How to Surgically Access Lesions Beneath the Hoof Capsule

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1. Introduction
Surgical invasion of the hoof capsule is frequently required to effectively treat a variety of conditions affecting the foot of horses. Conditions as simple as subsolar abscesses or as complex as exploration and drainage of the navicular bursa are routinely encountered in equine practice and require the practitioner to be well versed in the techniques and methods available to successfully treat a wide range of maladies. The purpose of this paper is to outline the approaches used by the authors to gain access to structures around and beneath the hoof capsule and to describe treatment protocols for selected conditions.

2. Subsolar Abscesses
Subsolar abscesses are probably the most common condition affecting the foot of the horse for which invasive methods are required. Affected horses often present with a severe lameness of grade 4–5 of 5. An increase in the strength of the digital pulse will be palpable as a result of the inflammation within the foot. Hoof-tester examinations may identify a focal area of sensitivity, such as over a nail hole; however, the pain is most commonly generalized over a large area of the sole. Perineural anesthesia of the palmar digital nerves just proximal to the collateral cartilages will often resolve the majority of the lameness. Occasionally, anesthesia of these nerves at the level of the proximal sesamoid bones is necessary, particularly when the abscess is in the toe region.

Careful examination of the bottom of the foot will often allow identification of a tract or crack that will lead to the abscess. Many times, paring of the sole with a hoof knife is necessary to identify black areas that may lead to the abscess. When a crack or black area is identified, careful exploration is necessary to identify if the abscess is beneath that area. A small, looped hoof knife or a no. 2 curette is useful to explore these areas. A small amount of hoof material should be removed until the crack or black area disappears or until the abscess is opened up. Often, a gray-colored fluid will escape or ooze from the abscess entry site after the abscess is penetrated. The authors prefer to make just enough of an incision to allow the fluid to drain from the abscess cavity. A large hole is generally unnecessary, but small holes can plug and result in recurrence of clinical signs. Large abscesses with significant undermining of the sole may need to be debrided more aggressively.
Routine care after debridement is placing the foot in a bandage to keep dirt and debris from plugging the drainage hole. A simple but effective bandage is made by placing a baby diaper on the bottom of the foot and securing it around the pastern with the self-stick tabs. We usually cover the diaper with an elastic cohesive bandage and then cover it with strips of duct tape to prevent the bandage from wearing through to expose the sole. This type of bandage will generally last 2–3 days or more for stalled horses.

3. Hoof-Wall Resection

Indications for removal of the hoof wall are commonly encountered in the equine practice and can be accomplished in several ways. Currently, the most common condition where hoof-wall removal is indicated as part of the therapy is structural damage and separation at the stratum medium and stratum lamellatum, which is commonly known as “white line disease.” The term white line disease is a misnomer, because the white line is anatomically defined as the junction of the hoof wall and sole; however, white line disease is the most common term used to describe the separation of the hoof wall proximal to the white line. In our opinion, this is a distinct and separate condition from other forms of separation such as a “seedy toe,” which is seen in chronic laminitis. White line disease seems to be a progressive deterioration of the attachment of the hoof wall; this is a result of keratolytic agents that have to be definitively identified. This loss of attachment can occur in hooves that appear healthy on the surface and have no known injury or disease. It is not uncommon for a normal-appearing hoof wall to have a significant amount of the hoof wall detached. This occurrence led to the early descriptions of “hollow hoof.” Farriers familiar with the condition often recognize its occurrence before significant damage has been done. This condition is easily treated with the removal of the diseased tissue and the application of an astringent or antiseptic. If, however, the hoof-wall separation is extensive, removal of the affected and undermined hoof wall is, in our opinion, the most effective way to affect a cure. It is common for the hoof wall to grow back normally and well attached. Hooves affected with chronic laminitis that have developed chronic seedy toe sometimes require dorsal hoof-wall removal to remove the diseased structures and allow an improved quality of hoof wall to grow back. These horses do not routinely regrow a normal hoof wall and typically have an abnormal hoof. Dorsal hoof-wall resection was at one time advocated for the therapy of acute laminitis, particularly where a gas line was apparent. This practice has lost support and is no longer recommended. Some cases of laminitis in which abscession has occurred can benefit from hoof-wall exploration and/or removal to facilitate draining and treating the submural infections. This procedure has usefulness in some cases, and its application varies depending on the condition. Hoof-wall removal can also be useful in dealing with extensively infected and unstable hoof cracks. Removal of the diseased and undermined hoof wall can allow for better resolution of the infection and facilitate treatment of the underlying sensitive tissues.

There have been numerous methods described for removal of hoof wall with each having their application and respective advantages and disadvantages. The most widely used method involves the use of a motorized tool, such as a Dremel, with Tungsten Carbide bits to remove hoof wall or create a groove to separate diseased from normal hoof wall (Fig. 1).

The advantage of using a motorized burr is that it allows controlled and precise removal of tissue. The biggest disadvantage is that it can be quite a slow process when large areas of hoof are being removed. If removal of large amounts of hoof wall is indicated, a pair of half-round nippers from GE Forge can be used to do the “rough” work, and the more precise “edges” can be touched up with the motorized burr.

The use of a hoof rasp and a hoof knife has been described for performing a dorsal hoof-wall resection in cases of subacute laminitis. Although this application is no longer recommended, the procedure can be useful in removing diseased or undermined hoof wall in chronic laminitis cases. This can be an effective and reasonably fast way of removing hoof wall. A variation of this method is using an electric sander with a carbide disc that will remove dis tended and diseased dorsal hoof wall in chronic laminitis cases.

After hoof wall is removed, depending on the condition being treated, it is usually indicated to keep the hoof wall bandaged until the exposed tissue is adequately cornified and the lameness has been resolved. Therapeutic shoeing may be indicated, depending on the case being treated. After the tissues are adequately cornified and firm to the touch, application of a composite reconstructive material may be considered.

The use of a sugar and betadyne paste has also proven to be useful in the treatment of hooves after the removal of the hoof wall. The hypertonicity combined with the antiseptic povidone-iodine does a nice job of drying out the underlying tissues without the use of more harsh astringents. After the tissues are shrunken and dried, the bandages can be removed; either iodine or thimersol can be used to further harden the cornifying tissues.

4. Sequestrum Removal From the Distal Phalanx

The formation of a sequestrum on the distal phalanx generally occurs as a consequence of introduction of environmental pathogens into the soft tissues of the foot. Routine, long-standing foot abscesses that are left untreated may, on occasion, secondarily invade the adjacent bone. When the infection becomes established in the adjacent por-
tion of the distal phalanx, the bone may lose its blood supply, resulting in the development of a sequestrum. Foreign bodies that penetrate the sole may impact the distal phalanx by causing a focal loss of blood supply and the formation of a sequestrum. Similarly, blood-supply alterations associated with laminitis may result in sequestrum formation.

Fig. 1. Chronic hoof crack for >2 yr that intermittently caused severe lameness as a result of underlying infection. (A) Solar view. (B) Lateral quarter. The unattached hoof wall surrounding the crack was removed with (C) a motorized burr until (D) healthy attached margins were encountered.
The clinical signs that would alert a practitioner to the possibility of a sequestrum would include a history of chronic lameness, recurrent purulent drainage from the sole, and the presence of a draining tract that leads to bone. Radiographic evidence of osteolysis or sequestration of a bone segment is definitive for this condition (Fig. 2). Occasionally, osteolysis, not a sequestrum, is identified, which is evidenced by irregular margination and loss of normal bone density. Either of these radiographic presentations (osteolysis or sequestrum) is evidence that surgery is indicated. The infection generally affects the soft tissues of the sole, laminae, and hoof wall as well as the distal phalanx.

Treatment is aimed at surgical debridement of the affected bone and surrounding soft tissues. The goals of surgery are to provide drainage of purulent exudates, debride infected soft tissue, and remove devitalized bone.

Surgery can be performed with the horse anesthetized or standing. The authors typically debride the distal phalanx with the horse standing and the foot blocked. A tourniquet applied around the fetlock to compress the digital vessels against the proximal sesamoid bones will greatly facilitate visualization during surgery (Fig. 3). The cornified sole surrounding the draining tract can be removed with a hoof knife, motorized burr, or in some instances, a scalpel. The laminae between the cornified sole and distal phalanx is removed by sharp dissection, and the draining tract is followed to the bone. Infected bone is softer than normal bone, which is removed with a large-basket spoon curette. The soft tissue and bone are curetted to healthy margins.

Post-operative care involves packing the surgical site loosely with an antiseptic- or antibiotic-soaked sponge and bandaging the foot with a diaper and duct tape. The surgical site is inspected daily, and any questionable devitalized tissue is debrided. Systemic antibiotics are indicated in many cases, but many horses recover without antibiotics. Non-steroidal anti-inflammatories (e.g., phenylbutazone, 2.2–4.4 mg/kg, q 12 h) are indicated to minimize inflammation and encourage weight bearing. In most cases, healing is usually complete in 8–12 wk.

Affected horses have an excellent prognosis for return to athletic function unless laminitis is the underlying cause of the phalangeal infection.

5. Keratomas

A keratoma is a benign, keratin-containing soft-tissue mass that develops between the hoof wall and the distal phalanx. The etiology is unknown but may be a response to chronic irritation.

The clinical signs are those of a progressively developing lameness that becomes more pronounced as the keratoma gradually enlarges and creates pressure between the hoof wall and distal phalanx. The lameness may be intermittent. As the keratoma enlarges, disruption of the external hoof architecture may become apparent as evidenced by a bulge in the hoof wall or inward deviation of white line.

The diagnosis is definitively confirmed when radiography of the digit reveals a semicircular or circular radiolucent defect at margin of the distal phalanx (Fig. 4). This radiographic lesion is the result of the expanding keratoma that causes focal bone resorption. The bone margin surrounding the
keratoma is smooth and not sclerotic, which differentiates a keratoma from an infection.

Surgery is indicated when the lameness is confirmed to originate in the foot using diagnostic blocks and the pathognomonic radiographic lesion is identified. The keratoma is approached by resecting the hoof capsule overlying the mass. The most difficult aspect of surgery is targeting the precise location in which to enter the hoof wall. This is best accomplished by taping radiopaque markers to the hoof wall and obtaining sequential radiographs to ascertain the location. A trephine or motorized burr is used to remove the hoof wall overlying the keratoma. Either method is less invasive than the hoof-wall resection technique previously used, and both preserve the stability of the hoof wall during the convalescent period.

Surgery can be performed in the anesthetized horse or the standing horse anesthetized locally. The authors prefer the standing approach for most horses, unless their temperament precludes this choice. Again, a tourniquet is employed to reduce hemorrhage and aid visualization.

Postoperatively, a foot bandage is applied and changed at 3–4 day intervals until the resected defect in the hoof wall has cornified. After granulation tissue has covered the exposed bone, astringents such as merthiolate (thiamersol) or iodine (2–7%) are applied to dry the tissue and enhance cornification. Phenylbutazone is administered as needed in the post-operative period. Antibiotics are generally unnecessary, because infection does not typically accompany the keratoma.

The prognosis for resolution of lameness and return to intended use is excellent. The hoof-wall entry site usually grows down in 6–12 mo and results in a normal-appearing foot.

6. Necrosis of the Collateral Cartilage

Infection and necrosis of the collateral cartilage can be seen as a sequelae to lacerations, foot abscesses, puncture wounds, gravel (chronic ascending infection under hoof wall), hoof cracks, and blunt trauma (over-reach injuries, kicking inanimate objects), all of which result in avascular necrosis.

Affected horses become lame when abscesses form within the cartilage. The lameness is often intermittent, ranging from mild when the abscesses are draining to the exterior to severe when the draining tracts seal for a period of time. When the infection becomes established, marked soft-tissue swelling over affected cartilage becomes apparent. Puru-
lent drainage from the cartilage may or may not be present at the initial exam depending on the patency of the draining tract.

The diagnosis is made by observation of draining tracts proximal to the coronary band over the affected cartilage. Radiographs obtained with a flexible metal probe in the tract or after infusion of contrast media into the tract will help determine the depth of the tract and confirm involvement of the cartilage. Most importantly, if the abscesses within the cartilage are draining at presentation, the horse may not be extremely lame. This should not delay surgery, because lameness will recur when the draining tracts seal again. Because the cartilage is relatively avascular, antibiotics and infusion of caustic agents into the draining tracts is usually ineffective in resolving the infection.

Surgery is indicated based on the presence of a swollen cartilage with draining tracts. Treatment is aimed at excision of the affected portions of cartilage and overlying soft tissue and establishment of ventral drainage. The surgery is accomplished with the horse in lateral recumbency. As with other foot procedures, a tourniquet is applied to enhance visualization during surgery. In addition, regional perfusion of the distal limb can be performed while the tourniquet is in place. Only the infected portions of the collateral cartilage need to be excised. During the surgical procedure, the foot is extended in an attempt to tense the palmar pouch of the distal interphalangeal joint and retract it from the deeper areas of dissection. The authors prefer to access the proximal portion of cartilage above the coronary band through a curved incision based proximally (Fig. 5). This technique preserves skin for primary closure and allows easier access to portions of the cartilage that will be accessed through the hoof wall later in the procedure. The skin flap is reflected proximally, and all accessible diseased proximal cartilage is removed. Diseased cartilage beneath and distal to the coronary band is removed through a trephine hole in the hoof wall (Fig. 5). The tissue and cartilage between the trephine hole and proximal incision is removed by sharp dissection to allow for ventral drainage. If the diseased tissue extends axially toward the joint, the integrity of the joint can be assessed using arthrocentesis and distention of the distal interphalangeal joint at a site remote from the surgical incision. At the completion of surgery, the skin incision is sutured, and the trephine hole is packed loosely with gauze sponges. The foot is bandaged until the skin incision is healed and the trephine hole is cornified. Systemic antibiotics are generally indicated for 7–10 days. Additionally, regional perfusion of the distal limb should be considered in cases where diseased tissue extends down to the region of the distal interphalangeal joint in a location that would risk penetration of the joint capsule with overzealous debridement.

The prognosis is good after complete resection of the diseased cartilage and soft tissue. Incomplete resection, however, may be complicated by recurrence of clinical signs and necessitate reoperation.

7. Conclusion

Because of the hoof capsule, surgery of the equine foot is often perceived to be quite difficult. Knowledge of the specific diseases that require surgical intervention as well as an in-depth understanding of the anatomy of the tissues beneath the hoof capsule is a prerequisite to successful surgical treatment. The surgical principles used to treat the conditions outlined can be applied to a variety of other conditions for which access through the hoof wall is required.

Footnote

*Vetrap, 3M Animal Care Products, St. Paul, MN 55144.