple small island grafts “glued” to an occlusive dressing, looks especially promising.

Pedicle Grafting
Pedicle grafting requires that there is enough skin close to the wound defect to be able to rotate skin into the area while still leaving at least some vascular supply intact. In most cases, this technique is used in the head region of horses, especially to cover fistulas over the maxillary sinus. The donor site may have to be left open to heal by second intention. The distal limbs do not have enough extra skin in most cases to rotate tissue. This technique requires general anesthesia.

5. Conclusion
Skin grafting can be a relatively simple technique for the equine practitioner to perform. The cosmetic end result is often superior to second intention healing. Care must be taken to minimize movement and bacterial numbers to provide the most successful results.

Acknowledgments

Declaration of Ethics
The Author has adhered to the Principles of Veterinary Medical Ethics of the AVMA.

Conflict of Interest
The Author has written a wound care book but has no conflict of interest with any manufacturers.

References and Footnote

*Sylastin, Kendall/Covidien, Mansfield, MA 02048.

Suggested Reading