

# Hoof Care and Disease

With club feet veterinarians aim to improve horses' comfort and minimize toe trauma.

PAULA DA SILVA/WWW.ARID.NL

NANCY LOVING, DVM

## Recognizing Club Foot Cases

Not all horses have symmetrical feet, and one of the more common problems they develop is a “club foot” appearance. This problem might appear at birth or develop later in life and can be identified based on classic signs and grades of severity.

Robert Hunt, DVM, MS, Dipl. ACVS, of Hagyard Equine Medical Institute, in Lexington, Ky., defined a club foot as having an angle greater than 60° (the angle the dorsal hoof wall makes with the ground). Usually there is at least a five-degree discrepancy between the affected foot and its opposite.

“Initially, an owner may recognize a space between the heel and the ground that develops slowly over two to three hoof trims,” Hunt explained. “The second sign is that the coronary band appears square and full. Then, the foot appears boxy with a dish in the front of the hoof wall. And eventually, the frog becomes quite recessed, the hoof contracts, and the horse appears ‘back at the knee.’”

With this change in biomechanics, Hunt said, “The foot is prone to injury since loading on the foot moves forward, altered from its normal, heel-first landing.”

A more accurate description of a club foot is a flexural limb deformity of the coffin joint. In most cases, shortening of the musculotendinous unit (which runs down the back of the leg) that shifts the load dorsally (forward) in the foot causes it.

Veterinarians have used multiple club foot classification systems: Type 1 refers to a club foot with a hoof axis less than 90°; Type 2 is greater than 90°. Or, they can use a grading system of the hoof axis relative to the opposite limb to define severity: Grade 1 is 3-5°; Grade 2 is 5-8°; Grade 3 has a broken-forward hoof-pastern axis (HPA)—in which the hoof wall angle is steeper than that of the pastern, hoof wall dishing, and irregular growth rings; Grade 4 has a hoof angle greater than 80°, a severely broken-forward HPA, marked concavity to the dorsal hoof wall, and the coronary band height at the heel is the same as at the toe.

“(Congenital cases) are self-correcting with minimal treatment other than toe protection.”

DR. ROBERT HUNT

Usually, congenital cases (present at birth) “are self-correcting with minimal treatment other than toe protection,” Hunt said. Veterinarians can also administer systemic oxytetracycline, but he says too much oxytetracycline treatment can cause excessive joint laxity.

An acquired flexural deformity usually appears when a foal is 4-6 months old. “It may result as a primary problem possibly due to a genetic predisposition,” he said. But “it is often secondary to other lameness ... such as pain elsewhere in the limb that alters weight-bearing on that leg.

“Treatment varies depending on age of horse, severity, and client expectations,” he stressed. “The guiding principle is to improve comfort and minimize toe trauma while trying to reestablish load bearing on the heels.”

He cautioned against using external shoe devices that improve the ‘look’ but don’t achieve a long-term solution. In assessing an adult horse with a club foot, Hunt urged veterinarians to carefully consider the horse’s intended use and to pay close attention to current management, including farrier care and nutrition.

## Localizing Pain in the Feet

Practitioners must hone skills and strategies for pinpointing equine foot pain so they can detect the slightest aberration with sharp eyes and deft hands. Debra Taylor, DVM, MS, Dipl. ACVIM, and John Schumacher, DVM, MS, of Auburn University’s College of Veterinary Medicine, described methods for pain localization.

Veterinarians should examine all aspects of a lame foot, noting any abnormal biomechanics that could contribute to pain. Taylor said, “The coronary band normally is straight or slightly arched, running at an angle about 20-25° from the ground plane. Hairs should lie flat against the coronary band, and the coronary band should feel full and spongy without a ledge.”

Hoof wall “tubules ... should be straight without flares or bends,” she added. “The white line should be tight and about ¼ inch wide (not stretched/separated). Normal frog width is 50-60% of its length. Its depth should reach the bearing surface with no relative space under the rear of the foot. The central sulcus should be wide enough to fit an index finger.” Contraction indicates possible pain. Collateral grooves at the frog sulci apex should be about 11

mm deep; depth might indicate sole depth and coffin bone orientation.

The heel should feel like a tennis ball on palpation, added Taylor, and there should be at least three- to four-fingers' width between the bulbs. Collateral cartilages should feel flexible with finger pressure, and the digital cushion should fill to the top of the cartilages. Always compare each foot to its opposite, and use hoof testers to assess for specific pain areas.

Changing gears, Schumacher described using digital anesthesia (nerve blocks) to localize lameness, suggesting that mepivacaine is the least irritating drug to use for regional or joint anesthesia. Historically, clinicians thought palmar digital nerve (PDN or heel) blocks numbed the back  $\frac{1}{3}$  to  $\frac{1}{2}$  of the foot. However, researchers have shown this block can also anesthetize the coffin joint, entire foot, and even the pastern joint, potentially interfering with lameness assessment.

"Blocking of the coffin joint is known to also numb the sole and even the heel if sufficient volume is placed into the joint," he reported. "Blocking the coffin joint also blocks the navicular apparatus with incidental anesthesia of the palmar digital nerves (which feed the navicular region). However, anesthesia of the navicular bursa only has an effect on sole pain at the toe but does not desensitize the heel."

In summary, practitioners must conduct a thorough physical exam and use hoof testers and flexion tests to reach an accurate foot pain diagnosis. He or she can use digital anesthesia to rule out problems in higher limb structures, but this method has limited value in localizing an area of distal limb pain. "Consequently," stressed Schumacher, "Results from digital anesthesia must be interpreted with caution."

### Biomechanics and Hoof Problems/Treatment

Lameness caused by foot problems is common in the horse, and it can significantly impact performance. Hoof bruising, heel soreness, and hoof cracks all create discomfort that alters a horse's gait and prevents him from giving his utmost to an athletic task. Nearly all equine foot diseases have their root in biomechanics, noted Andrew Parks, MA, VetMB, MRCVS, Dipl. ACVS, professor of Large Animal Medicine at the University of Georgia School of Veterinary Medicine, and veterinarians

and farriers must take a biomechanical approach to treating these problems.

Parks reviewed important elements of equine foot anatomy during his session.

He started with a bit of biomechanical anatomy review: While the long bones of the skeletal system, such as the radius (forearm) or the cannon bone, effectively transmit force from one end to the other, the distal phalanx (coffin bone, a short bone), acts as a shock absorber, transferring weight-bearing forces from the hoof to the skeletal system. This bone is also well-adapted for attachment to soft tissues (tendons and ligaments) that aid or resist movement.

"The principle forces acting on the foot are the weight of the horse, the ground

reaction force (GRF), and the tension in the deep digital flexor tendon (DDFT, which runs from the underside of the coffin bone to the flexor muscles higher in the leg)," Parks explained.

The GRF matches the weight the limb bears, but it is exerted in the opposite direction. When a horse's foot stands on a flat, firm surface, the GRF distributes around the perimeter of the hoof capsule. But when standing on a conformable surface such as sand, the GRF distributes broadly across the bottom of the horse's foot. In both cases GRF pressure is greatest approximately in the center of the foot, just in front of the coffin joint.

The hoof is unique in that it is comprised of many different types of integument that

## RADIOGRAPHS' ROLE IN FARRIERY

Radiographs are an often overlooked but indispensable tool for assessing a horse's feet and developing a hoof care plan that will maximize his soundness. Randy Eggleston, DVM, of the University of Georgia's School of Veterinary Medicine, explained that radiography allows the veterinarian to measure sole depth, solar angles, and foot balance, as well as evaluate the health of the coffin bone and then formulate advice for the farrier.

Because the hoof can conform to the stresses it incurs on impact with each footfall, a visual exam helps the practitioner evaluate it for distortions and abnormalities that might develop over time due to hoof imbalances. Eggleston recommended using radiography if the veterinarian observes abnormal hoof and/or distal limb conformation, abnormal growth patterns, or hoof distortions; and/or when distal (lower) limb anesthesia blocks out lameness.

To achieve good-quality images, the handler should square the horse up as best as possible on a firm surface, with his head and neck aligned straight; any twisting will distribute weight unequally between the feet. Eggleston recommended placing positioning blocks of similar height beneath each hoof.

Hoof hygiene is another key element to getting quality films, and Eggleston noted that the hoof wall and frog sulci (the grooves next to and in the middle of the frog), in particular, should be cleaned well.

Applying radio-opaque markers to the dorsal hoof wall and the bottom of the hoof allows the veterinarian to see these surfaces and angles on the radiographs and make accurate measurements and assessments. For images that require the frog sulci to be packed, he highly recommended placing the horse's foot in a water bath since this technique helps remove artifacts that can make X rays difficult to read.

Eggleston suggested that in addition to radiographing the hoof using a lateral-medial (side to side) view, the veterinarian should also obtain a horizontal dorsal-palmar (front to back) view aiming the X ray beam parallel to the bottom of the foot. With these multiple radiographic views, the veterinarian can obtain quantitative measurements to best plan trimming and shoeing strategies for the individual horse and facilitate good communication with the farrier to execute these recommendations.



To achieve good-quality images, place positioning blocks of similar height beneath each foot.

ERICA LARSON



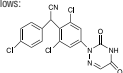
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**CAUTION**  
 Federal (U.S.A.) law restricts this drug to use by or on the order of a licensed veterinarian.

**NADA #141-268 Approved by FDA**
**DESCRIPTION**

 Diclazuril, (±)-2,6-dichloro-4-(4-chlorophenyl)-4-(4,5-dihydro-3,5-dioxo-1,2,4-triazin-2-yl)-benzenesulfonamide, has a molecular formula of  $C_{21}H_{14}Cl_4N_4O_2$ , a molecular weight of 407.64, and a molecular structure as follows:

 Dicazuril is an antiprotozoal (antiparasitic) compound with activity against several genera of the phylum Apicomplexa. PROTAZIL<sup>®</sup> (dicazuril) is supplied as oral pellets containing 1.56% dicazuril to be mixed as a top-dress in feed. Inert ingredients include dehydrated alfalfa meal, wheat middlings, cane molasses and propionic acid (preservative).

**INDICATIONS**

 PROTAZIL<sup>®</sup> (1.56% dicazuril) Antiprotozoal Pellets are indicated for the treatment of equine protozoal myeloencephalitis (EPM) caused by *Sarcocystis neurona* in horses.

**DOSEAGE AND ADMINISTRATION**
**Dosage:** PROTAZIL<sup>®</sup> (1.56% dicazuril) is administered as a top dress in the horse's daily grain ration at a rate of 1 mg dicazuril per kg (0.45 mg dicazuril/lb) of body weight for 28 days. The quantity of PROTAZIL<sup>®</sup> necessary to deliver this dose is 64 mg pellets per kg (29 mg pellets/lb) of body weight.

**Administration:** To achieve this dose, weigh the horse (or use a weight tape). Scoop up PROTAZIL<sup>®</sup> to the level (cap mark) corresponding to the dose for the horse's body weight using the following chart:

Weight Range of Horse (lb)	mLs of Pellets	Weight Range of Horse (lb)	mLs of Pellets
275 - 524	20	1275 - 1524	60
525 - 774	30	1525 - 1774	70
775 - 1024	40	1775 - 2074	80
1025 - 1274	50	-	-

 One 2-lb bucket of PROTAZIL<sup>®</sup> will treat one 1100-lb horse for 28 days. One 10-lb bucket of PROTAZIL<sup>®</sup> will treat five 1100-lb horses for 28 days.

**CONTRAINDICATIONS**

 Use of PROTAZIL<sup>®</sup> (1.56% dicazuril) Antiprotozoal Pellets is contraindicated in horses with known hypersensitivity to dicazuril.

**WARNINGS**

For use in horses only. Do not use in horses intended for human consumption. Not for human use. Keep out of reach of children.

**PRECAUTIONS**

 The safe use of PROTAZIL<sup>®</sup> (1.56% dicazuril) Antiprotozoal Pellets in horses used for breeding purposes, during pregnancy, or in lactating mares has not been evaluated. The safety of PROTAZIL<sup>®</sup> (1.56% dicazuril) Antiprotozoal Pellets with concomitant therapies in horses has not been evaluated.

**ADVERSE REACTIONS**

There were no adverse effects noted in the field study which could be ascribed to dicazuril. To report suspected adverse reactions, to obtain a MSDS, or for technical assistance call 1-800-224-5318.

**CLINICAL PHARMACOLOGY**

 The effectiveness of dicazuril in inhibiting merozoite production of *Sarcocystis neurona* and *S. falcatula* in bovine turbinate cell cultures was studied by Lindsay and Dubey (2000). Dicazuril inhibited merozoite production by more than 80% in cultures of *S. neurona* or *S. falcatula* treated with 0.1 ng/mL dicazuril and greater than 95% inhibition of merozoite production ( $IC_{50}$ ) was observed when infected cultures were treated with 1.0 ng/mL dicazuril. The clinical relevance of the *in vitro* cell culture data has not been determined.

**PHARMACOKINETICS IN THE HORSE**

 The oral bioavailability of dicazuril from the PROTAZIL<sup>®</sup> (1.56% dicazuril) Antiprotozoal Pellets at a 5 mg/kg dose rate is approximately 5%. Related dicazuril concentrations in the cerebrospinal fluid (CSF) range between 1% and 5% of the concentrations observed in the plasma. Nevertheless, based upon equine pilot study data, CSF concentrations are expected to substantially exceed the *in vitro*  $IC_{50}$  estimates for merozoite production (Dirikolu et al., 1999). Due to its long terminal elimination half-life in horses (approximately 43-65 hours), dicazuril accumulation occurs with once-daily dosing. Corresponding steady state blood levels are achieved by approximately Day 10 of administration.

**EFFECTIVENESS**

 Two hundred and fourteen mares, stallions, and geldings of various breeds, ranging in age from 9 months to 30 years, were enrolled in a multi-center field study. All horses were confirmed EPM-positive based on the results of clinical examinations and laboratory testing, including CSF Western Blot analyses. Horses were administered PROTAZIL<sup>®</sup> (1.56% dicazuril) Antiprotozoal Pellets at doses of 1, 5, or 10 mg dicazuril/kg body weight as a top-dress on their daily grain ration for 28 days. The horses were then evaluated for clinical changes via a modified Mayhew neurological scale on Day 48 as follows:

0. Normal, neurological deficits not detected.
1. Neurological deficits may be detectable at normal gait; signs exacerbated with manipulative procedures (e.g., backing, turning in tight circles, walking with head elevation, truncal swaying, etc.).
2. Neurological deficit obvious at normal gait or posture; signs exacerbated with manipulative procedures.
3. Neurological deficit very prominent at normal gait; horses give the impression they may fall (but do not) and buckle or fall with manipulative procedures.
4. Neurological deficit is profound at normal gait; horse frequently stumbles or trips and may fall at normal gait or when manipulative procedures were utilized.
5. Horse is recumbent, unable to rise.

 Each horse's response to treatment was compared to its pre-treatment values. Successful response to treatment was defined as clinical improvement of at least one grade by Day 48 ± conversion of CSF to Western Blot-negative status for *S. neurona* or achievement of Western Blot-negative CSF status without improvement of 1 ataxic grade. Forty-two horses were initially evaluated for effectiveness and 214 horses were evaluated for safety. Clinical condition was evaluated by the clinical investigator's subjective scoring and then corroborated by evaluation of the neurological examination videotapes by a masked panel of three equine veterinarians. Although 42 horses were evaluated for clinical effectiveness, combination of clinical effectiveness via videotape evaluation was not possible for one horse due to missing neurological examination videotapes. Therefore, this horse was not included in the success rate calculation.

Based on the numbers of horses that seroconverted to negative Western Blot status, and the numbers of horses classified as successes by the clinical investigators, 28 of 42 horses (67%) at 1 mg/kg were considered successes. With regard to independent expert masked videotape assessments, 10 of 24 horses (42%) at 1 mg/kg were considered successes. There was no clinical difference in effectiveness among the 1, 5, and 10 mg/kg treatment group results.

Adverse events were reported for two of the 214 horses evaluated for safety. In the first case, a horse was enrolled showing severe neurological signs. Within 24 hours of dosing, the horse was recumbent, biting, and exhibiting signs of dementia. The horse died, and no cause of death was determined. In the second case, the horse began walking stiffly approximately 13 days after the start of dosing. The referring veterinarian reported that the horse had been fed grass clippings and possibly had laminitis.

**ANIMAL SAFETY**

 PROTAZIL<sup>®</sup> (1.56% dicazuril) Antiprotozoal Pellets were administered to 30 horses (15 males and 15 females, ranging from 5 to 30 months of age) in a target animal safety study. Five groups of 6 horses each (3 males and 3 females) received 0, 5 (5X), 15 (15X), 25 (25X) or 50 (50X) mg dicazuril/kg (2.27mg/lb) body weight/day for 42 consecutive days as a top-dress on the grain ration of the horse. The variables measured during the study included: clinical and physical observations, body weights, food and water consumption, hematology, serum chemistry, urinalysis, fecal analysis, necropsy, organ weights, gross and histopathological examinations. The safety of dicazuril top-dress administered to horses at 1 mg/kg once daily cannot be determined based solely on this study because of the lack of an adequate control group (control horses tested positive for the test drug in plasma and CSF). However, possible findings associated with the drug were limited to elevations in BUN, creatinine, and SDH and less than anticipated weight gain. Definitive test article-related effects were decreased grain/top-dress consumption in horses in the 50 mg/kg group.

 In a second target animal safety study, PROTAZIL<sup>®</sup> (1.56% dicazuril) Antiprotozoal Pellets were administered to 24 horses (12 males and 12 females, ranging from 2 to 8 years of age). Three groups of 4 horses/sex/group received 0, 1, or 5 mg dicazuril/kg body weight/day for 42 days as a top-dress on the grain ration of the horse. The variables measured during the study included physical examinations, body weights, food and water consumption, hematology, and serum chemistry. There were no test article-related findings seen during the study.

**STORAGE INFORMATION**

Store between 15°C to 30°C (59°F to 86°F).

**HOW SUPPLIED**

 PROTAZIL<sup>®</sup> (1.56% dicazuril) Antiprotozoal Pellets are supplied in 2-lb (0.9 kg) and 10-lb (4.5 kg) buckets.

**REFERENCES**

1. Lindsay, D. S., and Dubey, J. P. 2000. Determination of the activity of dicazuril against *Sarcocystis neurona* and *Sarcocystis falcatula* in cell cultures. *J. Parasitol.* 86(1):164-166.
2. Dirikolu, L., Lehner, F., Natraas, C., Bentz, B. G., Woods, W. E., Carter, W. E., Karpieski, W. G., Jacobs, J., Boyles, J., Harkins, J. D., Granstrom, D. E. and Tobin, T. 1999. Dicazuril in the horse: Its identification and detection and preliminary pharmacokinetics. *J. Vet. Pharmacol. Therap.* 22:374-379.

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## “A proper diagnosis of abnormal forces on the foot must be achieved in order to apply appropriate therapeutic shoeing strategies.”

DR. ANDREW PARKS

continually grow, yet it functions as an extension of the musculoskeletal system. Parks said the hoof wall responds differently to forces depending on the rate at which they're applied.

“For example,” he says, “a force applied rapidly and immediately removed, such as the foot landing on the ground at speed, causes elastic change of foot shape that then immediately returns to its prior shape. In contrast, a prolonged and slow force applied to the foot deforms the tissue but when this force is removed, it takes much longer to return to its normal shape.”

**When biomechanics go wrong** Prolonged abnormal loading or force on the foot, as occurs with improper hoof growth, trimming, or shoeing, has consequences—it might deform the hoof wall, causing flaring and the coronary band to move proximally (upward). Hoof growth slows as the body attempts to restore the hoof to a normal shape, resulting in growth ring spacing irregularities.

Parks commented, “The coffin bone is suspended in the hoof by the lamellae on three sides with the deep digital flexor tendon taking up tension on the fourth side. Interestingly, if the horse is lacking a functional hoof wall, he can't walk because of painful pressure between the sole and coffin bone. However, if lacking a functional sole, he walks tolerably well if sensitive tissues are protected from pressure because the lamellae and DDFT support the coffin bone off the ground.”

**Biomechanics and treatment** As the horse begins each stride, associated shock waves can cause foot injuries. “Normally,” Parks reports, “there is natural damping of concussion by many structures such as the inner lamellae of the hoof wall, the digital cushion, collateral cartilages, the vascular plexus, and thick articular cartilage.”



### Convention Tweets

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@twinpinsequine

Treatment of club foot has to revolve around comfort.

**Hagyard**

@Hagyard

As the equine industry always evolves, core values of equine veterinary medicine remain the same. “Place welfare of horse first”

Applying a plain steel shoe to the hoof increases frequency of impact vibrations and maximum acceleration of the foot. In addition, he said, a steel shoe increases pressure on the navicular bone (which acts as a fulcrum around which the DDFT passes), restricts hoof expansion, and causes the heels to wear more rapidly than the toes.

To reduce impact shock waves, Parks recommended that veterinarians and farriers, “change the concussion of impact via a plastic shoe or a viscoelastic pad.” He suggested other biomechanical modifications for improving foot function: Use a pad to distribute the force evenly, move the GRF's center of pressure, and move the point of breakover back. In the latter case, rolling the toe shortens the moment arm around which the coffin joint rotates and eases breakover.

In all cases, Parks urged, “A proper diagnosis of abnormal forces on the foot must be achieved in order to apply appropriate therapeutic shoeing strategies. This doesn't mean that horses shouldn't be shod, just that clinicians should be aware that adverse effects occur (with certain shoeing practices) and there may be a need to mitigate these effects.”

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