How to Radiograph and Diagnose Fractures of the Tibia in the Field

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1. Introduction

Displaced and non-displaced fractures and proximal physeal fractures of the tibia are occasionally encountered in practice. Stress fractures of the tibia are one of the most common causes for hind limb lameness in the young Thoroughbred racehorse. Although making a diagnosis of a displaced fracture is self-evident, non-displaced and physeal fractures of the tibia often cause non-weight-bearing lameness with a variable degree of swelling and few other clinical signs, making diagnosis a challenge.

Stress fractures of the tibia occur most commonly in 2-year-old or unraced Thoroughbred racehorses. They often give minimal to no clinical evidence of their presence with the exception of lameness and a recent history of high-intensity exercise (racing or breezing). Diagnosis of stress fractures of the tibia in its upper portions of the limb is a clinical challenge because the site of pain is rarely amenable to identification through palpation or regional anesthesia. Historically, nuclear scintigraphy has been the imaging modality of choice for the diagnosis of stress fracture of the tibia, given its location on the upper portion of the limb and the high sensitivity of nuclear scintigraphy.

Because nuclear scintigraphy is an expensive imaging modality, the initial diagnosis is often not performed, and follow-up scintigraphic examinations are rarely performed. Digital radiography has become commonplace in equine practice over the last 6 years; therefore, collecting excellent quality images of the tibia has become a reality. In one study of 51 cases of tibial stress fracture, 33% (17 cases) were diagnosed through the use of radiographs alone. Making an initial diagnosis of a tibial fracture and return to exercise recommendations can be tailored to patient needs on the basis of the results of serial radiographic examinations and not standardized group recommendations.

Radiography of the tibia is often frustrating and typically inconclusive for several reasons. The technique is infrequently performed; therefore, questions regarding radiographic technique, plate positioning, and inexperience create uncertainty. The concave anatomy of the caudal aspect of the pelvic limb created by the musculature and the proximal tibia makes positioning of the cassette a challenge. Fine-quality, motion-free radiographs are essential if subtle findings such as endosteal sclerosis and periosteal new bone formation are to be identified. Finally, if radiographs are attempted...
within days after the history of high-speed exercise and lameness in the training Thoroughbred, they are likely to be inconclusive.

The objective of this presentation is to provide the ambulatory veterinarian with a simple technique to collect excellent-quality radiographs of the tibia to facilitate making the initial diagnosis. Another objective is to outline an appropriate schedule for taking follow-up radiographs after diagnosis so that return to performance recommendations can be based on findings of serial radiographic examinations tailored specifically to patient needs and not the customary recommendations of 6 months of convalescence after injury.

2. Materials and Methods

History and Physical Examination

Indications for radiographing the tibia are young Thoroughbred horses (usually less than 2 years of age) that have hind limb lameness on average of grade 3/5 within 4 days of any speed work (recent breezing or racing). Typically, these horses have not raced or are lightly raced before a diagnosis of tibial stress fracture. Many horses have a history of more severe lameness soon after exercise that improves over a 24-hour period with stall rest and non-steroidal anti-inflammatory drug treatment.

Horses rarely respond to firm palpation and percussion of the mid tibia, and lameness is exacerbated by a spavin test in up to 76% of cases evaluated in one study. Another indication for tibial radiographs is lameness that persists after a diagnostic low, four-point nerve block. Nerve blocks performed in more proximal locations on the hind limb are difficult to perform reliably.

Radiographing the Tibia

When obtaining radiographs of the tibia, we make three changes to what is conventionally described in the literature: (1) the perpendicular orientation of the cassette; (2) radiographing the tibia in halves; and (3) positioning the radiographer caudally behind the horse. Each of these is explained in detail.

Perpendicular Orientation of Cassette

Most digital radiography plates are rectangular in shape, with a shorter and longer axis. With these rectangular shapes, it is easier to rotate the plate so that the short axis of the plate is oriented up and down the limb. In other words, the long axis of the cassette is perpendicular to the long axis of the limb.
Radiograph the Tibia in Halves

We position the cassette and take radiographs of the tibia from two different perspectives: from the proximal aspect and from the distal aspect. This allows the entire tibia to be radiographed, given its length, and allows for higher technique settings on larger horses that have more soft tissue associated with the proximal aspect of the tibia. When this technique is used, approximately two thirds of the tibia fits on a standard-sized cassette; therefore, images of the middle can be evaluated in the top and bottom projections.

Position of the Radiographer and the Cassette

The radiographic machine and radiographer are positioned behind the horse. Given the concave anatomy of the musculature on the caudal aspect of the thigh, the dorsal position of the cassette allows it to
be positioned closer to the tibia in this location. In addition, this shorter plate-to-object distance allows for a more diagnostic image and lower technique settings (Fig. 1). The insertion of the patellar ligaments on the proximal aspect of the tibia is a useful landmark that allows for more exact positioning of the plate with respect to the tibia during the initial examination and during follow-up examinations.

Standard Projections
The operator stands behind the horse (Figs. 1 and 2) to collect our four standard projections.

1. A caudomedial-craniolateral oblique projection made at 45° medial to the dorsoplantar plane (Cd45M–CaLO; Fig. 2, red line);
2. A caudoproximal-craniodistal oblique projection made at 10° proximal to the supporting surface and parallel to the dorsoplantar plane (Cd10Pr–CrDiO; Fig. 2, black line);
3. A caudolateral-craniomedial oblique projection made at 45° lateral to the dorsoplantar plane (Cd45L–CrMO; Fig. 2, blue line);
4. A lateromedial (LM) projection (Fig. 2, green line).
The four standard projections taken from proximal and distal perspectives typically create a minimum of eight radiographic images. Most of the pathology that we find (especially in the 2-year-old Thoroughbred racehorse) is in the mid diaphysis on the Cd45M–CrLO projection (Fig. 2, red line); therefore, we usually recommend taking a few additional views, concentrating on the center of the tibia. The end result is up to 10 images per tibia. Because the occurrence of bilateral tibial stress fracture can be high,\textsuperscript{1,3} it can amount to up to 20 radiographs per patient.

Fig. 5. Example of a horse with a cortical fracture and the appearance of the fracture taken 30 days later.
3. Results

With hind limb lameness, the tibia is radiographed on day 1 of lameness if diagnostic blocks do not localize the lameness to the lower limb. Cases that are radiographically negative on day 1 are radiographed again on day 10. The author (PW) has radiographed approximately 100 tibias in 90 horses since January 1, 2008. Most of these radiographs were taken on 2-year-old Thoroughbreds preparing for an in-training sale. It is the presenting author’s estimation that when this combination of tibial radiographs is evaluated, approximately 50% of the 90 horses radiographed have evidence of either a fracture line or endosteal reaction consistent with a tibial stress fracture. If significant changes are identified, the radiographs taken earlier in time are often negative. In the presenting author’s experience, radiographs taken on day 1 of lameness are helpful in approximately 20% of cases and radiographs taken 10 days later are helpful in the remaining 80% of cases. It is the presenting author’s opinion that follow-up radiographs should be repeated for all cases that are negative initially.

Radiographic Diagnosis

Initial radiographic changes include an endosteal reaction that can progress to a periosteal reaction and a cortical fracture line originating from the outer cortex. Typically, bone develops on the endosteum and results in a sclerotic region that forms secondary to fatigue fracture. Radiographic evidence of endosteal, focal periosteal, or an intracortical fracture line is considered diagnostic of a stress fracture, although it is recognized that some horses will only develop endosteal reaction and never develop the periosteal reaction and/or a cortical fracture line.

Schedule of Initial Radiographs and Follow-Up Radiographs

Stress fractures can be difficult to detect early in the acute stages until the mineral content of the fracture line decreases by 30% of the total mineral content of the bone—a phenomenon called radiographic rarefaction. Thus, a fracture line that was not radiographically apparent on the initial radiographs may be detected on films obtained 5 to 10 days later. Horses with non-displaced fractures and physeal fractures are radiographed immediately after injury, and the diagnosis is often readily evident. In training, Thoroughbreds with the appropriate history should also be radiographed immediately after injury, although these initial radiographs can often be negative. These same horses should be re-radiographed in 10 days’ time and should be on restricted exercise schedules until these radiographs are repeated. Some fractures are never visible radiographically and may be preceded by the development of endosteal sclerosis.

Once the diagnosis of non-displaced or physeal fracture is made, follow-up radiographs should be taken every 30 days, and the results of these examinations should guide future exercise schedules. Non-displaced fractures can take up to 6 months to heal, but light exercise can begin at 3 months in advance of radiographic evidence of fracture healing. Physeal fractures can be returned to exercise in 4 to 6 weeks.

Once a diagnosis of tibial stress fracture is made, radiographs should be taken every 30 days and once before the horse does any high-intensity exercise (racing or breezing). Current recommendations are to stall-rest the horse until it is sound at the jog 5 to 7 days, followed by 60 days of paddock exercise or light galloping.

Some suggest that training can be resumed 4 to 6 weeks after diagnosis, although one author comments that training initiated sooner than 16 weeks after injury predisposes the horse to the recurrence of stress-related bone injury.

4. Discussion

Tibial stress fractures are one of the most common causes for hind limb lameness in the young Thoroughbred. Until digital radiography, the only way to confirm a tibial stress fracture was with a bone scan. Today, many of the digital radiography units on the market will produce very high-quality images of the tibia. In the presenting author’s experience with young Thoroughbred racehorses and 2-year-olds in training, approximately 90% of tibial stress fractures occur in the dorsal lateral aspect of the mid-diaphysis, and this observation is supported in the literature. Historically, radiography of the tibia was not practiced in the field because of the limitations of standard radiography: inexperience with radiographic technique, large cassette sizes, and the number of exposures needed and time delays in determining whether quality images were collected. Digital radiography has made high-quality, motion-free radiographs of the tibia a reality, so that endosteal sclerosis and periosteal new bone formation is significantly easier to identify. In one study, 45 of 58 (76%) tibial stress fractures were identified radiographically, and in another study, 33% of horses with tibial stress fractures were identified on the basis of radiographs alone. Most studies agree that stress fractures and non-displaced fractures of the tibia are significantly more common in proximal and mid-diaphyseal locations.

The three techniques used in this report allow the ambulatory veterinarian with a simple means to collect excellent-quality radiographs of the tibia to make the initial diagnosis. It also offers a schedule for serial follow-up radiographs after diagnosis so that return to performance recommendations can be based on patient needs (also see Figs. 3–6).

5. Conclusions

Hind limb lameness that originates in the tibia is common in the young Thoroughbred racehorse.
Aside from hind limb lameness, the absence of physical examination findings and clinical signs make fractures of the tibia a diagnostic challenge.

Taking quality radiographs is crucial when making an initial diagnosis of non-displaced fractures and stress fractures of the tibia. When obtaining quality radiographs of the tibia, three technical details will improve image quality and reproducibility: (1) turn the cassette so that the long axis is perpendicular to the tibia; (2) radiograph the tibia in proximal and distal halves; and (3) position the radiographer behind the horse and the cassette on the cranial aspect of the tibia.

Although four standard projections are taken, lesions are most often identified in the mid-diaphysis (70%), which suggests that the caudomedial-cranio-lateral oblique projection (Ca45M–CaLO; Fig. 2, red line) is the most useful projection. Typically, the tibia is radiographed on day 1 of lameness if diagnostic blocks do not localize the lameness to the lower limb. Significant pathology is identified in some of the cases, and a course of action is outlined on the basis of these radiographs. If significant changes are not identified, then radiographs are repeated in 10 days. In the presenting author’s opinion, the value of the technique is not to make an early diagnosis but to make a diagnosis in the field without a bone scan, and, if successful, to provide a radiographic lesion that can be followed over time with recovery recommendations that are individualized.

References