

PEER-REVIEWED

Managing degloving injuries of equine limbs

Because limb injuries in horses have several unique aspects, treatment is varied and sometimes involved. Here are the different methods for successfully treating degloving injuries.

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MANAGING a degloving injury of a horse's limb can be a diagnostic and therapeutic challenge. There is minimal soft tissue to protect the joints, tendons, vessels, and bone, so a careful workup is needed to detect injury to these structures. Undermined skin may hide an open joint, or crushing trauma may cause thrombosed vessels or tendon damage that is not readily apparent. Also, the lack of freely mobile skin makes defects more difficult to treat. Moreover, extended recovery periods and complications are often encountered with these injuries. This article tells you how to assess and treat various types of degloving injuries in horses and describes common complications.

Obtaining the history and evaluating the wound

Most degloving injuries result from an avulsion injury, where skin is removed from a limb as a glove is removed from a hand. These injuries can result from a wire fence or entrapment between solid objects. Because of the horse's nature and environment, most of these injuries involve the hindlimb.¹ These wounds are associated with a great degree of soft tissue injury and infection.^{2,3} Susceptibility to infection is enhanced by tissue deficits, skin flaps

with poor vascular supply, fecal or soil contamination, and inadequate early wound management.^{2,4,5} For this reason, when obtaining the history, determine what previous therapy may have been administered, as well as the cause and time of injury.

Digital exploration of the laceration will provide information regarding the extent of the injury and the structures involved. But be careful to avoid further wound contamination. Before clipping the area, apply a sterile water-soluble lubricant to the wound to prevent hair contamination. Then clip and surgically scrub the area around the wound. Use swabs to collect samples for bacterial culture and sensitivity testing. When palpating, wear a sterile glove or use a sterile probe. Local anesthesia (regional nerve blocks or ring blocks) combined with standing sedation (such as xylazine at 0.8 mg/kg and butorphanol at 0.02 mg/kg) or general anesthesia may be needed to adequately explore the wound.

Degloving wounds typically spiral around the limb from midway down the cannon bone to the level of the hock or carpus. The structures that may be damaged vary depending on which aspect of the limb is injured. A review of the anatomic structures in the area will help identify poten-



Figure 1

site of injury. Inspect the wound for leakage of this fluid during the injection. The ability to inject large amounts of fluid into the joint with ease (minimal pressure) provides additional evidence for joint involvement. Contrast radiographs should be used if any question of joint communication exists.¹

Treating the wound

The goal of wound care is to return the horse to a functional, cosmetic state as quickly as possible. The therapy selected will depend on wound status, financial constraints, patient temperament, and the intended use of the horse. If referral is necessary, clean and bandage the wound before shipment. In all situations, tetanus toxoid vaccination is essential.

Clean the wound

The primary benefit of lavage is the removal of debris. Large volumes of solution are generally used, at least initially; a hose or other source (*i.e.* fluid bags or pumps) can be used for up to 10 minutes once or twice daily. Discontinue lavage if there are any signs of tissue swelling or gray discoloration.

Pressure lavage can aid in removing debris, but some concern exists that high pressures may be detrimental.^{2,3,7} Intermediate-pressure lavage can be accomplished with a 35- or 60-ml syringe and an 18-ga needle (provides 7 psi) or with a plastic spray bottle. A dental irrigation device (*e.g.* Water Pik) on a low or intermediate setting provides 10 psi.²

Saline solution or tap water is preferable to sterile water for wound lavage because the latter is hypotonic and may damage cells.⁷

Povidone-iodine solutions are frequently used for wound lavage. With povidone-iodine, use a 0.1 to 0.2% concentration (1 to 2 ml of a 10% solution/1 L of water).^{2,8} This concentration is bactericidal, with effects lasting four to six hours.⁹ Concentrations greater than 5% were found to increase wound infection rates in children because of tissue toxicity.¹⁰ Chlorhexidine can also be used because it has a wide spectrum of activity with sustained residual activity and has been found to produce more rapid wound healing in dogs than does saline solution.^{8,9} The recommended dilution is 0.05% (1:40 dilution of 2% solution).⁸ Neither povidone-iodine nor chlorhexidine should be used in joints because they cause severe lameness and synovitis.¹¹

Several antibiotic solutions have been shown to reduce infection rates in contaminated tissues. Solutions containing aminoglycosides (0.1% gentamicin), penicillins (I use 10×10^6 IU/L), cephalosporins, and tetracyclines have been found effective.³ Additionally, antibiotics with systemic toxicity (*e.g.* lincomycin at 400 mg/L) can be applied locally with minimal side effects. The addition of tris-EDTA to antibiotic lavage solutions may potentiate the antibiotic's effectiveness.¹² Finally, applying water-soluble penicillin just before wound closure has been found to decrease infection rates.² Recommendations include intraoperative antibiotic lavage of each tissue plane as soon as possible to prevent bacterial adherence.¹³

Debride the wound

Mechanical removal of debris is best accomplished with sharp dis-

1. This laceration occurred when the horse caught its leg in a fence. Palpation of the injury revealed a flap extending across the medial aspect of the hock. The tarsometatarsal and distal intertarsal joints were found to communicate with the wound in that area.

tial problems, such as joint penetration (*Figure 1*), disruption of limb vasculature, or ligamentous damage (*see below*).⁶

Closely examine any lacerations near a joint. If the joint is open it can be difficult to obtain synovial fluid for examination or to identify synovial fluid in the laceration. Attempt to distend the joint with sterile saline or lactated Ringer's solution by injecting it away from the

section. Remove obviously devitalized and abnormal tissue as completely as possible while trying to avoid damaging important tissues.² Removal of all exposed devitalized tissue is ideal but may interfere with support or prevent closure. Staged debridement may be necessary, particularly for tissues with questionable viability or with crushing injuries, where further vascular impairment may occur over time. Color and attachment may be used as guidelines. Very dark or white tissue is usually nonviable. Tissue that is not attached to underlying structures and that does not bleed when cut is usually nonviable.

Give systemic antibiotics in some cases

Systemic antibiotic administration is frequently unnecessary in degloving injuries, particularly if the wound is left open. However, if penetration into a synovial cavity is suspected or if adequate drainage cannot be achieved, broad-spectrum coverage is desired until results of wound culture and sensitivity testing are obtained. Multiple bacteria, including anaerobes, are frequently involved.¹⁴ The combination of a cephalosporin with amikacin provided the best coverage at The Ohio State University.¹⁵ Because bacterial resistance is common, trimethoprim-sulfonamides were recommended only if sensitivity results were known.¹⁵

Apply topical antibiotics

A wide variety of topical solutions and ointments are applied to wounds. Most reduce only surface bacteria.³ Water-soluble ointments

such as silver sulfadiazine, bacitracin-neomycin-polymyxin, and nitrofurazone are preferred. Cream-based products such as gentamicin in an oil-in-water cream have been shown to slow healing.^{8,16} Caution should be taken with aerosolized powders because filler products and granules can act as foreign bodies.¹⁷

Close the wound

Primary wound closure is always tempting, and it's appealing to owners. But this type of closure is not always practical, recommended, or even possible with degloving injuries. Minimally contaminated wounds with a good vascular supply and adequate skin coverage that are seen within six hours of injury may be candidates for closure. Dehiscence is likely in the presence of poor vascular supply, infection, and excessive suture-line tension or motion.^{3,4}

Care should be taken to minimize the amount of tension at the site using stents or tension suturing patterns if necessary. Widely spaced vertical mattress sutures help remove the tension from the primary suture line.² Use the fewest sutures required to effectively close a wound. This includes buried sutures.¹⁸ Deep sutures should be used only to appose fascial layers, retinaculum, joint capsules, or transected tendons or ligaments.² When continued holding power is required, minimally reactive monofilament materials, such as stainless steel, polypropylene, polydioxanone, and polyglyconate, are preferred. Polyglactin 910 and polyglycolic acid may be useful when sutures are needed for temporary wound support.¹⁸ In all cases, use the smallest effective

suture material and needle.¹⁸

Hematomas and seromas can interfere with wound healing. Small areas of dead space may be controlled with pressure bandages or stents. Drains or mesh incisions may be useful.² For a mesh incision, make two or three staggered rows of stab incisions parallel to the wound after the skin is undermined; leave them open to allow skin expansion and drainage. Delayed wound closure should be considered when closure is possible yet significant tissue damage or contamination has occurred.¹⁹ Retracting wound margins or the development of rigid granulation tissue may interfere with secondary closure and prevent apposition of the skin edges.

Bandage the wound

Dressings that maintain moisture at the wound's surface have been found to speed healing in most species.^{16,20} However, more occlusive dressings may prolong healing of equine limb wounds. A recent study found more rapid healing of full-thickness wounds when equine limbs were bandaged with nonadherent gauze pads than with semi-occlusive or occlusive dressings.²¹

To absorb drainage, prevent motion, and protect the area, apply a heavier pressure wrap over the dressing.² Splints may be added to stabilize the wound and limb if needed. Flexor tendon lacerations or loss of collateral ligament support will require a cast. Casts also help minimize motion in the area of the wound and can be particularly helpful if the laceration occurs in a high-motion area or if it is closed under tension.^{16,22}

Cast application prevents visual inspection of the wound. Identification of wound infection can be delayed until it is quite advanced, making severe cellulitis or lymphangitis a potential complication, particularly in closed wounds. Delayed cast application or use of a bivalved cast (a cast that is cut in half immediately after application for easy removal and replacement) may also be considered.²² Complications arising from the use of a cast include cast sores and cast breaks. Recovery with a full-limb cast can be difficult, and ruptures of the peroneus tertius muscle can occur as the horse tries to stand.

Special considerations in wound management

Degloving injuries in the carpal and tarsal region can easily involve joints, tendons, and tendon sheaths. Affected horses can return to functional soundness with proper management; however, severe lameness can occur if treatment is not prompt and effective.^{23,24}

Joint involvement

With joint involvement, the goal is to remove the inciting agent and minimize joint damage. Joint lavage removes destructive enzymes as well as bacteria and debris.^{23,25} It may be accomplished by needle lavage, arthroscopy, arthrotomy, or drain placement. Through-and-through needle lavage is the most convenient method, but may be ineffective in chronic cases because of the development of fibrin clots within the joint. When performing joint lavage, use a balanced polyionic solution. Generally, 2 to 6 L of solution are used to irrigate a

joint. Lavage the joint daily until the cell count is less than 10,000 white blood cells/ μ l and any lameness or joint distention is minimized. Lavage may need to be continued at 48-hour intervals after the cell count has declined, depending on the persistence of clinical signs. Dimethyl sulfoxide (10 to 20%) or antibiotics such as gentamicin (500 mg) or amikacin (1 g) in or after application of the lavage solution may be useful.^{23,25}

Other antibiotics may also be effective intra-articularly depending on bacterial sensitivity results. Generally, the recommended systemic dose is administered into the joint once daily.²³ Systemic antibiotics should be used concurrently and continued for a minimum of three to four weeks.²⁴ Open joints should be left to heal by second intention or delayed closure.²⁵ If the treatment is effective, the lameness should respond within 24 hours, and a decrease in synovial effusion should be noted within 48 hours.²³

Affected horses should remain on anti-inflammatory agents during the inflammatory phase of healing and should be rested for 90 days to allow the cartilage to heal without being damaged by inflammatory enzymes or trauma.²³ Intramuscular polysulfated glycosaminoglycan (500 mg every four days for 28 days) and intra-articular hyaluronate sodium (see individual product recommendations for dose; can be repeated in two weeks if necessary) may help prevent cartilage degeneration.^{23,25}

The prognosis after joint involvement strongly depends on the time of diagnosis, the extent of damage, and the effectiveness of early ther-

apy.²⁴ Unsoundness is common with damage to the tarsocrural joint or to the carpus or fetlock. The distal tarsal joints are more resistant to lameness secondary to degenerative changes and are more amenable to therapy.²⁶ Laminitis in the contralateral limb has been reported.^{1,24} Younger horses may also develop flexural or angular limb deformities after abnormal weight-bearing.

Tendon lacerations

Loss of extensor tendon function leads to an inability to extend the toe, with knuckling of the distal limb.²⁷ Primary repair of these lacerations is not usually attempted. Limb support is required until the area is stable and the horse can adapt to the change in function. A splint can be taped to the dorsum of the leg over a padded leg wrap or wired to the hoof wall for support. As healing progresses, an extended-toe shoe will help prevent knuckling.²⁸

Injury to the flexor tendons carries a very guarded prognosis.¹ For the best results, the tendons must be stabilized with the ends closely apposed, and healing must occur with minimal adhesion formation. Primary repair of the lacerated tendon should be performed, if feasible.²⁹ This will usually involve transporting the horse to a referral institution. The limb should be supported for transport in a cast or splint bandage with the distal limb placed in flexion to minimize strain on the flexor tendons and vessels.²⁹ If surgical repair is not an option, similar support will be necessary for at least four weeks.¹ This should be followed by the use of a raised-heel shoe, which is gradually lowered to

increase weight-bearing and to break down adhesions.²⁸ Gradually increasing exercise can begin after two months. Healing is greatly impeded when the injury is within the tendon sheath.²⁹ Infections within a tendon sheath are treated similarly to joint infections.²³

Vascular damage

Vascular trauma and spasm can occur with entrapment injuries. Damage to the vessels may not be immediately obvious or even present initially (*Figure 2*). Laminitis in the affected leg can follow, as well as slower healing of the poorly vascularized tissues.⁴ Acepromazine (0.02 mg/kg intravenously or intramuscularly three to six times daily) and isoxsuprine (1.2 mg/kg orally b.i.d.) may be beneficial for improving vascular supply to the lower limb.

Dealing with delayed complications

Managing degloving injuries of equine limbs is aggravated by a high rate of delayed complications. These can become a source of dissatisfaction for the client without proper explanation and warning.

Sequestration

Exposure of bone with subsequent sequestration is common. Incomplete granulation tissue coverage, continued drainage, and, occasionally, a recurrence of the lameness are noted (*Figure 3*).³⁰ Radiographs are used to confirm the diagnosis of a sequestrum, usually at 10 to 21 days. Some sequestra may not be visible radiographically until after two weeks.

Removal of the sequestrum is



Figure 2



Figure 3

usually necessary for healing to proceed. This is most easily accomplished at three to four weeks postinjury when the fragment is loose and readily identifiable.³⁰

Epithelial deficiency
Lack of sufficient epithelial coverage is another common complication of degloving injuries. The tissue deficit may exceed the limits of wound contraction and epithelialization, making skin grafts necessary.²

Exuberant granulation tissue

In horses, exuberant granulation tissue is frequently observed in open wounds on the lower part of the limbs. Pressure bandaging or cast application appears to control granulation tissue formation.^{2,7} If exuberant granulation tissue develops, sharply debride to the level of the surrounding skin to encourage epithelial coverage. Topical corticosteroids applied under a bandage at each bandage change (every day or two) are generally effective in preventing recurrence.⁷ Astringents and caustic agents such as white lotion (zinc sulfate and lead acetate) are effective but will also destroy migrating epithelial cells.^{2,7} Innovative bandaging materials, such as cyanoacrylate, equine amnion, or temporary grafts, have also been shown to be effective in controlling granulation tissue in some cases.^{2,3,31}

Pinch, punch, and particularly tunnel grafts are the most amenable to use in the tarsal region.^{32,33} When using these grafts, first allow the wound to be covered with a smooth, healthy layer of granulation tissue.³² This stage may take one to eight weeks, depending on the amount of bone or tendon exposed. After grafting, place a bandage or cast on the leg to immobilize the region. Leave the bandage in place for at least three days to avoid disrupting the graft. The cast is usually removed after 10 to 14 days. After this, continued bandaging is recommended, and the horse should be kept in a stall until full epithelial coverage is obtained.³⁴ Epithelialization should be almost complete (the expected take of individual grafts is 65 to 90%) by four to five weeks.³⁴ A second graft may be nec-

essary for areas with incomplete coverage at this time.

Conclusion

While degloving injuries can appear highly detrimental to the future soundness of the horse, most will carry a favorable prognosis if appropriate and timely treatment is initiated. Careful evaluation for joint, tendon, or tendon sheath involvement is essential. The development of sequestration or proud flesh or the need for skin grafting can make these cases very involved, time-consuming, and costly. Owners need to be properly informed from the onset. They need to be aware not only of the initial steps in wound management but of possible future problems.

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