How to Mark the Foot for Radiography

Barbara T. Page, DVM; Robert M. Bowker, VMD, PhD; Gene Ovnicek, R.J.F.; and Tracey L. Hagen, DVM

Radio-opaque markers placed on the hoof capsule when radiographs of the equine digit are taken show the location of the third phalanx (PⅢ) with respect to the hoof capsule. This information can be used to position the breakover of the shoe or hoof capsule relative to PⅢ. Breakover of the shoe relative to the bony column can potentially decrease lameness in the digit and improve a low hoof–pastern axis. Authors’ addresses: Colorado Equine Clinic, 9616 Titan Rd, Littleton, CO 80125; (Page and Hagen); Dept. of Anatomy, Michigan State University College of Veterinary Medicine, East Lansing, MI 48824 (Bowker); and 525 Half Moon Rd., Columbia Falls, MT 59912 (Ovnicek). ©1999 AAEP.

1. Introduction

The location and position of the third phalanx (PⅢ) respective to the hoof capsule can be assessed when radio-opaque markers are placed on the hoof capsule before radiographs are taken. The hoof capsule, because it is epidermal tissue, is prone to distortion and stretching, as are the laminae attaching the hoof capsule to PⅢ. The position of PⅢ within the hoof capsule can vary because of internal physiologic and pathologic forces and external environmental forces. The combination of such forces in conjunction with the distensibility of the hoof capsule makes identification of the bony column within the hoof capsule difficult. Measurements taken from marked radiographs can help veterinarians and farriers determine where to position the breakover of the shoe if the horse is shod, or of the hoof capsule if the horse is not shod, relative to the bony column.

2. Materials and Methods

Thirty horses that presented to Colorado Equine Clinic, PC, between July 1996 and April 1999 with lameness in the digit that blocked out to a palmar digital nerve block were used. Barefoot and shod horses, and horses with forelimb or hind limb palmar heel lameness were included. Lameness was quantified on a scale of I to V. Radiographic markers (thumbtacks) were placed at the apex of the frog. The apex was located by trimming the superficial tissue at the apex of the frog to observe the frog blending to the sole. This transitional zone is marked by a color difference; the frog is darker, the sole lighter (Fig. 1). A 5-cm wire was placed along the dorsal hoof wall with the proximal aspect of the wire placed at the most distal hair follicles. Both front or both hind feet were placed concurrently on wooden blocks embedded with a horizontal radio-opaque wire. Feet were positioned so that the third metacarpus or third metatarsus was perpendicular to the ground. Efforts were made to have both forelimbs or hind limbs equally weighted. Lateral-medial radiographs were taken with both bulbs of the heel parallel to the x-ray beam. Radiographs were evaluated by drawing a line on each radiograph from the tip of PⅢ perpendicular to the ground (Fig. 2). A second line dorsal and parallel to the first line
Fig. 1. (A) Identification of true apex of the frog. (B) Placement of thumbtack into the true apex of the frog.

Fig. 2. Determining breakover from the radiograph.
was drawn at the following distances ahead of that line for the front limbs: 0.4 cm for horses weighing 200–300 kg, 0.5 cm for horses weighing 300–400 kg, 0.6 cm for horses weighing 400–500 kg and 0.7 cm for weighing horses 500–600 kg. For the hind limbs, the distance from the first line was decreased by 0.1 cm for each weight category. On each radiograph, the distance from the thumbtack to the most dorsal line was measured. On the solar aspect of the hoof capsule, the distance measured from the radiograph was measured from the thumbtack dorsally. Magnification on the radiographs was not significant because it measured at less than 0.1 mm. A perpendicular line was drawn between the medial and lateral walls of the hoof capsule at this distance (Fig. 3). To prepare the foot, flaky tissue covering the sole was removed and the hoof wall was trimmed or rasped circumferentially to 0.3 cm higher than the sole. The breakover of the shoe was placed at the line drawn on the sole, or if the horse was barefoot, the toe was rolled at a 15° angle to this location. Breakover was defined as the most dorsal location of the solar aspect of the hoof capsule that contacts the ground. This was the last part of the hoof capsule to leave the ground at the point of lift-off.

Evaluation of lameness and radiograph examination were repeated within 1 hour and again 6 weeks later. Differences between the results of lameness and the distance from the thumbtack to breakover before and after shoeing or trimming was documented, and the change in the angle between PI and PIII was measured and analyzed statistically.

3. Results
There was clinical improvement in soundness. The lameness grade improved by one grade within 1 hour after horses were shod in 15 of 30 (50%) cases ($p = 0.001$). At 6 weeks, 22 of 30 (73%) of the horses had improved 1 grade. Distance from the thumbtack to the breakover of the hoof varied from a preshoeing mean of 38 cm to a postshoeing mean of 23 cm, a mean difference of $-15$ cm ($p = 0.0001$).

Radiographs taken within 1 hour postshoeing showed improvement in the angle between PI and PIII. Mean angle between PI and PIII varied from a preshoeing mean of 22.6° to a postshoeing mean of 17.1°, a mean absolute change of $-5.5$° ($p = 0.0001$).

4. Discussion
Placement of the breakover of the shoe guided by marked radiographs decreased lameness in the equine digit in this study. One reason was improvement in the hoof–pastern axis. A low hoof–pastern axis has been implicated in such diseases as navicular disease, increased strain on flexor tendons, hoof cracks and palmar heel pain. The hoof–pastern axis can be increased or raised by raising the heels, but that method decreases the solar surface contact area. We improved low hoof–pastern axis by placing the breakover of the shoe relative to the tip of PIII.

The hoof–pastern axis increased because of biomechanical principles of motion. Bringing breakover closer to the tip of PIII decreased the distance between the fulcrum (breakover) and location of effort (insertion of the deep digital flexor tendon). Thus, as breakover is moved toward PIII, the length of the lever arm is decreased and inertia at movement decreases by the square of the distance, decreasing the tensile force of the deep digital flexor tendon (ddft). We attributed decreases in lameness to the decrease in strain on the ddft. Caution needs to be used because if the breakover is too close to the tip of PIII, a high hoof–pastern axis results, which may result in lameness.

The radiographic method described here can provide more accurate assessment of hoof–pastern axis; the axis can be measured and the data used for prognostic and ancillary therapeutic information. The disadvantage of this technique is the additional time (5–15 min) necessary to accurately place the radiopaque markers. Despite the extra time, we have found that setting the breakover of the shoe relative to the tip of PIII is helpful in treatment of lameness in the equine digit.

References