CLINICAL AND DIAGNOSTIC IMAGING FINDINGS IN HORSES WITH SUBCHONDRAL BONE TRAUMA OF THE SAGITTAL GROOVE OF THE PROXIMAL PHALANX

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Eight sports horses with unilateral (4) or bilateral (3) forelimb or unilateral hindlimb (1) lameness had subtle radiologic abnormalities of the subchondral bone of the sagittal groove of the proximal phalanx associated with moderate or intense increased radiopharmaceutical uptake. High-field or low-field magnetic resonance (MR) imaging confirmed the presence of a fissure fracture or subchondral and trabecular bone trauma. Seven of eight lesions were located approximately midway between the dorsal and palmar cortices of the proximal phalanx; the eighth was sited more dorsally. Two horses underwent follow-up MR imaging and abnormal signal intensity persisted, with little change. © 2011 *Veterinary Radiology & Ultrasound, Vol. 52, No. 6, 2011, pp 596–604.*

Key words: fracture, metacarpo(tarso)phalangeal, MRI, radiology, scintigraphy.

Introduction

INCOMPLETE SAGITTAL FRACTURES of the proximal aspect of the proximal phalanx have been described in racehorses[1,2] and sports horses.[3–5] Although these fractures may not always be evident at onset of acute lameness, they are usually apparent in a dorsopalmar radiograph after 10–14 days due to normal osteoclastic healing.[6] Often, there is also characteristic periosteal new bone on the dorsoproximal aspect of the proximal phalanx.

We recently documented an incomplete sagittal fracture midway between the dorsal and palmar aspects of the proximal phalanx in a showjumper, using scintigraphy and magnetic resonance (MR) imaging.[7] We also described several other horses with focal increased radiopharmaceutical uptake (IRU) in the proximal axial aspect of the proximal phalanx associated with lameness localized to the metacarpo(tarso)phalangeal region.[4]

Radiologically detectable osseous cyst-like lesions have been described in association with incomplete fractures of the proximal aspect of the proximal phalanx in sports horses.[5] It is possible that there is a continuum of injury, ranging from stress-related injury of the subchondral bone and/or full thickness cartilage defect extending into the subchondral bone to overt fracture.

Our objectives were to describe the history, signalment, clinical signs, and diagnostic imaging findings in lame sports horses with evidence of subchondral bone trauma of the sagittal groove of the proximal phalanx diagnosed using MR imaging.

Materials and Methods

Eligible horses ($n = 8$) had been examined for lameness related to the metacarpo(tarso)phalangeal region, had undergone MR imaging between January 2001 and December 2010, and had evidence of subchondral bone trauma of the sagittal groove of the proximal phalanx. Data concerning age, breed, work discipline, gender, height, bodyweight, clinical features, and response to diagnostic analgesia were recorded.

Seven horses underwent radiographic examination of the lame limb(s), including flexed lateromedial, dorsolateral-palmaro(plantaro)medial, dorsomedial-palmaro(plantaro)lateral, and dorsal 10° proximal-palmarodistal (D10°Pr-PaDi) (or dorsal 15° proximal-plantarodistal [D15°Pr-PlDi]) views.[8] Comparative D10°Pr-PaDi (D15°Pr-PlDi) images of the contralateral limb were obtained in unilaterally lame horses.

Nuclear scintigraphy was performed in six horses, with acquisition of both pool and bone phase images of the metacarpo(tarso)phalangeal region, after intravenous injection of ^{99m}technetium methylene diphosphonate (MDP) (10 MBq/kg).[9,10] Lateral and dorsal (plantar) pool phase and bone phase images were acquired statically over 2 minutes.

MR imaging of the metacarpo(tarso)phalangeal region was performed using either a high-field (1.5 T) magnet* (Horses 1, 2, 5) with the horse under general anesthesia or a low-field (0.27 T) magnet† (Horses 3, 4, 6–8) with the horse standing and sedated. Spoiled gradient echo (SPGR), T1-weighted gradient echo (GRE), T2* weighted GRE, fast

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*General Electric, Milwaukee, WI.

†Hallmarq Veterinary Imaging Ltd., Guildford, Surrey, UK.

TABLE 1. Summary of Signalment Data, Lame Limb, Duration of Lameness

No.	Age (Years)	Breed	Work Discipline	Lame Limb	Degree of Lameness*	Duration of Lameness (Months)
1	10	WBL	SJ	LF	2	1.5
2	7	WBL	SJ	RF	5	1
3	12	P	Dr	RF>LF	1	2
4	14	WBL	Dr	RF	1	3 intermittently
5	11	WBL	Dr	LF>RF	3	0.75
6	11	WBL	Dr	LF>RF	1	6 intermittently
7	10	A	E	LH	1	1
8	12	A	E	LF	2	7 intermittently

*0 = sound, 2 = mild, 4 = moderate, 8 = severe. WBL, warmblood; A, Arabian; P, pony; Dr, dressage; SJ, showjumping; E, endurance; LF, left forelimb; RF, right forelimb; LH, left hindlimb.

spin echo (FSE), and short tau inversion recovery (STIR) sequences were obtained in sagittal, transverse, and dorsal planes.[7,11] The phalangeal region and foot were also examined in five horses.

Radiographic and scintigraphic image analysis was performed prospectively by the examining clinician (S.J.D. or A.N.). MR images were assessed prospectively by an experienced analyst (R.M. or G.G.) and the examining clinician. All images were reviewed consecutively, retrospectively, without reference to previous records by S.J.D. Scintigraphic images were assessed subjectively; the lateral images were also assessed objectively by region of interest (ROI) analysis. A rhomboid-shaped ROI was placed within the area of IRU in the proximal aspect of the proximal phalanx; a second square-shaped ROI of standardized size was placed in the mid diaphysis of the third metacarpal bone (reference bone). Mean counts per pixel were recorded for each ROI and a ratio between the proximal phalanx ROI and the reference bone was calculated. Measurements were repeated five times for each limb with a coefficient of variance of $<2\%$. Radiopharmaceutical uptake was defined as normal if the ratio was <2; IRU was defined as mild, moderate. or intense if the ratios were ≥ 2 to ≤ 2.99, ≥ 3 to ≤ 3.99, and ≥ 4, respectively.[12]

Horse 8 underwent surgical treatment by insertion of a single 4.5 mm cortical bone screw in lag fashion from lateral to medial, using radiographic control. The remaining horses were managed conservatively, with box rest and an ascending walking exercise program for a minimum of 2 months up to 9 months, depending on the results of follow-up imaging. Advice was given concerning foot balance and shoeing, tailored to each individual horse. Follow-up information was obtained by re-examination of Horses 1–4 and 6. Additional information was acquired by telephone conversations with the owner, rider, and/or the referring veterinary surgeon.

Results

There were eight horses (five Warmbloods, two Arabians, and one pony), with an age range of 7–14 years (median 11 years), used for dressage (4), showjumping (2), and endurance (2) (Table 1). Height ranged from 145 to 173 cm (mean 157 cm, median 151 cm) and bodyweight from 373 to 632 kg (mean 507 kg, median 491 kg). Four horses had unilateral forelimb lameness, one had unilateral hindlimb lameness and three horses had bilateral forelimb lameness (only evident after diagnostic analgesia of the lamer limb). Three horses had been lame for <1 month, two for between 1 and 2 months, and three horses had intermittent lameness for 3–7 months (Table 1). Horse 4 had shown sporadic, severe lameness if worked hard and Horses 3 and 6 had a single episode of acute-onset, severe lameness during work which then improved, despite a previous history of more low grade lameness. Horse 7 had intermittent lameness after training sessions. Horse 8 had a single episode of severe lameness after an endurance ride that had rapidly improved.

Horses 1–6 had no localizing clinical features. Horse 7 had bilaterally symmetric distension of the metatarsophalangeal joint capsule; Horse 8 had reduced range of flexion of the left metacarpophalangeal joint. The degree of lameness in hand in straight lines ranged from 1 to 5 (0 = sound; 2 = mild; 4 = moderate; 6 = severe; 8 = non-weight-bearing)[13] (Table 1). Distal limb flexion tests were negative. Perineural analgesia of the palmar digital nerves performed immediately proximal to the cartilages of the foot (2×2 ml 2% mepivacaine‡) was negative in all horses ($n = 6$), including Horse 1 which had more severe lameness after anesthesia (Table 2). Palmar nerve blocks at the base of the proximal sesamoid bones (2×2 ml mepivacaine) resolved lameness, or resulted in contralateral limb lameness in six of seven horses. Lameness in Horse 8 remained unchanged and was improved by palmar (at the junction of the proximal three-quarters and distal one-quarter of the metacarpal region) (2×2 ml mepivacaine) and palmar metacarpal (2×1 ml mepivacaine) nerve blocks. Intraarticular analgesia of the metacarpophalangeal joint (6–10 ml mepivacaine) improved lameness in two of two horses. Local analgesia was not performed in Horse 7, with an

‡Intra-Epicaine, Dechra Veterinary Products, Shrewsbury, UK.

TABLE 2. Summary of Responses to Perineural Analgesia and Intraarticular (IA) Analgesia of the Metacarpophalangeal (MCP) Joint

Horse	Palmar Digital Nerves	Palmar (Base of Proximal Sesamoid Bones) Nerves	Palmar and Palmar Metacarpal Nerves	IA Analgesia MCP Joint
1	W	S	NP	I
2	NC*	S*	NP	NP
3	NC	I	NP	I
4	NC	S	NP	NP
5	NC	S	NP	NP
6	NC	S	NP	NP
7	NP	NP	NP	NP
8	NP	NC	I	NP

*Performed by referring veterinary surgeon. NC, no change; I, improved; S, sound; NP, not performed; W, worse.

history of intermittent lameness, because the horse was only marginally lame at the time of examination.

A very short vertical radiolucent line was identified in the subchondral bone of the sagittal groove of the proximal aspect of the proximal phalanx in the lame limb of two horses (one bilaterally) (Horses 1 and 5) (Fig. 1a). In five horses (Horses 2, 3, 6–8) there was a similarly positioned subtle, ill-defined radiolucent area in the subchondral bone of the sagittal groove, with thickening of the subchondral bone plate ± endosteal irregularity in four of these horses (Fig. 1b and c). In Horse 8 there was an ill-defined curved obliquely orientated radiolucent line crossing the subchondral bone plate into the trabecular bone (Fig. 1d). No other significant radiographic abnormality was detected. Horse 4 had undergone radiography elsewhere and the images were unavailable for examination.

There was intense IRU in the proximal axial aspect of the proximal phalanx in the lame(r) limb in three horses (Horses 1, 2, 7) (Table 3) (Fig. 2). There was moderate IRU in the proximal aspect of the proximal phalanx in the lame limb of two horses (Horses 3, 6), in one of which (Horse 3) there was more intense IRU in the distal axial aspect of the third metacarpal bone (Fig. 3). There was also moderate

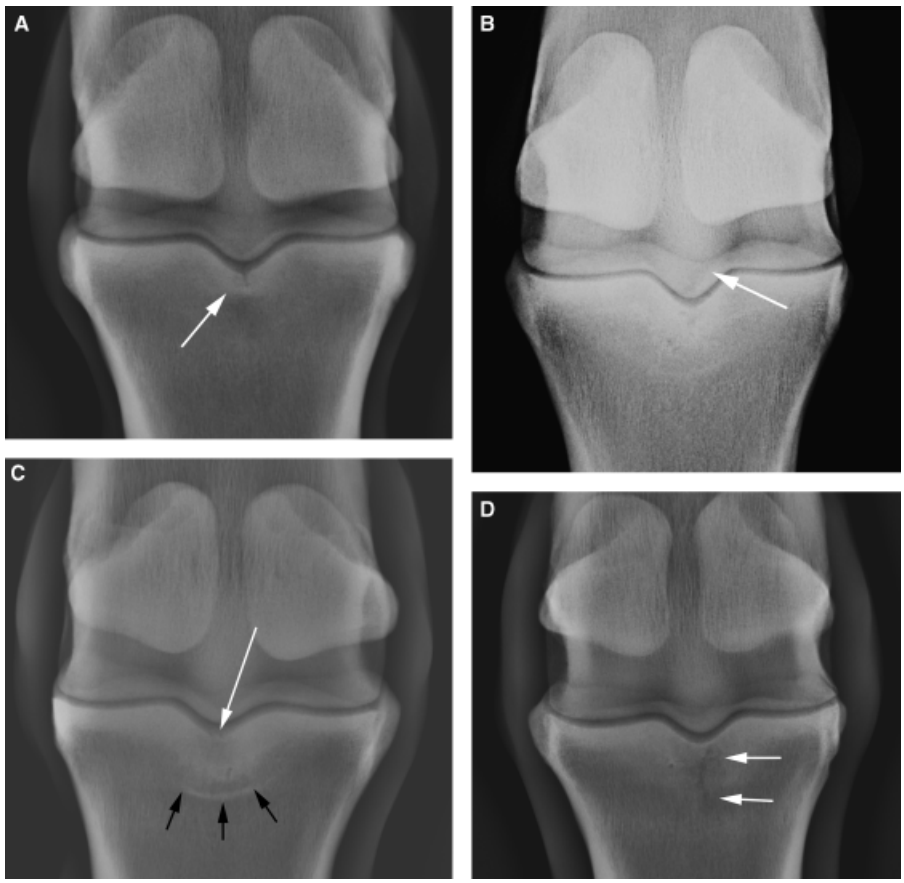

FIG. 1. Dorsopalmar radiographic images of the metacarpophalangeal joint of the lame(r) limb of Horses 5 (A), 2 (B), 6 (C), and 8 (D). Medial is to the left. (A) There is a short radiolucent line in the subchondral bone of the sagittal groove of the proximal phalanx (arrow). (B) There is an ill-defined radiolucent area in the subchondral bone of the sagittal groove of the proximal phalanx (arrow). (C) There is an ill-defined radiolucent area in the subchondral bone of the proximal phalanx axially (white arrow). The subchondral bone is thickened and has an irregular endosteal surface (arrows), distal to which is a semicircular radiopaque line. (D) There is an ill-defined curved radiolucent line (arrows).

TABLE 3. Summary of Scintigraphic and Magnetic Resonance Imaging (MRI) Findings

No.	Scintigraphy	MRI Findings
1	Intense IRU PP	Incomplete articular sagittal fracture of dorsoproximal aspect of PP with decreased SI in dorsal half of bone in T1W and T2W GRE images and more focal increased SI in STIR images
2	Intense IRU PP	Incomplete articular sagittal fracture of proximal aspect of PP midway between dorsal and palmar aspects with small crack in the articular cartilage just dorsal to fracture, with extensive increased SI in STIR images extending from dorsal to palmar aspects corresponding to low SI in T1W and T2W GRE images. There was a similarly located short fissure in the SCB of the contralateral limb, with no osseous reaction
3	Moderate IRU PP, intense IRU McIII	Very irregular endosteal margin of SCB of proximal axial aspect of PP with mild diffuse decreased SI distally in T1W and T2W GRE images and FSE and linear low SI extending dorsally and palmarly; focal increased SI in SCB axially in T1W and T2W GRE images; focal intense increased SI in fat suppressed images midway between dorsal and palmar aspects of proximal aspect of PP axially; diffuse decreased SI centered around sagittal ridge dorsal aspect of McIII in T1W and T2W GRE weighted images and FSE and mild increased SI in fat suppressed images. Enlargement of the proximal aspect of the lateral short CL of the MCP joint with increased SI in T1W and T2W GRE images
4	—	Incomplete short axial SCB fracture or bone trauma proximal aspect PP midway between dorsal and palmar aspects with increased SI in STIR images around it and in dorsal aspect of sagittal ridge of McIII laterally > medially, and corresponding decreased SI in T1W images and water fat cancellation artifact in T2W GRE images; diffuse mild decreased SI in surrounding bone in T1W and T2W images; mild trabecular decreased SI in T1W andT2W images in condyles McIII
5	Moderate IRU RF PP, mild IRU LF PP	Bilateral incomplete short axial SCB fracture proximal aspect of PP midway between dorsal and palmar aspects with focal increased SI in STIR coinciding with it; SCB thickened—diffuse mild decreased SI in surrounding bone in T1W and T2W images; decreased SI in distal dorsal and palmar aspect of McIII in midline in T1W images. In LF deep digital flexor tendon lesion extending from middle to distal phalanges
6	Moderate IRU LF and RF PP	Thickening of SCB plate at sagittal groove of PP, LF, and RF with irregularity of endosteal surface; within this bone is a circumscribed area of increased SI in STIR and T2W GRE images and intermediate SI in T1W images centered midway between dorsal and palmar; decreased SI in distal–dorsal aspect of sagittal ridge of McIII LF and RF
7	Intense IRU PP	Short fissure through subchondral bone in sagittal groove of PP, with diffuse decreased SI in T1W and T2W images and increased SI in STIR images around here and extending from dorsal to plantar and axial and slightly to lateral; rim of decreased SI in T2 GRE images reflecting fat water cancellation artifact; mild diffuse decreased SI in T1W images extending distally and dorsolaterally and in distal dorsal aspect of MtIII axially
8	—	Incomplete parasagittal fracture of axial aspect of PP with increased SI in fat suppressed images with large area of surrounding increased SI in STIR images, outlined in T2W images by rim of low SI reflecting water fat cancellation artifact; tracks dorsolaterally distally; abnormal mineralization of dorsal and palmar aspects of condyles of McIII characterized by low SI in T1W andT2W images

IRU, increased radiopharmaceutical uptake; PP, proximal phalanx; McIII, third metacarpal bone; MtIII, third metatarsal bone; SI, signal intensity; STIR, short tau inversion recovery; W, weighted; GRE, gradient echo; FSE, fast spin echo; SCB, subchondral bone; LF, left forelimb; RF, right forelimb; CL, collateral ligament; MCP, metacarpophalangeal.

IRU in the proximal axial aspect of the proximal phalanx in the less lame limb of one bilaterally lame horse (Horse 5). In the contralateral lamer limb of Horse 5 there was mild IRU. In five horses the region of IRU extended from the dorsal to the palmar aspects of the proximal phalanx, but was slightly greater dorsally than towards the palmar aspect. In Horse 5 the areas of IRU were more centrally located from dorsal to palmar. In all horses IRU was seen in both pool and bone phase images.

MR imaging findings are summarized in Table 3. All horses had abnormalities localized to the sagittal groove in the proximal aspect of the proximal phalanx, with alteration in signal intensity in all image sequences (Figs. 4–6). In four horses (Horses 3, 5, 6, 7) there were also abnormalities of the distal dorsal aspect of the sagittal ridge of the third metacarpal bone with reduced signal intensity in T1- and T2-weighted images and increased signal intensity in STIR images (Figs. 5 and 6). In two horses (Horses 4, 8) there were areas of low signal intensity in T1- and T2-weighted images consistent with mineralization in the palmar aspect of the condyles of the third metacarpal bone. In four horses (Horses 2, 5, 7, 8) a short discrete fissure through the subchondral bone in the proximal aspect of the proximal phalanx could be identified, midway between the dorsal and palmar aspects. In Horse 1 a fissure was located closer to the dorsal cortex. The fissures were characterized by linear increased signal intensity in the subchondral bone in T1- and T2-weighted images. In the remaining three horses (Horses 3, 4, 6) lesions were characterized by endosteal irregularity of the subchondral bone in the sagittal groove of the proximal phalanx, and alterations in signal intensity in the subchondral bone and the underlying trabecular bone (Table 3).

In seven horses, these osseous injuries were considered to be the primary cause of pain and lameness. In Horse 5, a core lesion of the deep digital flexor tendon was considered most likely to be the cause of an acute exacerbation of lameness in the lamer limb 7 days before examination.

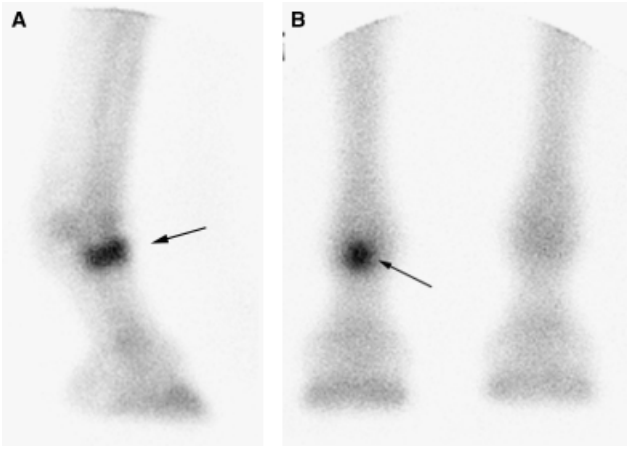

FIG. 2. Lateral (A) and dorsal scintigraphic images of Horse 2. The right forelimb is to the left in (B). There is focal intense increased radiopharmaceutical uptake in the axial proximal aspect of the proximal phalanx, extending from dorsal to palmar in the lateral image.

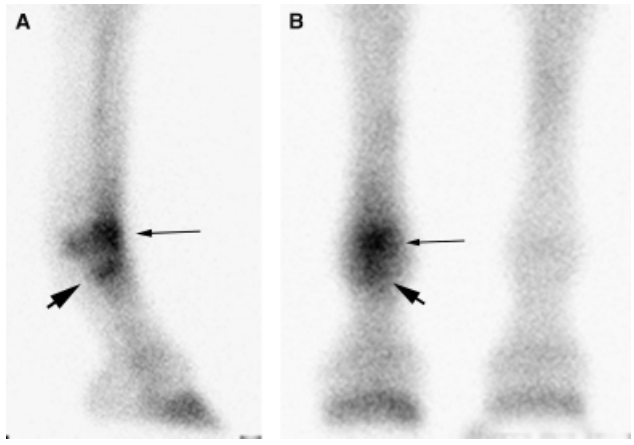

FIG. 3. Lateral (A) and dorsal (B) scintigraphic images of Horse 3. The right forelimb is to the left in (B). There is focal intense increased radiopharmaceutical uptake (IRU) in the distal dorsal axial aspect of the third metacarpal bone (arrow) and moderate focal IRU in the axial proximal aspect of the proximal phalanx, which extends from dorsal to palmar in the lateral image (large arrowhead).

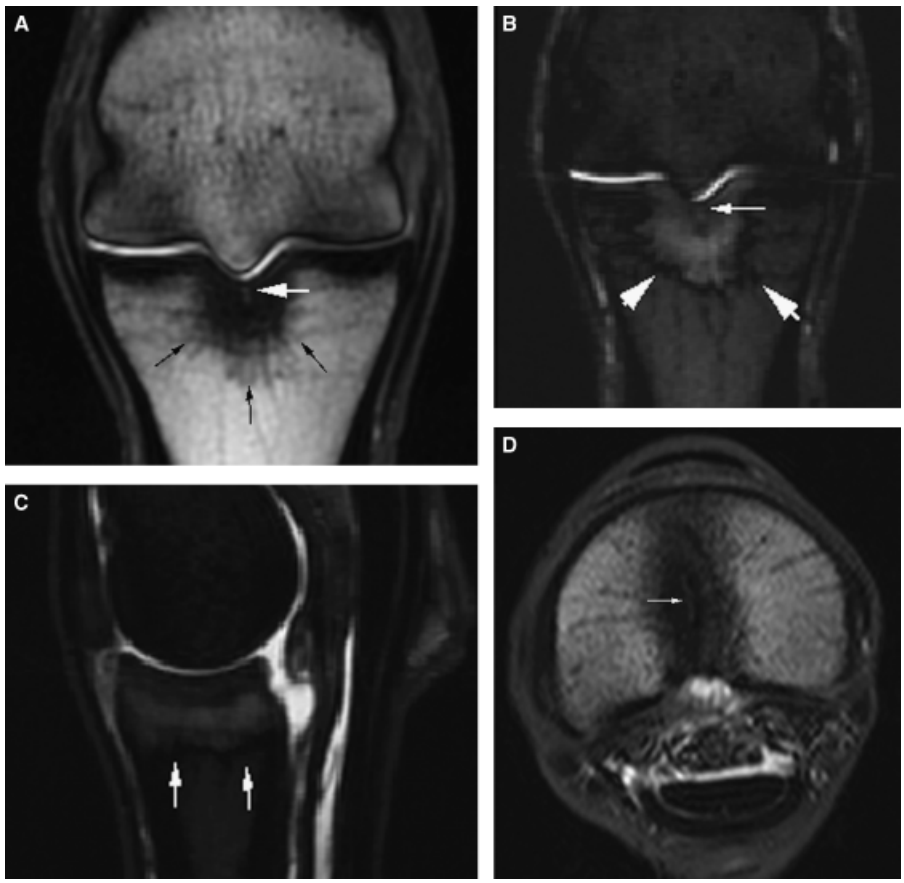

FIG. 4. (A) Dorsal T2* weighted gradient echo (GRE), (B) dorsal short tau inversion recovery (STIR), (C) sagittal STIR, and (D) transverse T2* weighted GRE high-field magnetic resonance (MR) images of the lame limb of Horse 2. Lateral is to the left of the dorsal and transverse images. (A) There is a fissure in the subchondral bone at the sagittal groove of the proximal phalanx (white arrow) surrounded by a region of diffuse low signal intensity (black arrows). (B) There is high signal intensity in the fissure in the subchondral bone at the sagittal groove (arrow) and diffuse increased signal intensity in the surrounding trabecular bone, bordered by a rim of low signal intensity (arrowheads). (C) There is high signal intensity throughout the epiphyseal region from dorsal to palmar (arrows). Compare with Fig. 2A. (D) Centrally there is an area of intermediate signal intensity (arrow) surrounded by a diffuse region of low signal intensity extending between the dorsal and palmar cortices.

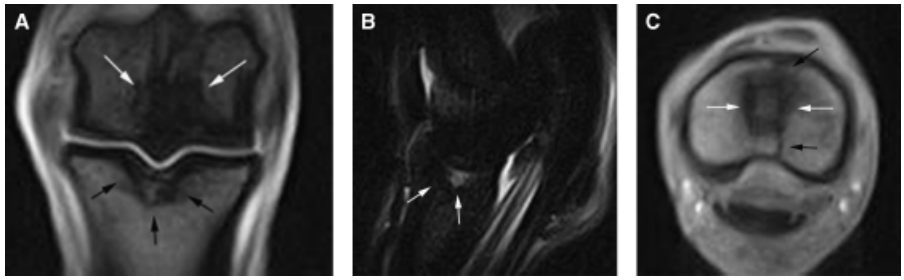

FIG. 5. (A) Dorsal T1-weighted gradient echo (GRE), (B) sagittal short tau inversion recovery, and (C) transverse T1-weighted GRE low-field MR images of the right forelimb of Horse 3. Lateral is to the left in the dorsal and transverse images. (A) There is a diffuse area of increased signal intensity in the subchondral bone at the sagittal groove of the proximal phalanx, with endosteal irregularity (black arrows). There is diffuse low signal intensity in the distal aspect of the sagittal ridge of the third metacarpal bone extending medially (white arrows). Compare with Fig. 3. (B) There is intense increased signal intensity in the subchondral and trabecular bone midway between the dorsal and palmar aspects of the proximal phalanx (arrows); there is also increased signal intensity on the proximal dorsal aspect of the sagittal ridge of the third metacarpal bone. (C) There is a central area of intermediate signal intensity surrounded by a broad band of low signal intensity (white arrows), with linear areas of low signal intensity extending towards the dorsal and palmar cortices of the proximal phalanx (black arrows).

Horses 1, 2, 3, and 6 underwent initial follow-up radiographic and scintigraphic examinations at 2–4 months after MR imaging; there was no progression of radiologic abnormalities and radiopharmaceutical uptake ratios were reduced, but IRU persisted. Follow-up MR imaging examination was performed in Horses 4 and 6, after 3 and 4 months, respectively, and there was persistent increased signal intensity in the region of the sagittal groove of the proximal phalanx in STIR images and the development of increased signal intensity in STIR images in the distal dorsal aspect of the sagittal ridge of the third metacarpal bone in Horse 4. Both horses were reassessed after an additional 4 months, at which time Horse 6 was in moderate work with no detectable lameness; Horse 4 was still on walking exercise. There was no change in the MR imaging appearance of the proximal phalanx in either horse.

Horses 1, 2, and 3 returned to full athletic function and had no recurrent lameness for between 2 and 6 years. Horse 6 has been in full competition work for 2 months. Horses 4 and 7 are in full work, 7 months after diagnosis, but have not yet competed. Horse 8 remained lame 6 months postoperatively and was retired without further investigation. Horse 5 is still convalescing from the deep digital flexor tendon injury, 7 months after diagnosis.

Discussion

We described eight horses with subchondral bone trauma of the sagittal groove of the proximal phalanx, although an overt fracture line was only evident in five horses. It is likely that these were not single episode event injuries, but the results of repetitive subchondral bone trauma, sclerosis of the subchondral bone and microfracture.

Subchondral bone trauma of the proximal axial aspect of the proximal phalanx is not a common sports horse injury, and was identified in eight of approximately 60 sports horses which underwent MR imaging of the metacarpo(tarso)phalangeal region in the study period. During this period approximately 4700 horses underwent in-depth lameness examination. Eight additional sports horses had focal, moderate to intense IRU in the proximal axial aspect of the proximal phalanx, with negative or equivocal radiologic abnormalities, but for financial reasons these horses did not undergo MR imaging. Five sports horses with subchondral bone injury of the proximal phalanx

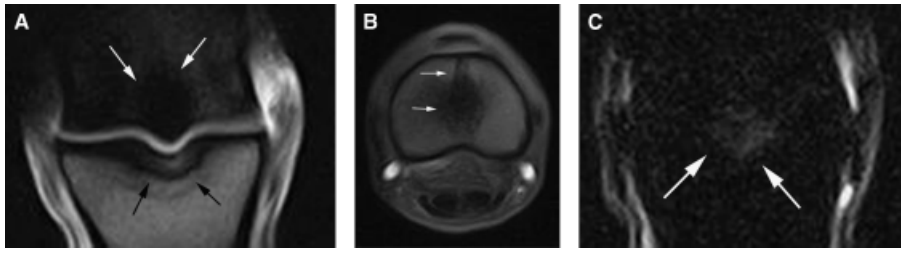

FIG. 6. (A) Dorsal T2* weighted gradient echo (GRE), (B) transverse T1-weighted gradient echo (GRE), and (c) dorsal short tau inversion recovery low-field MR images of the left forelimb of Horse 6. Medial is to the left in the dorsal and transverse images. (a) There is an area of high signal intensity in the subchondral bone at the sagittal groove of the proximal phalanx; the subchondral bone is thickened axially and has endosteal irregularity (black arrows). Note also the curved line of intermediate signal intensity distal to the subchondral bone. Compare with Fig. 1B. There is also diffuse decreased signal intensity in the distal aspect of the sagittal ridge of the third metacarpal bone (white arrows). (B) There is diffuse low signal intensity in the central part of the proximal phalanx (arrows) with low signal intensity lines extending to the dorsal cortex. (C) There is focal increased signal intensity in the axial proximal aspect of the proximal phalanx (arrows).

were documented in a series of 40 horses undergoing high-field MR imaging of the metacarpo(tarso)phalangeal region; however, a more specific anatomic location of the lesions was not described.[14] Thirteen sports horses with osseous injuries of the metacarpo(tarso)phalangeal region determined using low-field MR imaging were described, but no similar lesions were documented.[15]

MR imaging features of short incomplete sagittal fractures and stress injuries of the dorsoproximal aspect of the proximal phalanx have been described in 10 young Thoroughbred racehorses.[16,17] There was evidence of pre-fracture abnormalities, characterized by thickening of the subchondral bone plate of the dorsoproximal articular margin of the proximal phalanx. This is different from the anatomic location of the majority of lesions described in the current study. Moreover four of six horses examined radiographically 4 weeks after MR imaging developed periosteal new bone on the dorsoproximal aspect of the proximal phalanx,[16] a feature not seen in the current study. A further two young Thoroughbreds had diffuse increased signal intensity in fat suppressed images in the proximal aspect of the proximal phalanx consistent with bone contusion, but this was not localized axially.[17] There is an increasing recognition of proximal phalangeal fractures in endurance horses,[18,19] and it is notable that two of the eight horses in the current study were endurance horses. The configuration of the fracture in Horse 8 was not identical, but had some similarities, to the incomplete parasagittal fractures seen in Thoroughbreds.

The majority of horses in the current study did not have a history suggestive of a fracture. Short incomplete sagittal fractures of the proximal phalanx have been associated with mild to severe lameness, which sometimes may be barely perceptible.[6,20] However, there are usually clinical signs related to metacarpo(tarso)phalangeal region pain, including distension of the joint capsule, pain on pressure over the dorsoproximal aspect of the proximal phalanx and a positive response to distal limb flexion,[6,20] signs that were absent or infrequent in the current study. For this reason it was considered safe to perform diagnostic analgesia, except in Horse 2 with grade 5 lameness, which had been referred for scintigraphic evaluation of the foot following resolution of lameness by palmar nerve blocks performed by the referring veterinarian. Incomplete dorsoproximal fractures of the proximal phalanx are at risk of potentially catastrophic propagation. Whether the subchondral trauma and fissures identified in Horses 1–7 are at similar risk is currently unknown. Several horses in the current study had remained in full work, despite intermittent lameness, up to the time of examination. The absence of localizing clinical signs may reflect subclinical chronic disease of the proximal phalanx which progresses insidiously before the development of overt lameness.

High palmar digital analgesia improved lameness in three of five sports horses with incomplete fractures of the proximal phalanx identified radiologically,[5] however, in the current study palmar digital analgesia did not improve lameness in any horse. This may reflect the proximodistal site of injection, the volume of local anesthetic solution and the time after injection at which the response was assessed. It has been documented previously that palmar nerve blocks performed at the base of the proximal sesamoid bones have the potential to abolish metacarpo(tarso)phalangeal region pain,[4,5] as was seen in six of seven horses in the current study. Deterioration of lameness after a negative response to local analgesia of the distal aspect of the limb, as seen in Horse 1, is thought to reflect altered proprioceptive function of the foot and increased loading of a more proximal painful structure.

All horses examined radiologically in the current study had subtle alterations in the region of the sagittal groove of the proximal phalanx. However in no horse was periosteal new bone identified on the dorsoproximal aspect of the proximal phalanx, either at the initial examination or at follow-up examinations. This probably reflects the more palmar location of the lesions in the current study, compared with the more typical dorsoproximal incomplete sagittal fractures.[1,3,5] The absence of periosteal new bone was documented previously in three of 10 sports horses with incomplete sagittal fractures of the proximal aspect of the proximal phalanx.[5] A short vertical linear radiolucent defect in the sagittal groove has been described as a common incidental finding in Standardbred racehorses,[21] and was not associated with IRU. In the current study the radiographic abnormalities in the sagittal groove were associated with moderate or intense IRU and with more extensive abnormalities on MR images. However, Horse 2 did have a small fissure in the non-lame limb detected using MR imaging, which was not associated with any surrounding osseous reaction, nor was there IRU. In the majority of the horses in the current study examined using scintigraphy, IRU was present extending from the dorsal to palmar aspects of the proximal aspect of the proximal phalanx, in contrast to the more dorsal location seen in association with incomplete dorsoproximal fractures.[22]

An overt fracture line was not seen in MR images in all horses, although in many other respects the MR imaging appearance of the sagittal groove was similar among horses. The inability to detect a fissure may reflect the image quality of the low-field images, which were of lower resolution and larger slice thickness and are more prone to volume averaging artifacts[23] compared with the high-field images. Alternatively, the lesions identified may reflect localized subchondral and trabecular bone trauma, similar to the pathologic change associated with a stress fracture. It may be difficult to differentiate stress fractures from trabecular microtrauma using MR imaging because there is considerable cross-over in both the degree of pathologic

change and MR appearance.[24–29] In our experience it is not uncommon for a fracture line in the parasagittal groove of the third metacarpal bone to become detectable radiologically soon after detecting MR changes of high signal intensity on STIR images and low signal intensity on T1-weighted images, despite no fracture line evident on MR images, as observed by others.[15] This is similar to stress fractures in people.[26,28] It is possible that computed tomography may provide additional information.[30]

Related lesions were also seen in the distal dorsal aspect of the sagittal ridge of the third metacarpal bone in four horses, which were likely to be contributing to pain and lameness. In one of these horses (Horse 3) there was intense IRU in the distal dorsal aspect of the third metacarpal bone, compared with moderate IRU in the proximal aspect of the proximal phalanx. In racehorses and endurance horses, dorsal distal metacarpal and proximal phalanx lesions are frequently related, which may be a manifestation of hyperextension injury to the joint.[31]

We believe these injuries are likely to be the result of chronic repetitive trauma rather than single episode events. In Horse 3 concurrent injury of the lateral collateral ligament of the metacarpophalangeal joint may have contributed to lack of joint stability and the sudden acute lameness that occurred on one occasion during competition. In vitro studies have demonstrated that there is a biphasic ground reaction force at walk at most articular sites in the metacarpophalangeal joint, but at the sagittal groove the stress continues to rise after mid-stance.[32] The direction and magnitude of compressive and shear forces follow the ground reaction force. When standing, there is continual loading of the central portion of the joint,[33] with maximal loading towards the central and dorsolateral and dorsomedial aspects of the joint at the walk and trot. Although at high speed and jumping highest pressures occur dorsally, medially more than laterally, there is less pressure in the sagittal groove. It was suggested that the discrepancy between the loading of the sagittal groove and the other parts of the joint at the end of the stance phase may result in a large stress gradient which may predispose to injury.[32] The biomechanical effects of turning were not assessed in either of these studies. However, constant turning in showjumping and dressage horses is likely to influence forces between the sagittal ridge of the third metacarpal bone and the sagittal groove of the proximal phalanx.

The persistence of high signal intensity in STIR images despite resolution of lameness and the identification of an area of high signal intensity in nonlame limbs of unilaterally lame horses have been recognized previously in the horse.[34–36] Similar observations have been made in people.[37–39] The persistence of high signal intensity in STIR images or its resolution do not appear to be accurate predictors of future soundness.[35,36] Follow-up MR imaging was only performed in two horses in the current study and it is not known whether the lack of change in appearance is typical of subchondral bone injury in this location. This highlights the value of combining MR imaging with scintigraphic examination to determine the degree of osseous activity. Despite the absence of change in the MR images of Horse 6 there was both clinical improvement and reduction in the radiopharmaceutical uptake ratios. During the study period, one additional horse had diffuse low signal intensity in T1- and T2-weighted GRE images in the trabecular bone in the dorsoproximal axial aspect of the proximal phalanx immediately distal to the level of the subchondral bone plate bilaterally. This was consistent with mineralization. There was more focal increased signal intensity in STIR images dorsally, similarly located distal to the sagittal groove. The horse was lame bilaterally, but lameness was abolished completely by palmar digital nerve blocks performed at the level of the cartilages of the foot and was improved substantially by intra-articular analgesia of the distal interphalangeal joint. Lameness was attributed to osteoarthritis of the distal interphalangeal joints and mild desmopathy of the collateral ligaments. The MR imaging findings in the proximal phalanges were assumed to reflect either the result of previous injuries currently not contributing to lameness or subclinical injury. Based on these observations and the findings in two horses in the current study it is possible that MRI is of limited value for assessment of the response to treatment.

It is important to recognize that incomplete short fractures in the sagittal groove of the proximal phalanx in sports horses identified radiologically may be characterized by slow healing or an absence of healing if treated conservatively.[5] Horse 8 was managed surgically because of both the long duration of intermittent lameness and the length and configuration of the fracture line.

In conclusion, metacarpo(tarso)phalangeal region pain should be considered in horses with lameness abolished by palmar nerve blocks performed at the base of the proximal sesamoid bones. Subtle radiologic abnormalities of the subchondral bone of the sagittal grove of the proximal phalanx may herald more serious injury, meriting further investigation by scintigraphic and/or MR imaging. Persistence of MR signal intensity alterations appears to continue after clinical and scintigraphic improvement; therefore scintigraphy may be of most use in decision-making during follow-up evaluation of this type of proximal phalanx injury.

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