How I Perform an Island (Punch/Pinch) Skin Graft

P.O. Eric Mueller, DVM, PhD, DACVS

Free island skin grafts such as a punch or pinch graft can be easily performed in the field and are a helpful adjunct therapy to facilitate wound closure in the distal limb of horses. Case selection, preparation of the graft bed, meticulous technique, and perioperative care will greatly enhance successful graft acceptance. Author’s address: University of Georgia, College of Veterinary Medicine, Athens, GA 30602-7385; e-mail: emueller@uga.edu. © 2015 AAEP.

1. Introduction

A free skin graft is a section(s) of skin that has been completely detached from its vascular supply and relocated to a distant site. The graft must establish a new vascular connection to the recipient wound bed to survive. Skin grafts are also classified according to the source of origination. An autograph or isograph is a graft that is relocated from one area to a distant site on the same animal. Due to the minimal immune response induced by the host, this is the graft type most commonly performed in horses. An allograft is transferred between two animals of the same species, and a xenograft is transferred between members of different species.

The use of island skin grafts in horses should be considered for full-thickness wounds that cannot be closed primarily or heal by epithelialization and contraction. In horses, these wounds typically occur at or distal to the tarsus and carpus. These areas have a paucity of soft tissues and the wounds are subject to extreme tension and movement. It is important to communicate to the horse owner that the primary purpose of skin grafting of the distal limb is to increase the available surface area of epidermis from which epithelialization can proceed, thereby decreasing the time to complete epithelialization and wound closure, not necessarily to significantly improve the end cosmetic appearance of the wound. Improper graft bed or donor skin preparation, hemorrhage, infection, and movement are the most common causes of graft failure, regardless of the type of graft performed. Two types of free skin grafts that are commonly performed in standing horses are the punch graft and the pinch graft. With both techniques, careful case selection, meticulous preparation of the graft bed and surgical technique, and proper perioperative care are imperative to optimize graft acceptance and outcome.

Graft Acceptance

To maximize the acceptance of a graft, the wound bed must be well vascularized and free of infection. Although fresh wounds can successfully receive graft, the severe degree of trauma and contamination that accompany the majority of distal limb wounds in horses precludes them from being good candidates for grafting. Therefore, it is much more commonplace to graft a wound later in the healing process, after an established bed of healthy granulation tissue has formed.

Initial adherence of the graft to the recipient wound bed occurs through formation of a thin fibrin clot. Vessels and fibroblasts from the wound bed...
invade the fibrin clot within 48 to 72 hours, with the graft firmly adhered to the recipient wound bed by the tenth day after grafting. For the first 48 hours the graft is nourished by plasmatic imbibition, during which small vessels in the graft passively absorb plasma via capillary action. The graft has no inherent circulation during this period and becomes edematous. After 48 hours new capillaries in the center of the wound form and extend into the graft, anastomosing with existing capillaries in the graft. This process is called inosculation. During this time, additional new capillaries from the recipient site penetrate the graft and establish new microvasculature, a process called neovascularization. Effective revascularization and lymphatic flow occurs by the fifth day after grafting, leading to resolution of the edema. The epidermis of the graft becomes hyperplastic and often dies shortly after grafting, leaving exposed pale-pink dermis on the wound surface. These dermal tissue plugs resemble granulation tissue but may be differentiated by their pale-pink color as compared with the deeper, darker red color of granulation tissue. Epithelial cells migrate from the hair follicles and sweat glands within the dermis and soon cover the entire wound. Pigmentation of the graft site becomes evident approximately 4 weeks after grafting, with the appearance of hair 4 to 6 weeks after grafting.

Causes of Graft Failure
The most common causes of graft failure are infection, fluid accumulation under the graft, and motion. Granulation tissue is inherently resistant to infection because of its abundant blood supply and high population of phagocytic cells. However, when the concentration of bacteria within the granulation tissue exceeds innate humoral and cellular defense mechanisms, the result is a localized infection. Although various types of bacteria may cause an infection, \( \beta \)-hemolytic *Streptococcus* sp. are a particular common and virulent isolate. \( \beta \)-hemolytic *Streptococcus* organisms produce proteolytic enzymes that degrade the early fibrinous attachment of the graft to the recipient bed, thereby preventing early adherence and subsequent inosculation. This results in early graft failure. Clinical signs associated with \( \beta \)-hemolytic *Streptococcus* sp. infection include a glossy, friable appearance of the granulation wound bed, a wound surface that bleeds easily with minimal manipulation, and in more advanced stages, suppurative exudate. Although the gold standard for diagnosing infection in chronic wounds is a quantitative tissue biopsy with greater than \( 10^5 \) cfu per gram of tissue of any organism, \( \beta \)-hemolytic *Streptococci* sp. are the exception, with any level of the organism indicating infection.

Fluid accumulation in the form of hemorrhage, serum, persistent inflammatory exudate, or excessive and prolonged edema prevents graft adherence and vascularization by physically separating the graft from the recipient wound bed. Minimizing inflammation, controlling hemorrhage, and firmly compressing the graft to the recipient bed with a bandage will help minimized excessive fluid accumulation. As opposed to full-thickness sheet grafts, island grafts such as punch or pinch grafts allow excessive fluid to escape from the wound surface between the individual grafts, and therefore are less susceptible to failure secondary to fluid accumulation.

Excessive motion at the graft site is another cause of graft failure. Movement leads to shear forces at the graft-recipient wound interface, causing disruption of the fibrin seal and new vessel anastomoses and growth, interfering with the vital processes of plasmatic imbibition, inosculation, and neovascularization. This is of particular concern on wounds over high-motion areas such as the fetlock and tarsal joints. When grafting over high-motion areas it is optimal to immobilize the graft site with a half-limb or tube cast.

2. Materials and Methods

Case Selection/Preparation of the Graft Bed
In horses, skin grafts are most commonly utilized in chronic, slow-healing wounds of the dorsal distal limb. It is important that the granulation tissue recipient bed stays well vascularized and free of infection. If there is evidence of persistent inflammation, exudate, or a draining tract, it is imperative that the wound be thoroughly evaluated to rule out the presence of an underlying sequestrum or foreign body. Radiographic evaluation of the underlying osseous structures or ultrasound examination may be necessary to fully assess the suitability of the wound for grafting. Wounds that appear grossly abnormal or proliferative should be biopsied and examined histologically for the presence of cutaneous neoplasia such as equine sarcoid or squamous cell carcinoma. Healthy, vascular, granulation tissue should be uniform, smooth, deep red in color and free of exudate. More chronic, fibrous granulation tissue has a pale pink to gray appearance, representing the fibrous nature of the tissue and is not a suitable graft bed without additional preparation.

Once the recipient wound bed is deemed ready for grafting (healthy, adequate vascularity and free of infection), it should be lightly debrided with a scalpel blade or non-guarded disposable facial razor to a level just below the skin edge. This is performed approximately 36 to 48 hours before performing the grafting procedure. The sharp debridement serves two primary purposes: 1) removing surface contamination and resident bacteria, and 2) stimulates and provides time for new capillary growth to develop in the recipient bed. Fresh debridement of the wound bed can reduce the time from initial grafting to inosculation (plasmatic imbibition phase) from 48 to 24 hours. Following the debridement, a sterile, nonadherent, semi-occlusive pressure ban-
Dagea is applied to the wound to promote hemostasis and protect the wound bed. The bandage is changed daily until grafting. The author often applies Dakin’s solution (0.5% dilute sodium hypochlorite solution), a topical antiseptic to the recipient wound bed for 1 to 2 days prior to grafting. This solution is relatively safe for living tissues, reported to hasten the separation of dead cells from living tissue, and is effective in the presence of blood and serum. The solution can be applied directly to the wound bed, or applied to a sterile non-adherent dressing incorporated directly on the wound during bandaging.

Grafting Technique

Both the punch and pinch graft can be performed in the standing sedated horse. Horses should be up to date on tetanus prophylaxis. Preoperative procaine penicillin G (22,000 IU/kg, every 12 h, IM) and phenylbutazone (2.2–4.4 mg/kg, every 12 h) is administered for 24 to 48 hours. Horses are most often sedated with detomidine hydrochlorideb (0.01–0.02 mg/kg IV) and butorphanol taratec (0.01–0.02 mg/kg IV). The donor site is clipped and both the donor site and the graft wound bed are surgically prepared. The donor site is desensitized with 2% lidocaine hydrochloride, usually in an inverted “U” block so as not to directly infiltrate the skin that will be incorporated in the graft. The common donor sites for directly obtaining punch grafts from the horse are the ventrolateral abdomen, perineum, or portion of the neck that is concealed by the mane. Alternatively, an elliptical, 10-cm long × 4-cm wide full-thickness sheet of skin may be harvested from the cranial-pectoral area. The segment of skin is stretched and secured epidermal side down to a sterile piece of styrofoam or polypropylene block. The subcutaneous tissues are sharply excised away from the graft and the punch grafts obtained from the stretched sheet of skin.

Punch Grafts

Punch grafts are small, full-thickness plugs of skin that are harvested and implanted into the granulation wound bed using commercially available skin biopsy punches. The recipient sites in the granulation wound bed are created first to allow time for hemostasis prior to implantation. Because the skin graft plugs will undergo contraction after they are harvested, the biopsy punch used to make the recipient holes should be slightly smaller that the punch used to harvest the grafts. The author prefers to use a 5-mm punch to create the recipient holes and a 7-mm punch to harvest the donor grafts. It also is important to work from distal to proximal so that hemorrhage from creation of the recipient holes will not impair visualization of the wound bed. Starting at the most distal aspect of the granulation bed, recipient holes are made approximately 5 to 7 mm apart and 5 to 7 mm deep in a symmetrical pattern. A common mistake is to make the recipient holes too deep, in which case exuberant granulation tissue will cover the grafts and impede epithelialization. A single horizontal row of recipient holes are created, then each site is filled with a broken-off cotton-tipped swab to help control hemostasis (Fig. 1). This process is continued until all the recipient holes have been created. The cotton-tipped swabs are left in place until they are replaced with a graft plug.

The donor punches are either removed directly from the horse (Fig. 2) or from a sheet of skin removed from the cranial pectoral area using a 7-mm biopsy punch (Fig. 3). Removing the graft leaves a small circular defect at the excision site, so they should be harvested in a symmetrical pattern, approximately 1 cm apart to optimize cosmetic appearance. The grafts are harvested, the fascia and subcutaneous fat sharply excised from the dermal side of the plugs to facilitate plasmatic imbibition and revascularization, and then placed on sterile, saline-soaked gauze until they are placed in the recipient holes. The cotton-tipped applicator is removed, and the graft placed into the recipient hole. It is impractical and of little importance to attempt to line up the direction of the hair follicles of each plug given that the wound will heal primarily by epithelialization with minimal hair growth. After all the graft plugs are inserted (Fig. 4), the wound is covered with a nonadherent
dressing and pressure bandage. The author leaves the initial bandage in place for 4 to 5 days to allow for undisturbed adherence and revascularization during the plasmatic imbibition, inosculuation, and neovascularization phases. If the site is over a highly mobile area such as a joint, a cast or cast bandage should be utilized for 2 to 3 weeks to immobilize the area and optimize graft adherence. The cast can be bi-valved to allow access to the wound for bandage changes (Fig. 5).

The donor sites can either be closed with a single suture, staples, or left to heal by second intention. When a sheet of skin is removed from the cranial pectoral region en bloc, the incision should be sutured closed with an appositional or sometimes a tension-relieving pattern.
Pinch Graft

Pinch grafting is performed in a similar manner as punch grafting; however, instead of harvesting the plugs of skin, small 3–5-mm cones of skin are elevated with a curved cutting suture needle or a sterile 18 g hypodermic needle with the point bent 90°, and sharply excised with a scalpel. The grafts are placed on saline-soaked gauze sponges until implantation. The horse, donor site, and recipient bed are prepared as for punch grafting. A No. 15 scalpel blade is then used to create small pockets in the granulation recipient bed, in a symmetrical pattern to receive the grafts. It is important to work from distal to proximal so that hemorrhage from creation of the recipient pockets does not impair visualization of the wound bed. Starting at the most distal aspect of the granulation bed, recipient pockets are made approximately 5 to 7 mm apart and 5 to 7 mm deep in a symmetrical pattern. The scalpel blade is introduced at an approximately 45° angle, in a proximal-to-distal direction (Fig. 6). With the pinch technique, hemorrhage from the graft bed is difficult to control and the recipient sites difficult to identify soon after the recipient pockets are created. Therefore, the pinch grafts are immediately placed into their respective recipient pockets one by one as they are created. After all the pinch grafts have been inserted, the wound is covered with a nonadherent dressing\textsuperscript{a} and pressure bandage. If the site is over a highly mobile area such as a joint, a cast or cast bandage should be utilized for 2 to 3 weeks to immobilize the area and optimize graft adherence. Perioperative care is identical to that of punch grafting.

Both punch and pinch grafts are relatively easy to perform, economical, and can be performed on a standing, sedated horse. Each graft is independent of the others, and failure of one graft does not adversely affect the remaining grafts. Pinch grafting can be more tedious to perform and often results in an inferior cosmetic appearance compared with punch grafting; therefore, punch grafting is the method most often preferred by the author.

---

Fig. 5. Photograph demonstrating the use of a cast saw to bi-valve a half-limb cast-bandage. This allows removal of the underlying bandage and evaluation of the graft site. The bi-valved cast can then be reapplied over the new bandage and secured in place with inelastic tape, allowing continued immobilization of the graft site without the need to apply an entirely new cast.

Fig. 6. Photograph demonstrating the creation of recipient graft pockets in the wound bed using a #15 scalpel blade. Stab incisions are made at a 45° angle in a proximal-to-distal direction.
3. Results

With both techniques, 60 to 75% of the grafts can be expected to take (survive). The superficial, pigmented, epidermal portion of the grafts will usually slough within the first 1 to 2 weeks after grafting, exposing the pale underlying dermis and making it difficult to distinguish between the graft plugs and the surrounding granulation tissue. This should not be misinterpreted for graft failure. By 3 weeks the grafts become more readily apparent with pink rims of epithelium migrating centrifugally from the grafts (Fig. 7). Epithelial migration from the wound periphery and circumferentially from each graft coalesces to cover the entire recipient bed with epithelium. The wounds heal primarily with an epithelial scar with variable amounts of pigment and hair as the scar matures. The time required for the wound to become completely covered with epithelium is inversely related to the number of grafts placed within the recipient bed. As a rough guide, epithelialization of the distal limb usually progresses at a rate of 0.09 mm per day.4

It is important to note that because the initial epithelium layer covering of the wound is thin and extremely friable, the horse should be restricted to stall or small paddock confinement for an additional 4 to 6 weeks after the wound has healed to allow for maturation and thickening of the epithelial scar. Premature return to unrestricted turnout or athletic activity is a common cause for complete disruption of the epithelial scar, especially when located over high-motion areas, such as the fetlock, carpus, or hock joints.

4. Discussion

The use of island skin grafts in horses should be considered for full-thickness wounds that cannot be closed primarily or heal by epithelialization and contraction. There are several advantages of punch/pinch grafting. They are relatively easy to perform; can be performed in the standing sedated horse; and are economic alternatives to more expensive sheet grafting techniques. Additionally, each graft heals independently of one another and thus 100% graft acceptance rate is not necessary to effectively enhance the healing of the wound.4 It is important to communicate to the horse owner that the primary purpose of skin grafting is to decrease the time required for complete epithelialization and wound healing, not to significantly improve the end cosmetic appearance of the wound. The veterinarian must emphasize to the horse owner that the wound will heal with an epithelial scar and variable amounts of pigmented epithelium and hair.

Although the grafting techniques are relatively straightforward, improper graft bed or donor skin preparation, hemorrhage, infection, and movement can result in graft failure. With both punch and pinch grafting techniques, careful case selection, meticulous preparation of the graft bed and surgical technique, and proper perioperative care are imperative to optimize graft acceptance and outcome.

Acknowledgments

Declaration of Ethics

The Author declares that he has adhered to the Principles of Veterinary Medical Ethics of the AVMA.

Conflict of Interest

The Author declares no conflicts of interest.

References and Footnotes


"Telfa Pad, Covidien, Minneapolis, MN 55432.
"Dormosedan, Zoetis, Florham Park, NJ 07932.
"Torbugesic, Zoetis, Florham Park, NJ 07932.
"2-0 Prolene, Ethicon, Somerville, NJ 08876.