

Compendium

Traumatic Foot Injuries in Horses: Surgical Management

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Abstract: Managing traumatic foot wounds in horses may require surgical intervention. These wounds include coronary-band and heel-bulb lacerations, septic pedal osteitis, septic navicular bursitis, sepsis of the collateral cartilages, and hoof-wall injuries. This article provides a practical overview of the surgical management of these types of wounds.

Wounds of the equine foot range from simple lacerations and puncture wounds to deep, gashing wounds. Seemingly innocuous wounds may involve deep structures, possibly having a major effect on the prognosis. Injuries involving deep structures require sophisticated care, including surgery, to improve the outcome.

First Aid

When managing traumatic foot injuries in horses, equine practitioners should consider factors such as hemostasis, pain management, antibiotic therapy, topical treatment, anesthesia, and stabilization of the foot. Also, tetanus toxoid must be administered any time a horse is treated for a wound.

First aid, primarily control of hemorrhage, should be considered before treatment of any wound. In foot injuries, vessels supplying blood to the foot may be lacerated. Although I have rarely seen fatal hemorrhage due to foot injuries, significant blood loss can occur. Hemorrhage can be controlled by applying either a tourniquet at mid-cannon (**FIGURE 1**) or direct pressure with a tight bandage. The packed cell volume (PCV) and total protein concentration should be assessed to determine whether blood volume replacement is needed; however, in cases of acute hemorrhage (a duration of 12 to 24 hours), the PCV and plasma protein concentration may not accurately reflect the degree of blood loss until fluid shifts from the intracellular and interstitial spaces into the intravascular space. The PCV and total protein concentration may be of limited value because early blood loss may not be accurately reflected by the PCV or the total protein level. Although rarely used, whole blood transfusion or intravenous hypertonic or isotonic crystalloids may warrant consideration.¹ Pain management should be included. Initially, NSAIDs should be administered intravenously for a rapid onset of action. Butorphanol, along with sedation, is also effective for relieving pain.²

Perioperative Considerations

Although some foot wounds can be treated using standing sedation and local anesthesia, I prefer general anesthesia for managing complex cases because it allows close inspection of the wound, thorough debridement and lavage, and meticulous repair.

Hemostasis is paramount if debridement and/or excision is necessary, particularly for the foot. Using a tourniquet keeps the surgical field clear to allow a thorough, accurate assessment and surgical treatment. A wide, rubber tourniquet or a pneumatic cuff can be placed on the metacarpus/metatarsus. To obtain sufficient hemostasis, a roll of hard gauze should be placed on the medial and lateral aspects of the metacarpus/metatarsus under the tourniquet and directly over the palmar/plantar vessels (**FIGURE 1**). If a pneumatic tourniquet is used, inflation to 600 mm Hg is recommended (**FIGURE 2**); I have not seen complications at this



Figure 1. A tourniquet on the proximal metatarsus to control hemorrhage. Notice the gauze rolls on the medial and lateral surfaces of the limb to compress the vasculature.



Figure 2. A pneumatic tourniquet to control hemorrhage during debridement of a wound on the distal hindlimb of a horse.

pressure. Standing horses require sedation to withstand the pressure of the cuff.

Antimicrobial Therapy

The use of antimicrobial therapy depends on the amount of wound contamination and the character of the wound. Broad-spectrum antimicrobial therapy is recommended for injuries that may involve underlying structures such as synovial cavities, tendons, or ligaments. I prefer to use intravenous potassium penicillin and an aminoglycoside such as gentamicin (for adult horses) or amikacin (for foals).³ Oral administration of trimethoprim-sulfamethoxazole is adequate for noncomplex injuries. If antimicrobial therapy is needed for longer than 14 days, chloramphenicol is an excellent broad-spectrum oral antimicrobial⁴ (TABLE 1).

Intravenous regional limb perfusion (IVRLP) of antimicrobials is very effective for locally delivering a high minimum inhibitory concentration to tissues.⁵ IVRLP involves placing a tourniquet above the wound on the limb. A pneumatic tourniquet or a wide elastic tourniquet is used. The horse should be sedated to prevent movement after the infusion is started. Because repeated treatments are usually desirable, the smallest possible catheter should be used to minimize trauma to the vessel. It is imperative to keep the

vessel in the best possible condition. The dosage varies, but approximately one-third of a systemic dose of the antimicrobial is administered.⁶ The skin over a peripheral vein (i.e., palmar vein) is aseptically prepared, a 22-gauge butterfly catheter is inserted into the vein, and the antimicrobial is mixed with sterile saline to a volume of 15 to 35 mL and infused over a period of 1 minute (FIGURE 3). The tourniquet is left in place for 30 minutes to allow diffusion of the antibiotic. IVRLP is performed once daily for 3 to 5 days. Concentration-dependent antimicrobials, including amikacin and fluoroquinolones, are most often used. Time-dependent antimicrobials, such as cefazolin and imipenem, have also been used^{7,8} (TABLE 2).

Another means of delivering antimicrobials locally is sterile **antimicrobial-impregnated beads**. Although they have limited use in the foot because of space limitations, they can be used to maintain a constant antimicrobial level in an area for an extended period (15 to 30 days, depending on the antimicrobial used) through elution of the drug from the impregnated material. The beads may be made from sterile polymethyl methacrylate, hydroxyapatite cement, or plaster of Paris.⁹ In general, 1 to 2 g of antibiotic is added to 10 g of bead material.⁶ The antimicrobial and material are mixed, formed into beads on a suture, allowed to cure, and implanted using aseptic technique. It is important to make the beads in the appropriate size to fit into the wound. To increase the wound-bead surface area interface for maximal elution of the antimicrobial, a high number of small beads is preferred to fewer large beads; unused beads can be gas sterilized and stored for later use. Placement of beads in intrasynovial structures is not recommended because of potential cartilage erosion, inflammation, and lameness. The major disadvantages of polymethyl methacrylate are that it is not absorbable and heat-labile antibiotics cannot be incorporated within it.

As part of antimicrobial therapy, **topical application** is often used. Open wounds of the foot can be packed with 1 g of metronidazole powder or paste (FIGURE 4). Metronidazole is effective against anaerobic bacteria.¹⁰ The paste is made by crushing metronidazole

Table 2. Antimicrobials for Intravenous Regional Limb Perfusion^{7,8}

Antimicrobial	Dose
Amikacin	1000 mg
Cefazolin	1000 mg
Enrofloxacin	750 mg
Imipenem	1500 mg



Figure 4. Metronidazole paste placed in a foot wound of a horse.

Table 1. Antimicrobials Used in Horses With Wounds

Antimicrobial	Dose
Potassium penicillin	22,000 IU/kg IV q6h
Gentamicin (adults)	6.6 mg/kg IV q24h
Amikacin (foals)	22–25 mg/kg IV q24h
Trimethoprim-sulfamethoxazole	25 mg/kg PO q12h
Chloramphenicol	50 mg/kg PO q6h

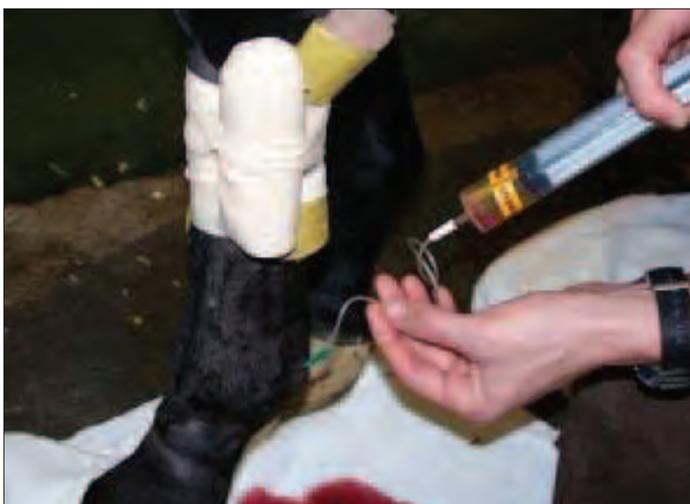


Figure 3. IVRLP of an antimicrobial on the forelimb of a horse. The tourniquet is placed at the level of the proximal metacarpus. The infusion is administered in the lateral palmar vein.

tablets and mixing the powder with a dilute 10% povidone-iodine solution (10 mL of povidone-iodine per 1 L of saline) to a paste consistency. The packing is replaced daily. Other topical antimicrobials that are beneficial for use on skin wounds include neomycin-bacitracin-polymyxin B, silver sulfadiazine, gentamicin, and cefazolin (unreconstituted powder).¹¹ Other topical treatments may also be beneficial for promoting healing of open wounds of the foot.¹²

Initial Wound Care

Equine foot wounds can easily become contaminated. Before surgical treatment can be considered, initial care of the wound must be performed. This includes preparation for clipping the hair around the wound. To help prevent contamination of the wound with hair

during clipping, (1) gauze sponges that are saline-soaked or are covered with sterile, water-soluble lubricant can be placed on or in the wound or (2) the wound edges can be brought together using towel clamps. The wound must be cleaned and lavaged. Pressure lavage is recommended because it effectively decontaminates by dislodging debris and bacteria using a dilute (weak tea color) povidone-iodine solution (10 mL of 10% solution per 1 L of saline) or chlorhexidine solution (25 mL of 2% solution per 1 L of saline). Recommended



Figure 5. A 65° dorsal-to-palmar radiograph of P3 with septic pedal osteitis. Note the sequestrum along the edge of P3 (arrow).



Figure 6. A horse's hoof wall and sole, which has been pared away to remove a sequestrum of P3.



Figure 7. A medicated bandage on a pony's foot after sequestrectomy of P3.

pressures of 7 to 15 psi may be achieved using a 35- to 60-mL syringe and an 18-gauge needle. However, human studies have revealed that higher pressures are needed if lavage is delayed for more than 4 hours after wounding.¹³ Pressures >70 psi should be avoided because they have been shown to drive debris and bacteria into tissue and cause waterlogging.¹⁴

Wounds Involving the Foot and Distal Extremity

Septic Pedal Osteitis

Septic pedal osteitis—an infection of the distal phalanx—commonly results from a deep puncture wound of the sole, but it can also result from a dissecting subsolar abscess, a hoof-wall avulsion, a soft tissue injury around the foot, or chronic laminitis with recurrent abscessation.¹⁵ Sequestration of bone is a common sequela of septic pedal osteitis (**FIGURE 5**).

Surgical debridement and removal of the sequestrum are indicated.¹⁵ The hoof is prepared aseptically for surgery, and a tourniquet is applied to the limb. With the use of a conventional, sterile hoof knife, the sole is carefully pared away to expose the sequestrum (**FIGURE 6**). In most cases, a draining tract can be followed to the sequestrum.

Once the distal phalanx has been debrided, the defect is (1) packed with a gauze pad medicated with metronidazole-povidone-iodine paste and (2) covered with a waterproof, aseptic bandage (**FIGURE 7**). The patient is administered systemic antibiotics (trimethoprim-sulfamethoxazole or chloramphenicol), and IVRLP is performed.

For long-term coverage of the solar defect, a medicine-plate shoe may be applied (**FIGURE 8**). This keeps the solar defect covered with medicated packing without the expense of a bandage (**FIGURE 9**). Coverage of the hoof defect is continued until granulation tissue forms, epithelializes, and keratinizes (**FIGURE 10**).

Septic Navicular Bursitis

Infection of the navicular bursa is most often due to a puncture wound in the caudal third of the frog (street nail injury). The



Figure 8. A medicine-plate shoe.



Figure 9. Solar packing placed under a medicine-plate shoe.



Figure 10. Keratinization of a surgical wound 9 weeks after removal of a sequestrum of P3.

presence of a penetrating foot wound in the navicular bursa may be confirmed by radiography (lateral and dorsopalmar or dorsoplantar views) with the foreign body in place¹⁶ (FIGURE 11). However, determining whether the navicular bursa is involved can be difficult if the penetrating foreign body is not present at the time of examination. Performing a radiographic fistulogram contrast study can help confirm the presence of a communicating tract in the

navicular bursa (FIGURE 12). Distention of the navicular bursa, by injecting contrast medium (e.g., iohexol) through a needle inserted percutaneously at a different location, may also identify a penetrating tract. Because this technique minimizes further contamination, some clinicians prefer it to direct injection of contrast medium through the puncture site.¹⁵

Endoscopic inspection of the navicular bursa (bursoscopy) and copious lavage using balanced, isotonic fluids is the preferred treatment when involvement of the navicular bursa has been confirmed¹⁷ (FIGURE 13). In chronic cases, ventral drainage is necessary if extensive fibrin, tissue necrosis, and debris are within the bursa. Ventral drainage is achieved by performing a navicular bursotomy in which a window is surgically created in the middle third of the frog, through the digital cushion and the deep digital flexor tendon (FIGURE 14).

The bursa is copiously lavaged under pressure using sterile polyionic solution. A needle should be placed into the distal interphalangeal joint and fluid injected under pressure to determine

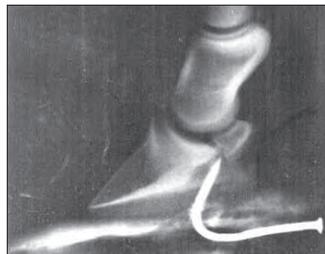


Figure 11. A field radiograph of a horse's foot with a nail penetrating the sole. Notice the point of the nail near the navicular bone. A dorsopalmar view should be obtained to determine the medial-to-lateral location of the nail.



Figure 12. A contrast fistulogram demonstrating a communicating tract in the navicular bursa due to foreign-body penetration of the frog of a horse's foot.



Figure 13. Bursoscopy of the navicular bursa.

whether the joint is involved. Escape of fluid through the wound confirms joint involvement (FIGURE 15). As an alternative, the navicular bursa can be lavaged by inserting a needle in the bursa and allowing the lavage fluid to escape through the wound. After lavage, injecting the bursa with an antimicrobial (TABLE 2) is highly recommended.

Postoperative treatment includes administration of IVRLP (using antimicrobials), systemic antimicrobials, and analgesic therapy. Depending on the severity of the injury, lavage may be repeated daily for 3 to 5 days. If a bursotomy was performed, the wound is packed with metronidazole-povidone-iodine paste and covered



Figure 14. A navicular bursotomy performed through the caudal third of a horse's frog to treat chronic septic navicular bursitis by allowing ventral drainage.



Figure 15. Sterile polyionic fluid is injected into the coffin joint of a horse with septic navicular bursitis. The fluid exiting the puncture in the frog indicates communication with the joint.



Figure 16. A horse with quittor due to a deep heel-bulb/corony-band laceration.

with a thick, aseptic foot bandage. A medicine plate is placed on the foot for long-term care. The prognosis for soundness is guarded to grave, depending on the severity and chronicity of the infection.^{17,18} The earlier the treatment, the better is the prognosis for soundness.¹⁹

Septic Chondritis of the Collateral Cartilages

Infection of a collateral cartilage (also called *quittor*) is usually due to a deep laceration of the medial or lateral region of the coronary band or the heel bulb

(**FIGURE 16**). This condition is characterized by chronic infection and necrosis of the collateral cartilage. Diagnosis is mainly based on the clinical signs. Affected horses are moderately to severely lame and have significant swelling and pain over the affected cartilage, with exudate draining from the wound. Radiography is recommended to detect changes (lysis) in the cartilage and possible bone or distal interphalangeal joint involvement (**FIGURE 17**). Concurrent involvement of the distal interphalangeal joint usually results in severe lameness. Contrast radiography may help determine whether the joint is involved.

Treatment involves excision of the necrotic and infected tissue and establishment of drainage. However, excision can be problematic due to inadvertent entry into the distal interphalangeal joint. The horse is placed under general anesthesia and positioned in lateral recumbency with the infected cartilage positioned uppermost.

The foot is aseptically prepared and a tourniquet placed on the limb. If there is a chronic open wound, sharp excision is used to remove the necrotic tissue (**FIGURE 18**). If there is only a draining tract at the coronary band, an incision (~5 cm long) that curves away from the coronary band is made over the tract. The skin is reflected distally to expose the underlying structures. Extending the foot during excision tenses the coffin joint capsule and retracts it from the area of dissection, minimizing the risk of accidental penetration.²⁰

Infected cartilage is removed until only healthy tissue remains. Once the infected tissue has been removed, the distal interphalangeal joint is lavaged using polyionic fluid to determine whether there is communication with the surgery site. If joint involvement is confirmed, the joint is lavaged using 1 L of sterile polyionic fluid, and an antimicrobial (1000 mg of amikacin in 5 mL of saline) is instilled into the joint (**TABLE 2**). If an extending incision was made, it is closed. Otherwise, the wound is left open and packed with metronidazole-povidone-iodine paste and aseptically bandaged. IVRLP is performed as described above. As the infection becomes controlled, a foot cast (see “Coronary-Band and Heel-Bulb Lacerations” below) may be applied to stabilize the foot and heel bulb in order to minimize excessive granulation tissue formation and facilitate healing by second intention.

An optional nonsurgical treatment for infected collateral cartilage is the application of commercially available medical maggots



Figure 17. A dorsopalmar radiograph of a horse's foot showing quittor. Notice the increase in soft tissue opacity on the lateral aspect of the coronary region, the lysis of the collateral cartilage, and the bony changes in P3.

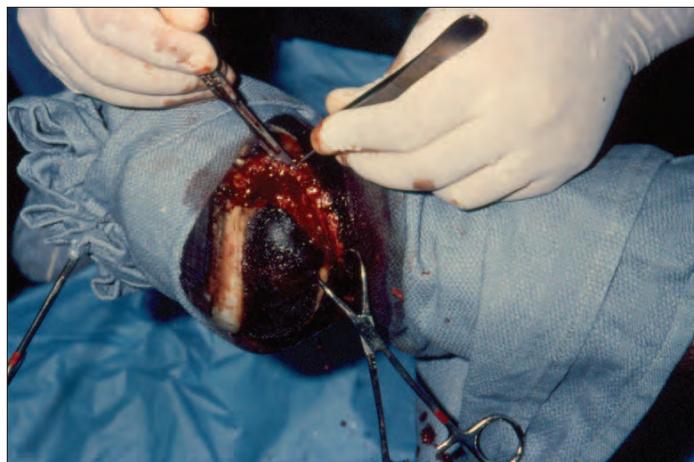


Figure 18. Surgical excision of infected and necrotic collateral cartilage.



Figure 19. Medical maggots. Image courtesy of Monarch Labs, Irvine, CA.



Figure 20. A puncture wound due to a nail at the coronary band.



Figure 21. A coronary laceration on a horse's foot. Lavage of the coffin joint, using a needle placed remotely from the wound, confirms joint involvement when fluid escapes through the wound (teat cannula).



Figure 22. An acute laceration of the lateral heel bulb.



Figure 23. Primary suture closure of an acute heel-bulb/coronary-band laceration. Notice the accurate alignment of the coronary band.



Figure 24. Excision of granulation tissue from a chronic heel-bulb laceration before delayed closure of the wound.

(FIGURE 19) directly to the wound to remove necrotic tissue.¹² Maggots can selectively consume necrotic tissue—up to 75 mg/d. Approximately five to eight maggots per square centimeter are used. A hydrocolloid dressing is placed over the wound and changed twice daily. The maggots must be changed every 2 to 4 days. The use of maggots removes the surgical risk of iatrogenic entry into the coffin joint, especially for deep infections.

In my experience, the prognosis for soundness is guarded unless there is joint involvement, in which case, the prognosis is poor. Although the prognosis for acute and subacute cases with early, complete surgical removal of diseased tissue has been reported as good,¹⁵ nine of 13 (69%) horses managed surgically were sound on follow-up.²¹ Maggot therapy was successful in alleviating the infection in a limited number of reports.²² Adverse effects of maggot therapy include irritation or itching at the wound side, possibly due to movement of the larvae.

Septic Arthritis of the Distal Interphalangeal Joint

Septic arthritis of the distal interphalangeal joint is usually due to a deep puncture wound in the frog, but it may also result from a puncture or laceration of the coronary band (FIGURE 20).

Wounds involving synovial cavities should be treated as an emergency. Effective lavage, aggressive local and systemic antimicrobial therapy, and analgesia are keys to success. The synovial cavity should be investigated to determine whether it is involved by injecting it with an isotonic, balanced electrolyte solution under pressure, via a site distant to the wound.²³ If the fluid exits the wound, the synovial structure is involved in the wound (FIGURE 21). Through-and-through lavage is imperative and is performed by using either a large-bore (14-gauge) needle or arthroscopic cannulas, with the fluid exiting the wound and a separate portal site. Pressurizing the fluid is key to improving the effectiveness of the lavage. This creates joint distention and dislodges debris or bacteria.



Figure 25. A foot cast applied to facilitate healing of a heel-bulb laceration that was primarily closed. Polymethyl methacrylate has been applied to the ground surface of the cast to minimize wear.

During lavage, the wound is thoroughly debrided. Intrasynovial antimicrobials and IVRLP using antimicrobials are concurrently administered (TABLE 2).

Depending on the degree of contamination, wounds involving synovial structures are usually closed primarily to avoid possible infection. An exception is deep puncture wounds, which are left open to heal by second intention.

Coronary-Band and Heel-Bulb Lacerations

It is important to closely examine coronary-band and heel-bulb lacerations for involvement of significant,

deeper structures (e.g., collateral cartilage, the distal interphalangeal joint, the deep digital flexor tendon sheath, the neurovascular bundle) (FIGURE 22). These types of injuries are best treated by primary closure, when possible, and the application of a foot cast.

Once the wound has been cleaned, debrided, and prepared, the wound edges are freshened and primary or secondary closure is performed using a suture pattern appropriate for areas of increased tension, such as a vertical mattress (FIGURE 23). When freshening the wound edges, it is important to preserve as much tissue as possible to minimize tension at the closure but ensure the wound edges have adequate vascularity. This reduces subsequent tissue necrosis, which would result in eventual wound dehiscence. With delayed closure, it is imperative that as much of the granulation tissue as possible is excised before closure²⁴ (FIGURE 24). A tourniquet is used to minimize bleeding and allow adequate visualization during wound closure. Maintaining alignment and apposition of

the coronary band is imperative to minimize hoof-wall defects or abnormal hoof growth (FIGURE 23).

Once the wound has been debrided and closed, a topical antimicrobial ointment is applied and a light, nonadherent dressing placed over the wound. A foot cast provides adequate immobilization to promote early and cosmetic healing and should be applied when possible (FIGURE 25). A foot cast is applied similarly to a conventional cast, using orthopedic stockinet under the cast. It may be applied equally well in a standing or an anesthetized patient.²⁵ During cast application, the foot is positioned in a near-normal standing position. The cast is applied so it extends to the mid-pastern region. If the cast extends more proximally than the mid pastern, cast sores on the distal aspect of the proximal sesamoids are a common adverse sequela. The top of the cast is sealed with an adhesive flexible tape. A properly applied foot cast can be effectively maintained for 14 to 21 days, which is often sufficient for complete wound healing.

Hoof-Wall Injuries

Hoof-wall injuries include vertical tears, usually at the quarter or heel, and subtotal avulsions (FIGURE 26). Most of these injuries are repairable unless there is significant loss (>50%) of the hoof wall. In these cases, euthanasia is strongly recommended.

Most hoof-wall injuries can be treated and repaired using local anesthesia in a standing, sedated horse. If the coronary band and underlying hoof-wall corium are still intact, the hoof segment is reattached. Maintaining alignment of the opposing hoof walls during reconstruction can aid normal regrowth of the hoof wall. If a hoof segment has been avulsed from the underlying dermal lamina, it is best to completely remove the segment. Hoof-wall reconstruction can be accomplished by lacing or bridging across the defect using flexible metal plates, suture material, or wire (FIGURE 27A). A foot (slipper) cast is also very effective at stabilizing the repair (FIGURE 27B). It may take multiple, sequential applications of foot casts to obtain enough hoof-wall growth at the coronary band (FIGURE 28). Adjunct treatments include patching across the injury and applying a bar shoe with clips. The sole surface of avulsed quarter or heel is trimmed so that it is “floated” off the



Figure 26. A hoof-wall avulsion injury.

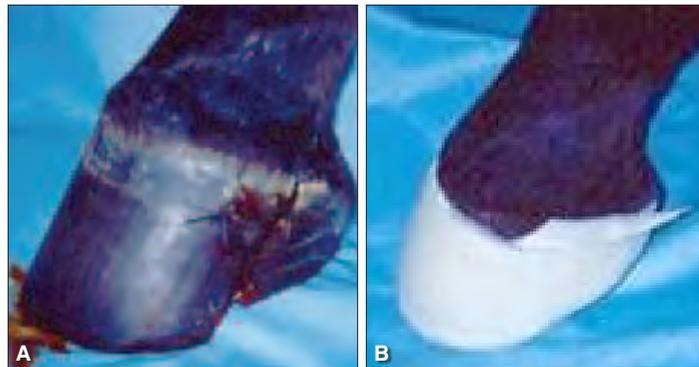


Figure 27. A hoof-wall avulsion injury. The heel of the avulsed hoof-wall segment in Figure 26 was “floated” off the ground surface (A). The hoof wall was laced with large suture (A) and a rim (slipper) cast applied (B).



Figure 28. The same foot as in Figures 26 and 27 after several months. Notice the new hoof growth proximal to the previous avulsion injury (arrow).

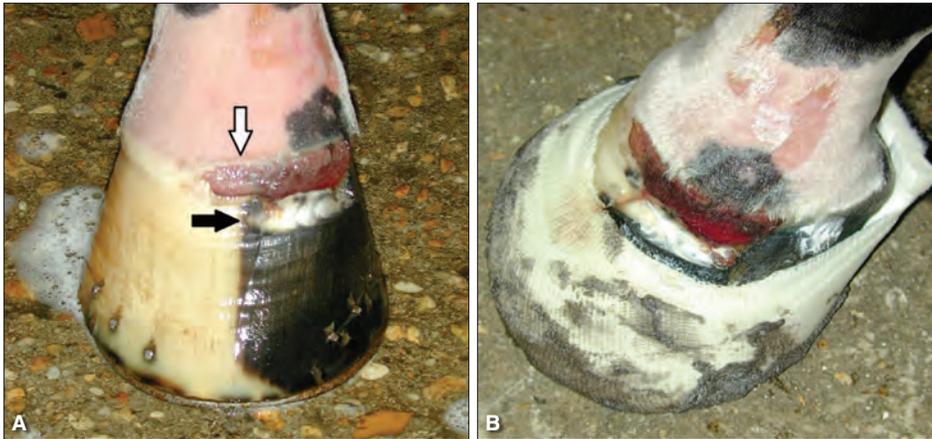


Figure 29. An avulsion injury of the hoof wall in a horse. Notice the fracture line in the hoof wall along the dark and white hoof junction (A). The soft tissue bulged at the coronary band where the hoof wall was avulsed (white arrow). The hoof wall was thinned just distal to the wound site (black arrow) to relieve pressure on the soft tissue (A). The foot was placed in a slipper cast (B).



Figure 30. The same foot as in Figure 29 at 1 year after injury. The avulsion injury completely healed.

ground surface. This reduces the shear forces along the avulsion line.

In some cases, the soft tissue may swell at the region where the avulsion involves the coronary band (FIGURES 29A and 29B). Thinning or removal of the hoof wall just distal to the coronary band reduces compression and the chance of necrosis of the laminae tissue¹⁵ (FIGURE 30).

Conclusion

Thorough examination of equine foot wounds is imperative to determine the most appropriate treatment. Hemorrhage control is essential during surgical treatment and repair. Systemic and local antimicrobial treatment, including IVRLP, should be a routine component of the treatment regimen. Thorough lavage of involved synovial structures is necessary to maximize the chance of a successful outcome. Both the severity of the synovial infection and the prognosis are positively influenced by rapid, appropriate treatment. When managing foot wounds, anaerobic infection should always be considered; if confirmed, the use of local metronidazole therapy is recommended. It is imperative to maintain or establish alignment of coronary-band injuries to ensure normal hoof growth.

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1. Which of the following is/are critical in first-aid management of traumatic foot injuries in horses?
 - a. hemostasis
 - b. pain management
 - c. tetanus toxoid administration
 - d. all of the above
2. Which of the following antimicrobials is not suitable for IVRLP?
 - a. chloramphenicol
 - b. amikacin
 - c. cefazolin
 - d. imipenem
3. Pressures ___ psi should not be exceeded when lavaging a wound during initial care.
 - a. >40
 - b. >50
 - c. >60
 - d. >70
4. Which of the following is a potential sequela of septic pedal osteitis?
 - a. rupture of the deep digital flexor tendon
 - b. sequestrum
 - c. loss of entire hoof wall
 - d. sheared heel
5. Which of the following can be used to determine whether the navicular bursa has been penetrated by a sharp object?
 - a. ultrasonography of the navicular bursa
 - b. a palmar digital nerve block
 - c. injection of contrast medium into the puncture wound followed by radiography
 - d. all of the above
6. Acute septic navicular bursitis is best treated using
 - a. ventral bursotomy.
 - b. a foot cast.
 - c. a foot soak.
 - d. bursoscopy and lavage.
7. Septic chondritis of the collateral cartilage is also called
 - a. *buttress foot*.
 - b. *quittor*.
 - c. *street nail*.
 - d. *white-line disease*.
8. A potential sequela of septic chondritis of the collateral cartilage is
 - a. sequestrum formation on P1.
 - b. rupture of the deep digital flexor tendon.
 - c. keratoma formation.
 - d. sepsis of the distal interphalangeal joint.
9. Coronary-band and heel-bulb lacerations may best be treated by
 - a. primary closure and application of a foot cast.
 - b. application of duct tape.
 - c. application of a splint.
 - d. none of the above
10. Which of the following is important during reconstruction of a hoof-wall injury?
 - a. elevation of the heels
 - b. alignment of the opposing hoof walls
 - c. use of cerclage wire
 - d. removal of the collateral cartilage on the affected side