Heel bulb lacerations in horses: 101 cases (1988–1994)

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EQUINE

Objective—To determine clinical history, structures involved, treatment, and outcome of lacerations of the heel bulb and proximal phalangeal region (pastern) in horses.

Design—Retrospective study.

Animals—101 horses.

Procedures—Medical records of horses with lacerations of the heel bulb and pastern were reviewed, and follow-up information was obtained.

Results—75 horses were Quarter Horses. Most horses were not treated with antimicrobial drugs prior to referral. Mean ± SD time from injury to referral was 24 ± 45 hours (range, 1 to 168 hours). Lacerations were most frequently caused by contact with wire or metal objects. In 17 horses, lacerations involved synovial structures; the distal interphalangeal joint was most commonly affected. One horse was euthanatized after initial examination. Wound treatment consisted of cleansing, lavage, debridement, lavage of affected synovial structures, suturing of fresh wounds, and application of a foot bandage or cast. Fifty-six horses were treated with systemically administered antimicrobial drugs. Follow-up information was collected for 61 horses. Fifty-one horses returned to their intended use and had no further complications; 10 horses had complications associated with the wound, and of those horses, 5 were euthanatized and 1 horse died from an unrelated cause. Horses with lacerations that involved synovial structures had worse outcomes than horses with lacerations that did not involve synovial structures.

Conclusions and Clinical Relevance—Horses that sustain heel bulb lacerations can successfully return to their intended use. Involvement of the distal interphalangeal joint is associated with poor prognosis. (*J Am Vet Med Assoc* 2005;226:418–423)

Lacerations of the heel bulb and palmar and plantar aspects of the proximal phalangeal (pastern) occur commonly in horses and are usually caused by contact with wire or other metal objects. Thorough examination of these lacerations is warranted because adjacent synovial structures may be affected. Involvement of the digital flexor tendon sheath, deep digital flexor tendon, proximal and distal interphalangeal joints, or podotrochlear (navicular) bursa is associated with a poor prognosis for return to soundness.[1–3] Foot lesions that develop subsequent to heel bulb lacerations (hoof cracks, coronary band avulsions, and collateral cartilage lesions) may also compromise the return to soundness.[1,2]

Treatment of uncomplicated heel bulb lacerations that do not involve synovial structures is associated with a good prognosis for return to soundness and an acceptable cosmetic appearance. Treatment generally consists of wound debridement, surgical closure, and bandaging or application of a cast.[1,2,4–8] Heel bulb lacerations often undergo delayed surgical closure because wound infection caused by microorganisms in the environment develops quickly.[2,4] Immobilization of the wound (ie, the distal portion of the limb) by application of a cast may enhance healing by limiting movement of the injured tissue, decreasing tension on sutures, and limiting development of excessive granulation tissue.[4,8] Delayed surgical closure and application of a cast can achieve good cosmetic and functional results.[2,4]

Management of lacerations of the heel bulb and pastern has been described in conjunction with management of lacerations of the distal portion of the limb and hoof injuries.[1,2,4,7] The purpose of the study reported here was to describe the clinical history, structures involved, treatment, and outcome of lacerations of the heel bulb and pastern in horses. We hypothesized that horses managed with a foot cast alone would have a shorter treatment period than horses managed with bandages alone and that horses with lacerations that involved a synovial structure would have worse outcome than horses with lacerations that did not involve a synovial structure.

Criteria for Selection of Cases

Medical records of horses that sustained lacerations of the heel bulb and distal portion of the palmar and plantar aspects of the pastern and were referred to the Texas Veterinary Medical Center for treatment from January 1988 to July 1994 were retrieved. Follow-up information was obtained via telephone interview with owners or trainers in 1994.

Procedures

Information collected from medical records included signalment, limb affected, time from injury to referral, cause of injury, antimicrobial drug treatment prior to referral, radiographic findings, involvement of adjacent structures, and treatment. Follow-up information included time of follow-up with respect to date of discharge from the hospital, whether the horse survived or

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was euthanatized, whether the laceration healed, cast complications, presence of lameness, whether the horse could be used as intended, whether a hoof wall defect had developed, and presence of a chronic wound.

At the Texas Veterinary Medical Center, initial treatment of the laceration in all horses consisted of cleansing and lavage with an antiseptic solution followed by examination of the wound to determine whether the digital flexor tendon sheath, deep digital flexor tendon, proximal or distal interphalangeal joints, navicular bursa, or collateral cartilages were involved. Perineural anesthesia was performed as required to facilitate examination. The integrity of synovial structures was determined via infusion of sterile polyionic solution[a] into the synovial cavity or tendon sheath at a site remote to the wound. Synovial structures that communicated with or were suspected to communicate with the wound were lavaged by use of a 14- or 16-gauge needle placed in the synovial structure in a position remote to the wound. A pump was used to force 1 to 2 L of sterile polyionic solution through the needle, and fluid was allowed to egress from the wound. The synovial structure was then infused with amikacin solution. Horses were sedated for this procedure, and synovial structures were lavaged on the day of initial examination and every other day until cytologic analysis and bacterial culture of synovial fluid or clinical signs indicated that the structure was no longer infected. Broad-spectrum antimicrobial drugs were administered systemically in these horses for a minimum of 2 weeks. Dorsopalmar, dorsoplantar, and lateromedial radiographic views of the foot were obtained in some horses to evaluate the middle phalanx, distal phalanx, and distal sesamoid (navicular) bone and determine whether radiopaque foreign bodies were present.

At the Texas Veterinary Medical Center during the time period of the study, lacerations of the heel bulb or pastern were treated by use of various protocols. Initially, wound margins were assessed and synovial structure integrity confirmed; the treatment protocol depended on the duration and degree of contamination of the wound. Wounds of short duration (< 8 hours), wounds with minimal contamination, or both were sutured (primary closure), and the distal portion of the limb was immobilized by use of a foot cast or sterile bandage. Wounds of short duration that involved a synovial structure were managed in a similar manner; a foot cast or bandage was applied at the surgeon's discretion after lavage of the synovial structure had been performed. Wounds of longer duration (> 8 hours), with or without involvement of a synovial structure, were treated appropriately and immobilized in a foot cast or bandage to allow for drainage of exudate and wound healing by second intention. Wounds of chronic duration in which granulation tissue was present were immobilized in a foot cast or bandage and allowed to heal by second intention. If a wound was severe and contaminated with debris, a foot bandage was applied after cleansing and lavage to allow for self-debridement of the wound for 7 to 10 days prior to application of a bandage or foot cast.

Horses were sedated and casts were applied with the foot held above the ground by an assistant. A felt strip 1 inch wide was placed around the pastern just below the metacarpophalangeal joint. A double layer of stockinette 3 or 4 inches wide was placed over the foot and extended approximately 2 inches proximal to the felt strip. Three rolls of fiberglass cast material[b] 3 inches wide were applied to include the foot and extend proximally to the middle of the first phalanx. The foot was placed on the ground during the final curing process to allow the cast to conform to the normal axis of the hoof and pastern.

Follow-up information was obtained via telephone interview with owners, trainers, or both. Outcome was considered successful if the horse was sound and able to be used at a level of performance that equaled or exceeded the level achieved before injury. For horses that did not have successful outcomes, the reason for failure, degree of improvement, and alternate use were determined when possible.

Statistical analyses—Values for various parameters were calculated and are reported as mean ± SD unless otherwise indicated. A paired *t* test was used to compare duration of treatment in horses treated with foot casts alone with that in horses treated with bandages alone. A χ^2 analysis was used to compare outcome in horses treated or not treated with antimicrobial drugs prior to referral, horses with or without synovial structure involvement, and horses treated via primary closure of the wound versus horses treated via healing by second intention. A value of $P < 0.05$ was considered significant.

Results

One hundred one horses were included in the study. Seventy-five horses were Quarter Horses, 6 were Thoroughbreds, 5 were Tennessee Walking Horses, 5 were horses from the Quarter Horse Appendix, 3 were Paint Horses, 3 were Appaloosas, 2 were Arabians, and 2 horses were of unknown breed. Eleven horses were sexually intact males, 32 were females, and 58 were geldings. Mean age of horses was 7 ± 4 years (range, 1 to 23 years).

The forelimbs of 61 horses (31 left and 30 right) and hind limbs of 40 horses (22 left and 18 right) were involved. Seventy-five horses were not treated with antimicrobial drugs prior to referral, whereas 20 horses were treated. The type of antimicrobial drug, route of administration, and duration of treatment were not recorded in the medical records. Medical records of 6 horses did not contain any indication whether the horses had been treated with antimicrobial drugs prior to referral.

Time from injury to referral (mean, 24 ± 45 hours; range, 1 to 168 hours) was known for 60 horses. The cause of injury was known in 87 horses; 41 horses sustained lacerations from contact with wire, and 46 horses sustained lacerations from contact with metal objects. The degree of lameness assessed during the initial examination at our hospital was not recorded in the medical records.

Radiographs of the foot were available for review for 38 horses. No lesions of bone were detected in 23 (60.5%) horses. Nine (23.7%) horses had radiographic

changes consistent with damage of the distal phalanx, 5 (13.2%) had radiographic changes consistent with damage of the middle phalanx, and 1 (2.6%) horse had radiographic evidence of damage of the navicular bone.

All horses initially underwent cleansing and lavage of the wound. Synovial structures were involved in 17 of 101 horses. Thirteen horses had lacerations that involved the distal interphalangeal joint. The digital flexor tendon sheath was involved in 3 horses, and in 2 of these horses, the deep digital flexor tendon was damaged. The proximal interphalangeal joint was involved in 3 horses. In 2 horses, lacerations involved both the distal interphalangeal joint and the proximal interphalangeal joint; 1 of these horses was euthanatized at initial examination because of the chronic duration of joint infection and poor prognosis.

The lacerations of 30 horses were sutured. All 30 horses had injuries of < 8 hours' duration and wounds that were minimally contaminated with debris. Lacerations were sutured with size 1 or size 2 polypropylene (n = 8 horses) or polydioxanone (13); the type of suture material was not specified for 9 horses. The wounds of 70 horses were not sutured and allowed to heal by second intention. Most of these horses had wounds contaminated with debris or had sustained the injury several days prior to referral. It was assumed that self-debridement was used to manage many of these wounds; however, an exact number could not be determined from medical records. No wounds underwent delayed secondary closure.

Overall, a foot cast was applied in 52 horses; duration of cast immobilization was 2.8 ± 1.0 weeks. Twenty-four horses were managed solely with cast immobilization; these horses had duration of cast immobilization of 3.1 ± 0.9 weeks. Twenty-eight horses were managed with a combination of cast immobilization followed by bandage application; duration of cast immobilization and bandaging was 5.1 ± 2.1 weeks. Forty-eight horses were managed by bandaging alone; duration of bandaging alone was 4.1 ± 1.3 weeks. Therefore, bandages were applied in 76 horses overall; duration of bandaging was 3.2 ± 2.2 weeks. Duration of cast immobilization alone was significantly shorter than that of bandaging alone.

In 13 of 16 horses with synovial structure involvement, affected synovial structures were lavaged and amikacin solution was instilled. Two proximal interphalangeal joints were lavaged, and 12 distal interphalangeal joints were lavaged. The tendon sheath of 3 horses was not lavaged. Four horses with synovial structure involvement were managed solely with cast immobilization for 4 ± 0.9 weeks. Six horses were managed with a combination of cast immobilization and bandaging; duration of cast immobilization was 3.3 ± 2.1 weeks, and duration of bandaging was 1.3 ± 0.6 weeks. Bandages alone were applied in 6 horses; duration of bandaging was 3.1 ± 2.1 weeks.

Fifty-six horses were treated with systemically administered antimicrobial drugs immediately after initial wound treatment. Antimicrobial drug treatment consisted of trimethoprim-sulfadiazine in 36 horses (15 mg/kg [6.8 mg/lb], PO, q 12 h) and enrofloxacin in 20 horses (5 mg/kg [2.3 mg/lb], PO or IV, q 24 h). The remaining 44 horses were not treated with antimicrobial drugs.

Follow-up information was obtained for 61 of 100 horses; mean time to follow-up was 37 ± 26 months after hospital discharge. Fifty-five of 61 (90%) horses survived and did not develop complications during the course of treatment. Five (8.0%) horses were euthanatized because of development of major complications associated with the wound; 4 of these horses had lacerations that involved the distal interphalangeal joint, and 1 horse had tendon sheath involvement with subsequent disruption of the deep digital flexor tendon. Another horse died as a result of an unrelated cause. No significant difference in outcome between horses with follow-up information that were treated or not treated with antimicrobial drugs prior to referral was found.

In 55 of 61 (90%) horses with follow-up information, the laceration had completely healed by the time of follow-up. One of 18 horses in which the wound was sutured and 9 of 43 horses in which lacerations were allowed to heal by second intention had unsuccessful outcomes. The difference in outcome between horses with follow-up information that had their wounds sutured and those in which wounds were allowed to heal by second intention was significant.

Fifty-one of 61 (84%) horses were judged to have had a successful outcome by their owner or trainer and returned to their intended use without signs of lameness. Ten (16%) horses had unsuccessful outcomes according to their owner or trainer; these horses were persistently lame or unable to be used as intended. Of these 10 horses, 5 were euthanatized and 1 died.

Follow-up information was available for 7 of 12 treated horses with lacerations that involved the distal interphalangeal joint. Four were euthanatized after discharge from the hospital because of infectious arthritis refractory to treatment. In 1 horse, a laceration that involved the distal interphalangeal joint healed, and the horse survived but was persistently lame. Complete wound healing and return to intended use without complications were noted in 3 horses. Follow-up information was available for 1 of 2 horses with lacerations that involved the proximal interphalangeal joint; the wound had healed completely, but the horse was persistently lame. Follow-up information was available for 2 of 3 horses with lacerations involving the tendon sheath. One horse was euthanatized because of damage to the deep digital flexor tendon, and in 1 horse, the wound healed completely, although the horse was unable to return to its previous performance level. Horses with lacerations that involved a synovial structure had a significantly poorer outcome than horses with lacerations that did not involve a synovial structure. A hoof wall defect developed in 11 of 61 (18%) horses, and 4 (7%) horses had wounds that necessitated continuing treatment.

Discussion

The data for this study were obtained from medical records dated 1988 to 1994. All data for this study, including telephone follow-up with owners, were compiled in 1994 and recently organized for publication. It

is our observation that treatment of similar heel bulb lacerations has not changed in recent years at Texas A&M Veterinary Medical Teaching Hospital. We have reviewed numerous medical records from horses that sustained heel bulb lacerations from 1994 to the present at our hospital, and treatment methods have remained the same except for the additional treatment modality of regional antimicrobial limb perfusion in horses with involvement of synovial structures. Therefore, we believe that the information in this study is valid and useful for equine practitioners.

Lacerations of the heel bulb and pastern are common injuries in horses. These wounds usually heal after debridement and lavage followed by primary or delayed primary closure and wound immobilization or wound immobilization alone with healing by second intention.[5] In our study, 51 of 61 horses for which follow-up information was available returned to their intended use after the wound had completely healed.

Laceration of adjacent synovial structures, however, may result in permanent lameness or euthanasia. Synovial structures were involved in 17 horses in our study. The distal interphalangeal joint was most commonly affected. Although follow-up information was available for only 7 of 12 treated horses with lacerations that involved the distal interphalangeal joint, 4 horses were euthanatized because of infectious arthritis refractory to treatment, and 1 horse was persistently lame, presumably as a result of development of osteoarthritis. Follow-up information was available for only 3 of 5 horses that had involvement of either the digital flexor tendon sheath or proximal interphalangeal joint, and 1 had persistent lameness. It appears that heel bulb lacerations should be closely examined to determine whether synovial structures are involved. Results of our study suggest that horses with heel bulb lacerations that involve synovial structures have a poorer prognosis for complete recovery, compared with horses without involvement of synovial structures.

Traumatic wounds involving synovial structures usually carry a poor prognosis, as seen in the horses in this study. Severe or chronic infections are difficult to treat because of the vascular thrombosis, ischemia, and tissue necrosis that accompany these injuries. Resolution of the infection requires delivery of an appropriate antimicrobial to infected tissues in concentrations greater than the minimum inhibitory concentration.[9]

Vascular injury or thrombosis limits the delivery of systemically administered antimicrobials. Regional limb perfusion involves delivering an antimicrobial under pressure to a selected region of the limb through the venous system.[10] Results of studies[11] indicate that peak antimicrobial concentration in synovial fluid is 221 µg/mL after perfusion of the distal portion of the limb versus 7.6 µg/mL for IV administration; tissue concentrations remained greater than the minimum inhibitory concentration 8 hours after perfusion. Although regional limb perfusion with antimicrobials was not used as a treatment in horses with involvement of synovial structures reported here, we have since added this treatment modality for similarly affected horses. We suspect that the outcome may have been improved had we used regional limb perfusion in horses in this study.

Another treatment option for septic synovial structures is arthroscopic lavage of the joint or digital tendon sheath. An advantage of this technique is the ability to assess cartilage and synovial structure damage, which is useful in predicting prognosis. In addition, arthroscopic lavage allows more complete and thorough lavage of bacteria and debris from the joint capsule. Disadvantages are the need for general anesthesia and the financial cost of the surgical procedure.

In our study, infectious arthritis of the distal interphalangeal joint and disruption of the deep digital flexor tendon were 2 reasons for euthanasia in horses with heel bulb lacerations involving adjacent synovial structures. On the basis of the frequency of synovial structure involvement in our study, we recommend that horses that are to be referred to a secondary examiner be treated with broad-spectrum antimicrobial and nonsteroidal anti-inflammatory drugs prior to transport. Although no significant difference in outcome between horses treated or not treated with antimicrobial drugs prior to referral was found, failure to treat with antimicrobial drugs may allow infectious microorganisms to proliferate and result in infectious arthritis that may be refractory to treatment. Treatment with anti-inflammatory drugs may be indicated if the lameness in the injured limb is of such great severity that laminitis in the opposite limb could develop. Most horses in our study were not treated with antimicrobial drugs prior to referral. Optimally, cytologic examination and bacterial culture and susceptibility testing of synovial fluid should be performed prior to antimicrobial drug treatment to avoid interference of these drugs with bacterial culture of synovial fluid; however, if these procedures cannot be performed prior to referral, treatment with broad-spectrum antimicrobial drugs is recommended until synovial structure involvement can be determined. Fifty-six horses in our study received antimicrobial drugs as part of the treatment regimen. Trimethoprim-sulfadiazine was used most commonly because it has broad-spectrum activity, can be administered PO, and is relatively inexpensive. Selected horses were treated with enrofloxacin. The authors, however, do not recommend the use of fluoroquinolones as first-line antimicrobial drugs for treatment of horses with heel bulb lacerations because of the potential human health risk associated with the development of bacteria resistant to fluoroquinolones. We speculate that the fluoroquinolones were likely selected for horses with involvement of synovial structures or failure to respond to other antimicrobials, although this was not noted in the medical records.

Initial treatment of heel bulb lacerations should consist of wound debridement, cleansing, and lavage with an antiseptic solution; however, extensive debridement of the wound should be avoided because of the possibility of damaging the neurovascular bundle. Dilute (0.1%) povidone iodine solution is considered the antiseptic of choice.[12] Chlorohexidine solution should be used cautiously near joints and tendon sheaths.[8] All horses in our study underwent this treatment during initial examination.

After thorough cleansing, the wound should be explored to determine the severity of damage to soft tissue and involvement of synovial structures. Early recognition of joint involvement is important because treatment can be initiated immediately and joint destruction prevented.[3] The proximal and distal interphalangeal joints should be infused with a sterile polyionic solution to establish the integrity of the joint capsule adjacent to the wound. The integrity of the digital flexor tendon sheath can be determined by attempting to distend the sheath via injection of sterile polyionic solution and by visual inspection. Ultrasonographic examination of soft tissue structures near the wound may be useful for determination of the extent of soft tissue injury.

Affected joints and tendon sheaths should be lavaged aggressively on the day of initial examination and then every other day until analyses of synovial fluid or clinical signs indicate that lavage is no longer required.[3] In our study, 13 of 16 horses underwent lavage of a synovial structure. The distal interphalangeal joint was the most common synovial structure injured and to undergo lavage. The proximal interphalangeal joint underwent lavage in 2 horses; however, for reasons that could not be determined from medical records, none of the lacerated tendon sheaths were lavaged. All lacerations that involve synovial structures should be considered contaminated, and delayed primary closure of the laceration should be performed if possible, but only after the synovial structure has been lavaged repeatedly, is no longer infected, and does not communicate with the wound. In our study, no wounds underwent delayed primary closure; synovial structures were lavaged, and wounds were allowed to heal by second intention.

Most horses in our study had contaminated wounds or wounds of chronic duration. Wound age is not as important as the health and nature of the wound; however, wounds older than 6 to 8 hours[13] should be closed by use of delayed primary closure or allowed to heal by second intention[4] as for most horses in our study. Wounds of chronic duration that contain granulation tissue should be allowed to heal by second intention, or delayed secondary closure should be performed.[4] In our study, 30 wounds were sutured and 70 wounds were allowed to heal by second intention.

On the basis of the results of our study, we recommend primary closure of heel bulb lacerations and support of the wound margins by use of a cast or bandage as the treatment of choice for lacerations that are not grossly contaminated with debris and are of short duration (< 8 hours).[13] When a wound is severely contaminated or tissues are severely traumatized, we suggest application of a foot bandage for 7 to 10 days for debridement of the wound to occur naturally prior to cast immobilization. Application of a cast over severely contaminated wounds or nonviable tissue is not recommended until debridement is complete to avoid delay or inhibition of wound healing.[4]

In our study, all horses (n = 52) in which casts were applied (whether bandaged after cast removal or not) wore the cast for 2.8 ± 1.0 weeks. Cast complications were uncommon; only 2 of 15 horses with follow-up information that had been managed with a cast alone developed pressure necrosis of the skin, which resolved with cast removal and bandage application. Foot casts protect wounds by limiting movement of wound edges, providing tension relief of suture lines, decreasing development of exuberant granulation tissue, and providing a moist environment for reepithelialization.[14] Casts provide more complete immobilization than bandages and are especially useful for treatment of wounds that involve the foot and pastern, areas that are in constant motion.[11] In our study, application of casts was an effective method of long-term immobilization of heel bulb lacerations. The authors' clinical impressions are that there are fewer cast complications with foot casts than with casts applied to the distal portion of the limb or the whole limb. The reasons for these differences are not known, but may include location, use of a smaller amount of cast material in the foot cast, or the foot cast application technique. One potential complication of casts is the development of pressure necrosis of the skin at the top of the cast. To prevent development of this complication, we apply casts to feet that are elevated off the ground and then allow the horse to stand on the limb before the fiberglass cures. This procedure helps conform the inner surface of the cast to the dorsum of the pastern and may have prevented the development of pressure necrosis of the skin even after long-term immobilization.

A properly maintained foot cast in which the top of the cast is secured to the skin with elastic tape to prevent wood shavings, sand, or manure from entering the cast can decrease the incidence of wound contamination. All owners were instructed to monitor horses with a foot cast for complications, including development of a greater degree of lameness and hair loss or lesions above the cast that could indicate development of pressure sores; owners were also instructed to check the cast for breakage. Bandaging alone was used as the primary method of wound immobilization in 48 horses, with duration of bandaging of 4.1 ± 1.3 weeks, which was significantly longer than wounds treated with cast immobilization alone.

Treatment of heel bulb lacerations should be specific for each horse. Owners should be informed of the serious nature of lacerations of the heel bulb and given a realistic prognosis for outcome; owners should also be made aware of potential development of complications. Lacerations of the heel bulb may involve soft tissue and bony structures required for support of body weight. Adjacent structures such as the digital flexor tendon sheath, proximal and distal interphalangeal joints, and deep digital flexor tendon of the pastern can be damaged. Although involvement of the navicular bursa was not found in the horses in this study, the authors have detected its involvement in other horses that had sustained heel bulb lacerations and clinicians should be aware of this possibility. Complications that may arise when synovial structures are involved include chronic infection or development of osteoarthritis. Overall, horses that sustained a heel bulb laceration that did not involve a synovial structure had good prognosis for returning to their intended use.

a. Sterile polyionic solution, Abbott Laboratories, North Chicago, Ill.
b. Vetcast, 3M Corp, Minneapolis, Minn.

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