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Use of computed tomography to diagnose new bone formation associated with desmitis of the proximal aspect of the suspensory ligament in third metacarpal or third metatarsal bones of three horses

Marc T. Launois, DMV; Jean-Michel E. F. Vandeweerd, DMV, MS; Roland A. R. Perrin, DMV; Laurent Brogniez, DMV; Francis G. Desbrosse, DMV; Peter D. Clegg, MA, VetMB

Case Description—3 horses with lameness localized to the proximal aspect of the metacarpus or metatarsus.

Clinical Findings—All horses had evidence of problems that originated from the proximal aspect of the suspensory ligament (PASL), including signs of pain on palpation, positive results of diagnostic nerve blocks, ultrasonographic detection of enlargement and diffuse areas of reduced echogenicity in the proximal region of insertion of the ligament, and radiographic detection of increased mineral opacity in the proximal aspect of the metacarpus or metatarsus. Desmitis of the PASL was diagnosed in each horse; however, conservative treatment failed to improve the lameness. The horses were taken to surgery for splitting of the PASL and osteostixis of the proximal aspect of the third metacarpal or metatarsal bone. At that time, the proximal aspect of the metacarpus or metatarsus was evaluated via computed tomography (CT), which identified new bone formation at the proximal aspect of the third metacarpal or metatarsal bone that had not already been identified.

Treatment and Outcome—In all horses, the newly formed bone was removed surgically under radiographic and CT guidance, and the splitting and osteostixis that had been planned were performed. After rehabilitation, all horses returned to full training at 6 months after surgery. All horses responded well to the surgical treatment and were sound 8 months afterward.

Clinical Relevance—Use of CT imaging should be considered in lame horses with pain associated with the proximal aspect of the third metacarpal or metatarsal bones that does not improve with conservative treatment. (*J Am Vet Med Assoc* 2009;234:514–518)

A 14-year-old 692-kg (1,522-lb) Hanoverian stallion (horse 1) used for dressage was referred to our hospital for assessment of a recurrent left forelimb lameness attributed to desmitis of the PASL that became evident with an increase in exercise intensity and competition frequency. Conservative treatment had failed to improve the condition. During physical examination, the horse appeared to resent palpation of the PASL. Lameness of the left forelimb was consistently observable when the horse was trotted on a hard surface in a straight line and in a circle on the left rein. Diagnostic analgesia was attempted to isolate the source of the problem. Lameness failed to improve with palmar digital, abaxial sesamoid, and palmar metacarpal (low 4-point) nerve blocks; however, it was completely abolished 30 minutes after application of a lateral palmar nerve block.

Dorsopalmar, lateromedial, and oblique radiographic projections were obtained (settings, 80 kV and 5 mAs). The dorsopalmar projection revealed a 0.3 × 1.0-cm region of increased mineral opacity that was 2 cm distal to the carpometacarpal joint, immediately adjacent to the medial aspect of the MC2, whereas no abnormality was evident in other projections (**Figure 1**). Ultrasonography revealed enlargement of the cross-sectional area of the PASL, in comparison with that of the contralateral limb. Diffuse regions of reduced echogenicity within the suspensory ligament and slight irregularity of the palmar aspect of the cortex of the MC3 were also visible.

After discussion with the owner, the horse was anesthetized for diagnostic CT and therapeutic osteostixis[1] of the proximal aspect of the MC3. Before surgery, potassium penicillin G (22,000 U/kg [10,000 U/lb], IV) was administered. Anesthesia was induced with xylazine (1.1 mg/kg [0.5 mg/lb], IV), ketamine (2.2 mg/kg [1.0 mg/lb], IV), and diazepam (0.05 mg/kg [0.023 mg/lb], IV). After tracheal intubation, anesthesia was maintained with 3%

Abbreviations

CT	Computed tomography
MC2	Second metacarpal bone
MC3	Third metacarpal bone
MT2	Second metatarsal bone
MT3	Third metatarsal bone
MT4	Fourth metatarsal bone
PASL	Proximal aspect of the suspensory ligament

From Clinique Equine Desbrosse, 18 rue des Champs, La Brosse, 78470, St Lambert des Bois, France. Dr. Clegg's present address is Department of Veterinary Clinical Science and Animal Husbandry, University of Liverpool, Leahurst, Neston, South Wirral L64 7TE, England.

Address correspondence to Dr. Vandeweerd.

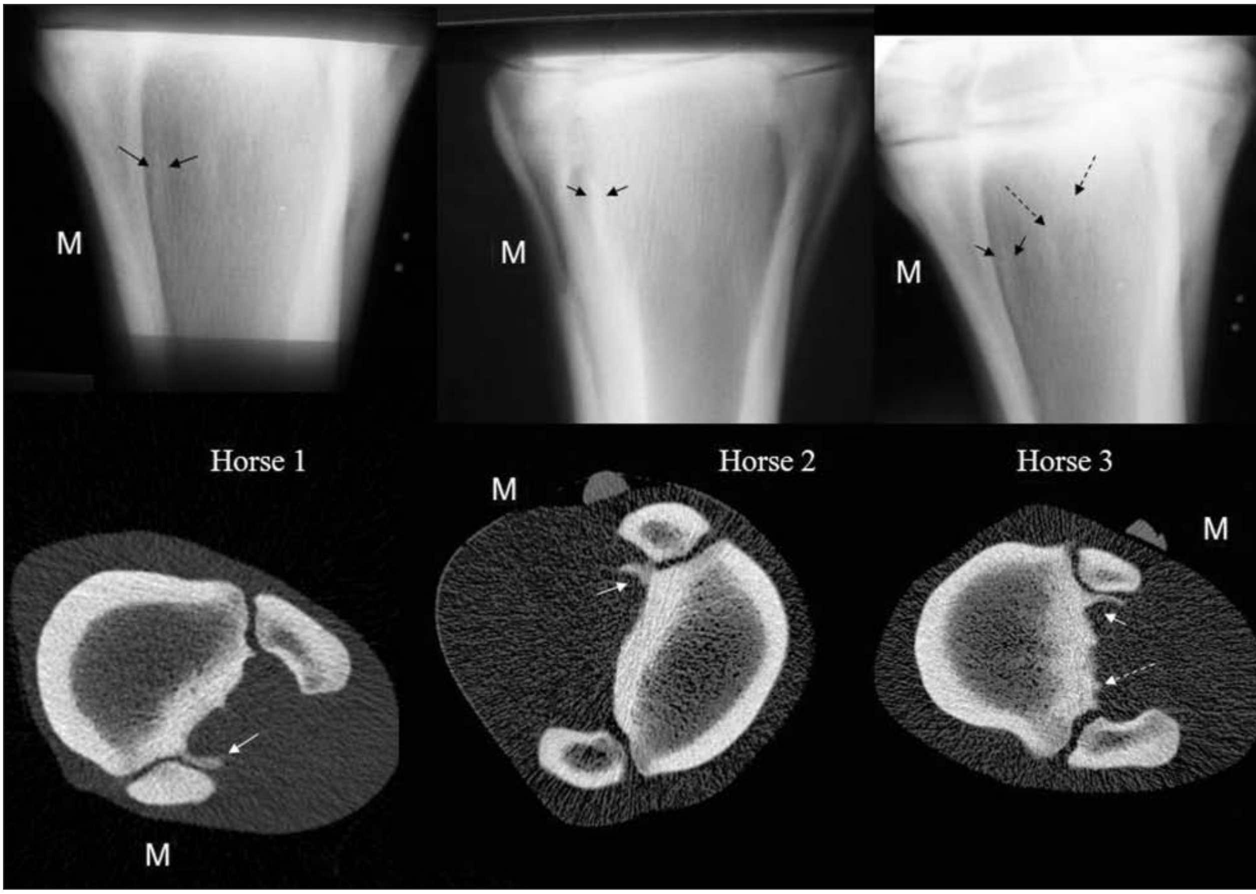

Figure 1—Radiographic (top row) and CT (bottom row) images of the proximal aspect of the MC3 or MT3 in 3 horses with desmitis of the PASL. Plain arrows indicate sharp exostoses. Dotted arrows indicate sites of remodelling of the bone. M = Medial side of the limb.

halothane in oxygen. The horse was positioned in right lateral recumbency, and hair was clipped from the region of the foot to the mid radius.

Computed tomographic evaluation of the proximal aspect of the metacarpus was performed with a radiopaque marker placed abaxial to the proximal aspect of the MC2. Images were obtained with a peripheral quantitative CT scanner.[a] The x-ray tube in the translate-rotate multidetector system is operated at a maximum of 60 kV at an anode current of 0.3 mA (mean energy, 45 keV). The fan beam detector of the system consists of 6 cadmium telluride detectors with amplifiers, rotating in a gantry with an opening of 300 mm. In the longitudinal direction, the minimal step width for scans is 0.01 mm over a full length of 350 mm.[2] We modified the system to allow horizontal and vertical use by mounting it on a frame that is moved with electric motors and adding wheels and a brake. This resulted in a 200-kg scanner that is mobile and can be moved within the hospital, including into the surgical theater.[3] The system makes use of computer software to control the scan, display the images, and measure bone densities. Additional software[b] is used to obtain 3-dimensional images.

The site of interest was first determined via a scout scan of the proximal aspect of the MC3. Ten 2-mm slices were obtained. Images were evaluated at a window width of 600 Hounsfield units and a window level of 300 Hounsfield units. The palmar aspect of the cortex of the MC3 was irregular at the region of insertion of the suspensory ligament, and sharp, new bone formation was identified axial to the MC2 (Figure 1). The location and extent of the lesion were identified in relation to the radiopaque markers, and the skin was aseptically prepared for surgery. A 10-mm skin incision was performed over the region of the identified lesion, the flexor tendons were maintained in a lateral position, and a ligament knife was advanced to the bone through the suspensory ligament and the overlying fascia. A periosteal elevator was used to palpate the region of bone proliferation. Adhesions identified between the axial surface of the reactive bone and the suspensory ligament were sharply transected with a ligament knife. Surrounding reactive bone was resected with chisels and periosteal elevators. The suspensory ligament was split, and osteostixis of the palmar aspect of the cortex of the MC3 was performed at 5 sites on the proximal aspect of the MC3. In each site, the knife was advanced through the suspensory ligament, and the blade was moved in a proximal-to-distal direction for approximately 1 cm, keeping the blade parallel to the fibers. A 2.5-mm drill sleeve was then inserted to facilitate drilling through the cortical bone with a 2-mm drill bit. The skin was apposed by use of 1-0 polypropylene suture in a simple interrupted pattern. The limb was bandaged with sterile gauze covered by a support wrap.

The horse recovered from anesthesia without complications. Perioperative phenylbutazone (2.2 mg/kg, PO, q 12 h) and potassium penicillin G (10,000 U/kg [4,545 U/lb], IV, q 6 h) were administered for 3 days. The horse was treated with phenylbutazone (2.2 mg/kg, PO, q 12 h) for 5 days after surgery. Sutures were removed after 14 days, and bandages were maintained until 3 weeks after surgery. Treatment after discharge consisted of stall rest for 6 weeks followed by 2 weeks of hand walking.

Two months after surgery, the horse was reassessed. At that time, its gait was apparently normal with no signs of lameness when walking in a straight line. Radiography and ultrasonography of the previously injured metacarpus were performed. The holes drilled in the bone at the osteostixis site appeared as irregular lucencies on radiographs, as expected after 2 months. No major change in thickness or echogenicity of the suspensory ligament was evident in ultrasonograms. For those reasons, the horse was permitted to begin light jogging in hand, with a gradual increase in activity each day. The horse was reassessed at 4 months after surgery by the referring veterinary surgeon and resumed usual dressage work afterward. Full training resumed 6 months after surgery, and at 8 months after surgery, the owner reported that the horse was sound.

Another horse, an 8-year-old 574-kg (1,263-lb) Oldenburg gelding (horse 2), was admitted to our hospital for evaluation of a left hind limb lameness of 2 weeks' duration. During physical examination, digital palpation along the axial aspect of the left MT2 and proximal aspect of the suspensory ligament elicited signs of pain. Lameness of the left hind limb was evident when the horse was trotted on a hard surface in a straight line. Lameness was exacerbated after flexion of the distal portion of the limb. Physical examination revealed no other abnormalities. Diagnostic nerve blocks of the distal portion of the limb did not alter the lameness; however, lameness was abolished by local infiltration of 10 mL of 2% mepivacaine hydrochloride axial to the MT2 and MT4, deep to the digital flexor tendons around the proximal attachment of the suspensory ligament. Dorsopalmar, lateromedial, and oblique radiographic projections of the left MT2 and MT4 were obtained. A 2-mm-wide, 10-mm-long region of increased mineral opacity was evident medial to the MT2 on the dorsoplantar projection (Figure 1), and this opacity was not visible on the other projections. Ultrasonography revealed that the proximomedial aspect of the suspensory ligament was hypoechoic, in comparison with that of the ipsilateral limb. Irregularities of the plantar cortex of the MT3 were also visible axially to the MT2.

Initially, the horse was treated by hand walking for 2 weeks, after which light trotting was progressively introduced. At reassessment 2 months later, the left hind limb lameness was unchanged; therefore, surgical osteostixis and splitting of the suspensory ligament were suggested. At surgery, CT imaging was performed as described for horse 1 and revealed a thin, 1-cm-long region of new bone formation originating from the plantar cortex of the MT3 medial to the MT2 (Figure 1). Surgery was performed as for horse 1. An adhesion between the suspensory ligament and the bone proliferation on the MT3 was palpated and transected. The exostosis was then removed, and the osteostixis and splitting were performed. Postoperative treatment and discharge instructions were the same as for horse 1. After 60 days, the horse was sound at reassessment and began jogging. At 4 months after surgery, it was still sound, the holes created in the proximal aspect of the metatarsus during the osteostixis procedure were opaque on radiography, and no deterioration of the suspensory ligament was detected during ultrasonography. Six months after surgery, the horse resumed full training, and it was sound at the last point of follow-up (8 months after the surgery).

A third horse, a 6-year-old 560-kg (1,232-lb) Hanoverian gelding (horse 3) that was used for dressage, was admitted for evaluation of a right hind limb lameness of 2 months' duration. The referring veterinarian had diagnosed desmitis of the PASL and recommended osteostixis of the MT3 in addition to bone marrow injection. Physical examination revealed a slight enlargement of the proximomedial aspect of the metatarsus. Digital palpation of the area elicited signs of pain from the horse. The horse had a consistent lameness, and an excursion of the hip of several centimeters was evident when the horse was trotted in a straight line on a hard surface. The lameness was exacerbated during lunging by lead of the right rein. Flexion of the distal portion of the limb and firm pressure on the proximal aspect of the suspensory ligament caused an increase in the severity of the lameness. Results of diagnostic perineural anesthesia of the distal portion of the limb were negative, but the lameness improved completely after infiltration of 10 mL of 2% mepivacaine hydrochloride axial to the MT2 and MT4 and deep to the digital flexor tendons around the proximal attachment of the suspensory ligament.

Dorsoplantar, lateromedial, and oblique radiographic projections of the right metatarsal region were obtained, and focal areas of increased mineral opacity in the proximal aspect of the MT3 were visible in the dorsoplantar view (Figure 1). Ultrasonography revealed that the proximal aspect of the suspensory ligament was thicker, in comparison with that of the ipsilateral limb. Osteostixis and bone marrow injection were performed; however, after 4 months of controlled exercise, the referring veterinarian reported that the lameness had deteriorated. Controlled hand walking was continued, but no improvement was reported 7 months after surgery. The radiologic and ultrasonographic appearance of the metatarsus was unchanged at that point; therefore, diagnostic CT was performed while the horse was anesthetized, as described for horses 1 and 2. The CT images revealed a 2-mm-wide, 10-mm-long, sharp region of new bone formation axial to the proximal aspect of the MT2. The new bone was removed surgically as in horses 1 and 2. After surgery, the owner was instructed to provide stall rest for the horse for 2 months, followed by hand walking for 30 days. The horse was subsequently released into a small paddock and was reported to be sound 4 months after surgery. The owner was contacted 6 months after the surgical procedure, at which time the horse was being lunged and no signs of lameness were observed.

Histologic examination of the resected area of bone proliferation was performed in horses 1 and 3. The section of the bone fragments contained cancellous bone with adjacent ligament and a small amount of loose connective tissue. Cancellous bone was mostly mature and had areas of prominent remodelling, with increased osteoclastic activity and fibrosis adjacent to tendon. In other areas, Sharpey fibers were of unremarkable appearance and merged imperceptibly with adjacent bone.

Discussion

Injury to numerous structures in the proximal aspect of the metatarsus or metacarpus may cause lameness. Differential diagnoses include desmitis of the PASL,[4–6] avulsion fracture of the MC3 or MT3 at the origin of the suspensory ligament,[1,7,8] cortical fatigue fractures or stress reactions in the palmar or plantar aspect of the MC3 or MT3,[4] and exostosis of the MC2, MC4, MT2, or MT4.[9] Pain associated with the tarsometatarsal or carpometacarpal joints, the carpal sheath or carpal retinaculum, the tarsal sheath, the deep digital flexor tendon or its accessory ligament, and the superficial digital flexor tendon should also be considered.[10]

Diagnosis of the cause of pain originating from the PASL, its region of insertion, or both may be challenging.[11] Visual examination, systematic palpation, and careful comparison of the ipsilateral limb should be performed. Slight edema, localized heat, and pain elicited by pressure applied to the suspensory ligament may be evident. The horse may appear to resent flexion of the distal portion of the limb, and this act may accentuate lameness. However, these clinical signs may be lacking.[10,12] In all horses of the present report, palpation of the suspensory ligament was resented, and lameness was exacerbated after flexion of the distal portion of the limb.

Diagnostic analgesic techniques are usually required to confirm the origin of orthopedic pain in horses. Various techniques have been described, but none are necessarily specific.[13–17] In horse 1, a lateral palmar nerve block was used.[17] In horses 2 and 3, mepivacaine hydrochloride was injected axial to the MT2 and MT4 and deep to the digital flexor tendons around the proximal attachment of the suspensory ligament. In all horses, the lameness was completely abolished after analgesic infiltration.

Radiologic changes of the proximal aspect of the MC3 or MT3 are an inconsistent finding in acute desmitis of the PASL but can be evident with chronic episodes of the disease, avulsion of the suspensory ligament, or stress fractures of the proximal aspect of MC3 or MT3.[10] In a retrospective study[18] of horses with lameness localized to the proximal aspect of the metacarpus or metatarsus, the only radiographic abnormalities detected in 22 horses that were examined were exostoses of MC2, MC4, MT2, or MT4 in 5 horses. In desmitis of the PASL, increased opacity of the proximal aspect of the MC3 or MT3 can be identified via dorsopalmar or dorsoplantar projections and may be associated with enthesophyte formation at the region of insertion of suspensory ligament.[4,10] Opacities can also be detected in other circumstances such as periostitis and new bone formation after trauma, tearing of the attachment of the suspensory ligament, fatigue fractures of MC3 or MT3, and damage of the interosseous ligament. Mineralization may develop in the soft tissues, particularly in the suspensory ligament, as the result of trauma or drug injection.[19] In the radiographs of horses 1 and 2, a thin region of increased mineral opacity was visible and orientated along the axis of the MC2 or MT2. However, it was impossible to accurately assess the size and direction of the lesion via a lateromedial projection. The lesion was not evident on the other projections. In the radiographs of horse 3, multiple opacities associated with the MT3 were visible, including a linear region of increased mineral opacity parallel to the longitudinal axis of the MT2.

Ultrasonograms images of the proximal insertion of the suspensory ligament are typically difficult to interpret, and unremarkable ultrasonographic findings do not rule out a lesion at the attachment of the suspensory ligament. Ultrasonography of the suspensory ligament in the area of the proximal aspect of MC2, MC4, MT2, and MT4 can be inconclusive because of difficulties in maintaining good surface contact and acoustic shadowing by refraction artifacts caused by the margins of the bone, the flexor tendons, and vascular structures. This makes it difficult to determine with ultrasonography whether an exostosis is affecting the suspensory ligament.[9,20,21] In horses 1 and 3, irregularity of the palmar or plantar cortex of MC3 or MT3 was broadly visible, but the area close to the MC2 or MT2 could not be accurately visualized.

Bone lesions in metacarpal and metatarsal bones have been detected via nuclear scintigraphy.[21] Magnetic resonance imaging is also a valuable diagnostic modality that allows diagnosis of injury in horses with lameness localized to the proximal regions of the metacarpus and metatarsus, including exostoses.[9,18] These modalities are not available in our practice and were not used. Although contrast among soft tissues with conventional CT is not as good as that with magnetic resonance imaging, some evaluation can be made. However, the imaging system we used can measure bone density and geometric variables of bone via peripheral quantitative CT. The machine is not intended for other purposes and is inappropriate for diagnosis of soft tissue injury.[3]

To our knowledge, the diagnosis of new bone formation of the proximal aspect of MC3 or MT3 via CT has not been reported. New bone formation that was not fully revealed via radiology or ultrasonography was accurately identified in all horses in the present study. The contours of the bone lesions were measured by use of 3-dimensional software before surgery. However, bone proliferation in the interosseous area is not uncommon, and it would be interesting to know whether sound horses have similar CT findings. It would also have been informative to have evaluated via CT the contralateral proximal region of the metacarpus or metatarsus to compare findings. We cannot exclude the possibility that the new bone formation detected in horse 3 was secondary to the first surgical procedure.

Bony and soft tissue lesions may develop concurrently in the palmar aspect of the metacarpus or metatarsus, and this may have an important bearing on prognosis.[19] Large exostoses have been incriminated as a cause of persistent lameness in some horses in which they cause mechanical irritation of the suspensory ligament. Adhesions between exostoses of the MC2 and the suspensory ligament reportedly cause lameness.[9] The

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histologic findings in the present study indicated that proliferating and remodelling bone existed adjacent to the tendon, which would have been consistent with the presence of an enthesophyte; however, repair of a previous avulsion fracture could not be excluded. There was no evidence of tendon mineralization.

Conservative and medical treatment may be unsuccessful in horses with desmitis of the PASL, particularly in the hind limbs.[1,7,8] We have performed splitting and osteostixis in other horses with avulsion fractures of the palmar or plantar aspect of the cortex of the MC3 and MT3 at the origin of the suspensory ligament.[1] However, the present report involves the first time that we diagnosed sharp, new bone formation in MC3 or MT3 and removed it surgically. Surgical removal of exostoses and transsection of their adhesions were successfully performed by others in another study.[9] However, in that study, the number of horses was small, and the follow-up period was too short to make any conclusions about the usefulness of the intervention. In addition, in one of the horses, multiple surgical procedures were performed, and the contribution of each procedure to the improvement in lameness was not known. It is also possible that the horses would have improved without the removal of the region of bone proliferation.

In the study reported here, the use of CT enabled detection of changes that were not radiologically and ultrasonographically evident. New bone formation at the proximal region of insertion of the suspensory ligament should be considered as a differential diagnosis in horses with a chronic or recurring lameness originating from the proximal aspect of the MC3 or MT3. Surgical removal of exostosis may be a treatment option, but additional studies involving a larger number of horses than the number evaluated in this report are required.

a. XCT 3000, Stratec Medizintechnik GmbH, Pforzheim, Germany.
b. VolView, Kitware, New York, NY.

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