Hoof Cracks and Wall Defects

G. Kent Carter, DVM, MS; and Jason Maki, Dipl WCF, CJF

Authors' address: Department of Large Animal Clinical Sciences, Texas A&M University, College of Veterinary Medicine and Biomedical Sciences, College Station, Texas 77843; e-mail: kcarter@cvm.tamu.edu.

1. Introduction

Hoof cracks and wall defects are common problems encountered in equine practice that vary in severity and clinical significance to the individual horse. Many simple cracks or defects may require nothing more than adequate trimming and shoeing of the foot. However, unstable complicated cracks and large or unstable defects will require removal of the affected tissues or stabilization and therapy to address the complications (e.g., infection) to prevent or treat lameness. The major goals of treating hoof-wall cracks and defects are to correct the cause, when possible, debride affected tissues, and stabilize the hoof wall, when necessary. Other supportive treatments, such as treatment of local infections and therapeutic shoeing, can also be important to a successful outcome.

2. Hoof Cracks

Hoof-wall imbalances from conformational abnormalities and/or improper trimming and shoeing can be associated with the occurrence of hoof-wall cracks. However, there are a number of horses with apparently structurally sound feet and good shoeing practices that develop hoof cracks. If imbalance or shoeing abnormalities exist, correcting the observed abnormalities should help in the resolution and prevent recurrence of the crack. If, however, imbalances and shoeing or trimming problems are not observed, therapeutic shoeing options may be less apparent.

Poor hoof care and neglect are causes of hoof cracks. Excessive hoof length, which predisposes the hoof wall to break off, can lead to hoof cracks, usually originating at the solar surface and migrating proximally. Hoof cracks are not uncommon in horses maintained barefoot. However, the cracks that we are asked to deal with in most performance horses are in shod horses, and most occur at the coronary band at the quarter and migrate distally. A true quarter crack usually leads to instability, inflammation, and infection.[1] Feet that are long-toed with short-shod underrun heels is a common hoof conformation that is observed in horses presented with quarter cracks, particularly in racehorses.[2] A sheared heel is apparent on most cases of quarter cracks in performance horses seen by the authors. In observing a typical foot affected by a sheared heel and a quarter crack, one can see a distinct proximal deviation of the coronary band at the site of origin of the crack (Fig. 1). This deviation of the coronary band is not typically seen on the opposite side of the foot. In the authors' experience, this occurs far more commonly on the medial heel of the forefeet. However, sheared heels and quarter cracks can occur on the lateral heel, partic-

NOTES

Fig. 1. A foot with a quarter crack. Note the displacement of the coronet in the area of the crack.

ularly in horses with excessive toe-in conformation. Quarter cracks are not common in the rear feet, but they are occasionally encountered. Although sheared heels are usually conformation-related, they can be exacerbated by trimming and shoeing when the abnormal hoof growth and distortion are not recognized and appropriately addressed. In some cases, therapeutic shoes applied for lameness problems can create distortion of the hoof capsule and lead to a sheared heel and a quarter crack. An example is a wedged-egg bar shoe applied to help relieve pain from navicular disease that leads to a quarter crack.

3. Therapy

Appropriate attention to the imbalances that occur in the foot, both medial lateral balance as well as dorsal to palmar balance, is as important as any other therapy done to the foot. You can repair a hoof crack by a number of techniques and employ several shoeing options, but continued appropriate trimming and balance of the foot are necessary to effectively heal and manage a foot affected with a quarter crack for the long term. It is not uncommon for the authors to examine horses that have hoof cracks that stabilized and then reoccurred, because the original hoof imbalances were not addressed. The authors have successfully managed numerous quarter cracks by properly applied trimming and shoeing without stabilization of the crack by other described methods. However, many of the horses presented with quarter cracks are intended to perform, and time out of training is undesirable to the owners. Therefore, stabilization of the hoof crack in concert with appropriate trimming and shoeing is often employed to allow the horse to perform while the crack grows out. A commonly occurring hoof imbalance seen by the authors in a foot with a medial quarter crack is a long medial sheared heel, a long lateral toe, and usually to some degree, an underrun heel. Trimming to address these abnormalities includes shortening the medial heel, particularly from the crack or bulge in the coronary band palmar, shortening the lateral toe, and backing up the bearing surface of the heels to the widest part of the frog combined with backing up the toe to allow for a better break-over of the hoof. Floating of the heel palmar to the hoof crack, although not a universally accepted concept, has been useful in these authors' hands. By removing ground forces palmar to the crack, it allows the hoof capsule's proximal distortion to somewhat correct. In fact, when trimming a horse with a crack, it is common to float the affected heel, trim the opposite toe quarter, and then, allow the horse to stand on a flat surface while the other three feet are trimmed and shod. In most cases, there will be a discernable change in the coronary band; usually, the affected heel will have settled to some degree and in some cases, become weight-bearing on the ground surface. It may be of further advantage to allow the horse a period in the stall with sole and frog support to effectively float the affected heel for a longer period of time, allowing for more accommodation before shoeing and repair. Allowing the hoof palmar or plantar to the crack opportunity to correct as much as possible before stabilizing it with a rigid repair will afford a better long-term outcome. Therefore, these authors usually shoe the horse with a bar shoe, float the medial heel, and postpone rigid repair for 1–2 wk. This period allows more opportunity to correct the sheared heel and for the coronet to assume a more normal position; it also allows time to ensure that the infection in the crack is controlled. Various configurations of bar shoes can be used to effectively increase the bearing surface of the foot, provide palmar support, and decrease the independent vertical movement of the heels. Types of bar shoes commonly employed include straight-bar, egg-bar, z-bar, and heart-bar.[3]

Hoof-crack stabilization, although not always necessary, can be an important aspect of dealing with cracks that are causing lameness, increasing in size, or occurring in horses that must perform. There are numerous techniques and materials described for repairing hoof-wall cracks that have merit in individual circumstances. Methods of repair can be rather complicated and require some expertise to apply, whereas others, although simple, may not provide adequate stabilization for the horse to compete and the crack to heal. Regardless of which method of repair is applied and what supportive care is provided, the goal of any repair technique is to provide adequate stability of the hoof wall adjacent to the crack. The degree of stabilization and strength of the repair required can vary with the use of the horse and whether a period of rest from athletic use can be afforded. The challenge often facing the practitioner is the importance of the horse's continued performance with a hoof crack that is creating lameness. One important aspect of treating hoof-wall cracks that is often not stressed

enough is to not make a bigger problem with your treatment. There are several techniques described that use screws placed into the hoof wall as part of the repair. Screws are incorporated into fiberglass repairs[4] and screw and wire repair; additionally, screws with an adjustable tension-band device[5] and plates of a variety of materials attached across the crack with screws are used. Although these can be effective and are routinely used, problems such as lameness or submural abscesses can be encountered if the screws impinge on the sensitive lamina. In the authors' experience, most horses will tolerate the use of 0.375-in sheet-metal screw, but some will not. Horses with thin hoof walls and cracks near the heels or coronary band have the highest risk for problems with screws. If a screw used in a composite hoof-crack repair penetrates the sensitive lamina and creates a submural abscess, it may require removal of the hoof-wall repair and part of the hoof wall to resolve the complication. The horse could be out of use for an extended period of time if this happens.

There are a number of repair techniques described that use stainless-steel wire or synthetic material in different suture patterns across the crack. To achieve these repairs, holes are drilled into the hoof wall to accommodate the sutures. It is extremely important that these drill holes not penetrate the sensitive laminae, because if the drill holes expose sensitive laminae and the suture is used in conjunction with a composite repair, a submural abscess and associated complications could arise. Lacing the crack with synthetic material and incorporating it into the composite repair has been described as an effective method of repair that provides good stabilization of the crack.[6] A more recently described similar approach uses a relatively fine-gauge wire suture that incorporates a small metal tab,[a] which prevents the wire from cutting through the hoof wall.[3] One advantage to this technique is that the small-size wire requires a much smaller hole and drill bit, and therefore, there is less damage to the hoof wall and less likelihood of exposing the sensitive lamina with the drill bit.

Several materials have been used in composite reconstruction of hoof-wall cracks and hoof-wall deficits. Flexible polymethylmethacrylate,[b] seems to be most commonly used for this purpose, and these materials can be used by themselves or in combination with several methods used to stabilize the hoof-wall crack. It is not uncommon for hoof-wall defects to be filled with the polymethylmethacrylate material alone, but most veterinarians recommend incorporating fabric such as spectra, fiberglass, or kevlar in the repair. Incorporation of a composite in the repair of the hoof-wall crack will aid in the strength and stability of the repair. It is imperative that proper application principles be followed when performing these repairs, because the material may not adhere to the hoof properly or abscessation of sensitive tissues could occur under the repair.

If a composite is to be used in the repair, the following principle should be followed to improve chances for success and decrease potential for complications. Clean the crack with a Dremel[c] tool and a cross-cut tungsten carbide bur.[d] All loose horn and debris should be removed from the crack. Cracks that are infected and/or have exposed non-keratinized tissue should be opened to enhance drainage and treatment of the crack. If non-keratinized tissue or infection is present, either (1) delay further repair until lamellar tissues are keratinized and can be safely covered, providing stabilization (for example, wire fixation without a composite covering can be done at this time, and composite reconstruction can be done at a later date), or (2) if immediate repair is required, use a technique to allow drainage and treatment of the crack and prevent abscessation under the composite repair. Infected or exposed areas can be protected by applying modeling clay/dough[e] or hoof putty[f] over the tissues and placing a drain tube of small silastic or rubber tubing along the crack for the length of the repair. The tubing can be removed after cure of the polymethylmethacrylate, leaving a tunnel that transverses the crack and provides drainage that is accessible to therapy. Although it is the authors' preference to allow infections to resolve and the tissue to keratinize before application of the polymethylmethacrylate, there are times where rapid return to athletic use warrants the application of a polymethylmethacrylate before healing. If this is done, it is extremely important that adequate drainage be afforded.

The hoof wall should be sanded, dry, and clean before application of the polymethylmethacrylate. If the hoof is not dry, it can be slowly dried with a heat gun (paint stripper) and then treated with acetone or denatured alcohol before application of the polymethylmethacrylate. A wrap of elastic bandage[g] at the coronary band prevents the polymethylmethacrylate material from contacting the skin and hair above the coronary band.

When applying the polymethylmethacrylate, it is desirable to incorporate fiber (kevlar, spectra, or fiberglass) into the repair for strength and cover the repair with plastic wrap to improve the appearance and cure of the resin. After curing, the rough edges are trimmed and sanded and then the horse is shod with the appropriate shoe. The authors prefer a bar shoe in many cases, but the location and severity of the crack will affect the shoeing regimen chosen. If the horse is exposed to excess moisture and mud, this will affect the longevity of the composite repair and hoof quality under the repair. Therefore, it is important to avoid excess exposure to moisture.

Fig. 2. A hoof with white-line disease. Note the probe inserted into the affected area of the hoof.

4. Hoof-Wall Removal for Hoof-Wall Defects

Indication

Indications for removal of hoof wall are commonly encountered in the equine practice and can be accomplished in several ways. Currently, the most common condition that we see when hoof-wall removal is indicated as part of the therapy is the structural damage and separation at the stratum medium and stratum lamellatum, 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 hoof wall proximal to the white line. In the authors' experience, this is a distinct and separate condition from other forms of separation, such as a seedy toe seen in chronic laminitis. White line disease seems to be a progressive deterioration of the attachment of the hoof wall that seems to be the result of keratolytic fungal and/or bacterial agents. 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 an outwardly normal-appearing hoof wall to have a significant amount of hoof wall unattached (Fig. 2). This occurrence led to the early descriptions of hollow hoof. Farriers familiar with the condition often recognize its occurrence before significant damage is done. This is easily treated with removal of the diseased tissue and use of an astringent/antiseptic. If the hoof-wall separation is extensive, removal of the affected undermined hoof wall, in our opinion, is the most effective way to affect a cure. It is common for the hoof wall to grow back completely 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 grow back 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 abscessation has occurred can benefit from hoof-wall exploration and/or removal to facilitate draining and treating the abscessation. This procedure has usefulness in some cases, and its application will vary with personal preference. 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 better resolution of the infection and facilitate treatment of the underlying sensitive tissues.

Hoof-wall injuries can sometimes result in areas of unattached, unstable hoof wall, and removal is indicated. It is not uncommon for the authors to encounter horses that have avulsions of part of the hoof wall that require removal of unattached, undermined hoof wall. If the hoof wall is undermined, unstable, and separated from the dermal laminae, it is not providing support for the foot and in most cases, is best to be removed. Removal of the unattached areas facilitates healing and allows normal hoof growth to occur.

Procedure

There have been numerous methods described for removal of hoof wall, and each has its application and respective advantages and disadvantages. Probably the most widely used method involves the use of a motorized tool, such as a Dremel, and tungsten carbide bits to remove hoof wall or create a groove to separate diseased from normal hoof wall.

The advantage of this procedure is the controlled and precise removal of tissue. The biggest disadvantage, in our opinion, is that it can be quite slow when removal of large areas of hoof is necessary. Hand-held Dremel tools are adequate for most practitioners' needs and are readily available and affordable. If, however, this procedure is routinely performed, larger, more powerful equipment with a flexible shaft is a worthwhile investment. The use of a die grinder with a tungsten carbide bit has been described as a superior method.[7] The authors routinely use a flexible-shaft motorized bur in the removal of hoof wall. However, if a large amount of hoof-wall removal is indicated, the rough work is done with a pair of half-round nippers,[h] and the final work is done with the motorized bur.

The use of a hoof rasp and a hoof knife has been described for performing a dorsal hoof-wall resection in cases of sub-acute 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 is using an electric sander with a carbide disc, which will remove distended and diseased dorsal hoof wall in chronic laminitis cases.

The use of a cast cutter has been described for hoof-wall ablation in chronic non-healing hoof

Fig. 3. Removal of a keratoma from the hoof.

cracks. The main advantage of using the cast cutter is that it greatly speeds up the procedure. The main disadvantage to its use is that it lacks the control and precision of a motorized bur. With the cast-cutter technique, it is important to not cut the coronary band and not cut too deeply when cutting through the hoof wall into the sensitive lamina. A cast cutter or surgical saw can be used to facilitate hoof-wall removal for other conditions such as a keratoma (Fig. 3). Alternately, a trephine of appropriate size can be used to remove portions of the hoof wall to aid in removal of a keratoma without removal of the hoof wall from the coronary band to the solar surface, which maintains stability to the hoof capsule.

After the 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 lameness has resolved. After the tissues are adequately cornified and firm to the touch, application of a composite reconstruction may be considered, if needed.

The use of a sugar and betadyne paste has proven useful in the treatment of hooves after removal of the hoof wall and exposure of laminae. If the exposed tissues are not cornified, a mildly hypertonic material is preferred by the authors to use on the soft tissues as a first stage in the healing process, because 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. Harsh astringents, like strong 7% iodine, when used at this time will damage tissues and delay healing. After the tissues have shrunk and dried, then remove the bandages and use tincture of thimerosal to further harden the tissues. In conditions such as white-line disease, the exposed tissues are often not suppurative or moist and support the use of a more aggressive astringent/disinfectant. A number of disinfectants/astringents may be used; the authors prefer tincture of thimerosal, because it provides good results and the color allows for better determination of infected tracts at later evaluations.

Therapeutic shoeing is applied as indicated for the conditions being treated. Most feet will benefit from the use of a bar shoe and moving the breakover back, particularly in conditions where the dorsal hoof capsule is removed. The type of shoe that is applied will depend entirely on the magnitude and location of the hoof wall removed.

5. Discussion

Management of hoof cracks and wall defects are an important aspect of equine veterinary and farriery practice. Understanding the predisposing factors, causes, and therapeutic options provides the practitioner with the knowledge to effectively manage these problems. Experienced and effective farriery practices are essential to a successful outcome. In many cases, the teamwork of the equine veterinarian and the farrier significantly increases the opportunity for a successful outcome.

References and Footnotes

1. O'Grady SE. Quarter crack repair: an overview. *Equine Vet Edu* 2001;216–219.
2. Moyer W. Hoof wall defects: chronic hoof wall separations and hoof cracks. *Vet Clin North Am [Equine Pract]* 2003; 463–477.
3. O'Grady SE. How to repair a quarter crack, in *Proceedings*. 47th Annual American Association of Equine Practitioners Convention 2001;287–290.
4. Butler J. The repair of hoof cracks using fiberglass and screws, in *Proceedings*. 22nd Annual American Association of Equine Practitioners Convention 1976;235–237.
5. Blackford JT, Blackford LAW, Latimer FG. Adjustable tension band stabilization of hoof cracks in horses, in *Proceedings*. 37th Annual American Association of Equine Practitioners Convention 1991;497–512.
6. Moyer W. Repairing hoof cracks in the horse: a review and a report of a new technique. *Compend Cont Educ Pract Vet* 1983;S495–S498.
7. McKinley I. Repairing quarter cracks and managing wall separations, in *Proceedings*. American Association of Equine Practitioners Focus Meeting on the Foot 2009;175–180.

[a]Tenderhoof Solutions, Fonthill, Ontario, Canada LOS 1EO.
[b]Equilox, Equilox International, Pine Island, MN 55963.
[c]Dremel, Dremel Tool Co., Emerson Electric, Racine, WI 53401.
[d]MSC Industrial Supply, Melville, NY 11747.
[e]Play-Doh, Hasbro Inc, Pawtucket, RI 02861.
[f]Keratex putty, Advance Equine, Versailles, KY 40383.
[g]Elastikon, Johnson & Johnson Co. Inc., Skillman, NJ 08558.
[h]Half Round, G.E. Forge & Tool Inc., Grover Beach, CA 93433.