MRI features of subchondral bone injury in the metacarpophalangeal and metatarsophalangeal joints of horses

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INTRODUCTION
Subchondral bone injury is common in the fetlock joint of horses. However, without marked structural bone damage or demineralization subchondral bone injury may not be visible radiographically or scintigraphically and magnetic resonance (M R) imaging may be necessary to make the diagnosis. We investigated the incidence of subchondral bone injury with high field M R in 40 horses with lameness attributable to the metacarpo/metatarsophalangeal (M P) joint region in which it was difficult to reach a definitive diagnosis with other imaging modalities.

MATERIALS AND METHODS
M R imaging was performed with the horses under general anesthesia in a 1.5 T M agnet (Siemens Symphony). The standard M R imaging protocol included a dual echo (proton density (PD) and T2) turbo spin echo (TSE) sequence in sagittal and transverse planes with a slice thickness of 3 mm and 4 mm respectively, a short inversion recovery (STIR) sequence in sagittal and transverse planes with slice thickness of 3 mm and 4 mm respectively, a 3-dimensional fast low angle shot sequence (3D FLASH) with fat saturation in a sagittal plane with slice thickness of 2 mm and a 3D FLASH sequence without fat saturation in a dorsal plane with slice thickness of 2 mm.

RESULTS
M R evidence of subchondral bone injury was found in 19 of 40 (48%) horses, (14 in forelimbs and 5 in hindlimbs). Evidence of subchondral bone damage was bilateral in 8 horses and unilateral in 10 horses (total 24 limbs). Abnormal M R signal in subchondral bone included diffuse or focal signal increase in STIR images, diffuse T1, PD and T2 signal decrease with trabecular thickening, and focal T1, PD and T2 signal increase associated with localized loss of trabecular or cortical bone. Combinations of different signal abnormalities were frequently present in bone. Areas of signal hyperintensity were commonly surrounded by an area of signal hypointensity, presumably due to sclerosis. The transverse and sagittal PD-weighted images were most useful for recognizing sclerosis-related signal changes. The PD-weighted images provided good anatomic detail of bone including trabecular thickness and density. The STIR images were most useful for identifying increased fluid signal within bone. The 3D FLASH images with fat saturation were most useful for detection of small, focal areas of bone or cartilage loss because of the smaller slice thickness and improved cartilage contrast in this sequence. All but one horse with bone edema associated with subchondral bone disease had a corresponding increased in radionuclide uptake on nuclear scintigraphy.

Subchondral bone lesions were the only finding in 7 horses, although 4 of these had multiple sites of abnormal bone signal in the affected joint. Subchondral bone abnormalities were accompanied by obvious cartilage loss in 6 more horses. In 3 horses, a chip fracture of the dorsoproximal margin of the proximal phalanx was present concurrently with subchondral bone abnormalities in other areas of the joint. Finally, subchondral bone abnormalities existed in 9 horses with soft tissue injuries at the level of the M P joint (3 suspensory branch desmitis, 3 intersesamoidean desmitis, 2 distal sesamoidean desmitis and 1 deep digital flexor tendonitis).

The medial condyle of the distal M C/M T III was most commonly affected (15 limbs), followed by the lateral condyle of the metacarpus (6 limbs) and the proximal phalanx (5 limbs). There were 7 horses with subchondral bone injury at the palmar/plantar aspect of the metacarpal/metatarsal condyles. Three were racehorses, 2 were Warmbloods used for hunter jumping, 1 was a Warmblood used for dressage and 1 was a Thoroughbred used for 3-day eventing. In 5 affected condyles there was a roughly circular area of sclerosis adjacent to the palmar/plantar surface of the condyle, varying in size from 10 to 20 mm diameter. In 4 affected condyles, 1 or 2 small, focal, areas of hyperintensity in T2 and PD images were present in the sclerotic bone, immediately adjacent to the palmar articular surface. In 2 affected condyles, a large area of bone edema was the only finding. In 2 racehorses, there was loss of articular cartilage and subchondral bone in the palmar aspect of the affected metacarpal condyle, varying from 2 to 6 mm in depth.
There were 9 horses with subchondral bone injury at the dorsal aspect of the metacarpal/metatarsal condyles, 6 Warmbloods (3 dressage and 3 jumpers), 2 Western pleasure horses and one Thoroughbred used for hunting. Abnormalities were found in 6 forelimbs and 3 hindlimbs. A history of acute lameness was reported for 5 horses, while lameness was chronic in 4 horses. Lesions were located at the dorsal aspect of the medial condyle of M C/M T III in 7 horses, 4 of which had a concurrent area of subchondral bone injury at the dorsal aspect of the sagittal ridge. The dorsal aspect of the sagittal ridge was only affected in 1 horse and another horse had generalized subchondral bone edema across the whole dorsal surface of both condyles and the sagittal ridge. Dorsal osseous lesions consisted of an area of sclerosis extending for 10 to 20 mm from the dorsal surface of M C/M T III into the cancellous bone. Small, focal areas of signal hyperintensity in T1, T2 and PD images, suggestive of small osseous cyst-like lesions, varying from 2 to 6 mm diameter, were seen within the area of sclerosis in 9 of 13 limbs. Eight focal hyperintensities were found in the dorsal aspect of the medial condyle and 1 focal signal hyperintensity in the dorsal part of the sagittal ridge. Six of the focally hyperintense lesions were confluent with the dorsal articular surface of M C/M T III and in 3 of these a defect was present in the articular cartilage overlying the osseous lesion. In 4 horses with bilateral dorsal subchondral bone injury, the areas of focal signal hyperintensity surrounded by sclerosis were only seen in the lame limbs, while sclerosis was the only lesion present in the non lame limbs. Subchondral bone injury was present in the proximal aspect of the proximal phalanx in 4 horses. All horses were Warmbloods, of which 3 were used for dressage, and 1 for jumping. Lameness was of acute onset in 3 horses and chronic insidious onset in 1 horse. Lesions typically consisted of a focal hyperintensity in T1 or STIR images, surrounded by an area of sclerosis distal to the sagittal groove of the proximal phalanx in 4 limbs.

**DISCUSSION**

The subchondral bone of M C III or M T III was the most commonly affected tissue in horses with occult M P joint lameness in our study. Subchondral bone injury in M C III or M T III of non racehorses occurred predominantly in the dorsal aspect of the medial condyle. This location is different from that of condylar injuries in racehorses and has only been described rarely in horses used for other equestrian activities. Subchondral bone injury of M C III or M T III is less common in mature Sportshorses and general purpose pleasure horses and its location less predictable than in racehorses. Cartilage defects or osseous cyst-like lesions were found in the majority of dorsomedial subchondral bone lesions, which suggests that focal traumatic injury to the articular surface at the dorsomedial aspect of M C III or M T III might be an initiating cause. Focal trauma to articular cartilage and subchondral bone can result in osseous cyst-like lesion formation and remodeling in adjacent bone. A relationship between dorsal impact injury and palmar osteochondral disease in the M P joint has been proposed as evidence for a cyclical repetitive overextension disease mechanism in the M P joints of racing Thoroughbreds. However, such a mechanism would not explain the high incidence of dorsomedial lesions nor the variable distribution between forelimbs and hindlimbs, both unilaterally or bilaterally, in the variety of horse breeds seen in our study. Contrary to the dorsomedial location, subchondral bone injury in the palmar/plantar aspect of the lateral metacarpal/metatarsal condyle of racehorses is well recognized. Although there were only 3 racehorses in our study, they all had this injury. Furthermore, we observed 4 distinctly different M R signal patterns in the affected condyle of these horses. Lesions varied between bone edema without sclerosis, sclerosis without edema, sclerosis with focal osteonecrosis and intact articular cartilage, and palmar erosions with both loss of articular cartilage and subchondral bone osteonecrosis. These M R signal patterns correspond with the pathologic changes described in palmar osteochondral disease and it is possible that they reflect 4 different stages of increasing severity in a disease continuum that ultimately leads to severe osteoarthritis. Although stress reactions in the condyles of M C III and M T III in racehorses are usually diagnosed scintigraphically, a nuclear scan does not provide structural information on the degree of tissue damage and therefore the disease stage. Bone edema, sclerosis and small focal areas of necrosis are most likely associated with the early stages of this disease and can only be detected with M R imaging. Once bone lysis is present radiographically, treatment is rarely successful. It follows that early M R imaging of palmar osteochondral disease may improve the prognosis by allowing early selection of treatment.

**CONCLUSION**

In conclusion, lameness originating in the M P joint region may be associated with osseous or soft tissue injuries that may not be identified in radiographic, ultrasonographic or scintigraphic examinations. M R imaging was able to provide important diagnostic information about these lesions resulting in an accurate diagnosis. A combination of osseous and soft tissue injuries is common in lameness originating in the M P joint region. Further studies are required to investigate the prognosis of the individual lesion types.
FURTHER READING AND REFERENCES


