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ORIGINAL ARTICLE

Radiographic changes of the proximal third metatarsal bone do not predict presence or severity of proximal suspensory desmopathy in a predominately Quarter Horse population

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Abstract

Background: Comparison of radiography to magnetic resonance imaging (MRI) can help objectively assess the value and limitations of radiographs in orthopaedic disease processes. The tarsus and proximal suspensory origin of the metatarsus are commonly imaged regions for lameness. The knowledge gained by comparison between imaging modalities will aid in improving accuracy of radiographic interpretation.

Objective: To compare the radiographic and MRI findings of the proximal third metatarsal bone (MTIII) and proximal suspensory ligament using MRI as the gold standard.

Study design: Retrospective observational study.

Methods: Single hindlimbs of 35 horses with radiographic and high-field (3Tesla (3T)) MRI studies were blindly evaluated by two board-certified veterinary radiologists and a radiology resident. Severity and location of the following parameters were assessed: radiographic MTIII sclerosis and lucent regions, MRI endosteal metatarsal sclerosis and bone marrow lesions, plantar cortical proliferation and resorption, and proximal suspensory desmopathy (PSD).

Results: Radiographic osseous changes of MTIII were identified in 54% of limbs, whereas 40% limbs had osseous changes on MRI: 43% of limbs had PSD on MRI. No significant association was found between the presence of radiographic changes in MTIII and PSD on MRI ($P = .7$). A statistically significant association and positive correlation was found between the severity of radiographic changes and MTIII plantar cortical proliferation and resorption on MRI ($P = .01$).

Main limitations: Retrospective study with no histopathology. Ability to correlate findings with lameness was limited by the lack of standardised time intervals between onset of lameness, diagnostic analgesia and advanced imaging.

Conclusion: Radiographic bony changes of proximal MTIII do not reliably predict presence or severity of PSD but are associated with osseous changes at the proximal MTIII. The presence of radiographic changes should warrant additional diagnostics in the region prior to making conclusions about the presence or absence of PSD.

KEYWORDS
enthesopathy, horse, magnetic resonance imaging, proximal suspensory ligament, radiographs, tarsus

1 | INTRODUCTION

Proximal suspensory desmopathy (PSD) and distal tarsal pathology are frequent sources of lameness in multiple equine disciplines. Diagnostic analgesia in this region can be relatively non-specific with false positive and false negative results. Substantial tarsal pathology has been found in horses that showed significant improvement after subtarsal analgesia and, conversely, PSD has been identified in horses with improvement after intra-articular tarsal blocks.[1-7] Multimodal imaging is often required to investigate the root cause of lameness in these horses and can include radiography, ultrasonography, nuclear scintigraphy, computed tomography and magnetic resonance imaging. Radiography and ultrasonography are frequently employed prior to advanced imaging.

Common radiographic findings in the proximal third metatarsal bone (MTIII) include increased trabecular and endosteal bone density (sclerosis), areas of decreased bone density and enthesophyte formation.[8-10] These changes have been reported to be found more commonly in hindlimbs than forelimbs.[8-10] Magnetic resonance imaging findings of PSD include enlargement, altered fat and muscle bundle architecture and areas of abnormal increased signal.[4,7] Comparisons of the proximal metatarsal region have been made between radiography and nuclear scintigraphy, radiography and ultrasonography and ultrasound and magnetic resonance imaging.[4,8,9,11-14] A recent comparison between radiographic and ultrasonographic findings of the proximal metacarpus and metatarsus has found that horses with PSD had more increased radiopacity in the lateral aspect of the metatarsus, and a multifocal distribution pattern was more common in hindlimbs with PSD.[13] Limited comparisons with a low number of clinically affected horses have been made between radiographic examination and MRI.[7]

A better understanding of radiographic lesions compared with MRI findings will aid in the interpretation of radiographic studies for practitioners. The specific aims of this study are to (a) compare the radiographic and MRI findings of the proximal MTIII and (b) compare radiographic finding of MTIII and MRI findings of the proximal suspensory ligament. It was hypothesised that radiographic changes of the proximal MTIII would not correlate with the presence of PSD.

2 | MATERIALS AND METHODS

2.1 | Horses

The study had a retrospective, observational design. Horses included in the study had a standard four view radiographic study and high-field (3T) MRI study of the tarsus/proximal metatarsus. A search of electronic medical records between the years 2012 and 2018 was performed to identify equine MRIs of the proximal metatarsus and distal tarsus at a dedicated veterinary imaging centre. Veterinarians who referred cases for MRI were asked to provide radiographic images.

At a minimum for inclusion, both imaging modalities had to extend from the proximal intertarsal joint to the metatarsal nutrient foramen in the field of view. Radiographic studies had to include the four standard radiographic views: lateromedial, dorsoplantar, dorsolateral-plantomedial oblique and dorsomedial–plantolateral oblique. All radiographs had to be produced by digital radiography with DICOMS available and screened for appropriate exposure. Radiographic technique was not known nor standardised given that the radiographs were acquired from multiple private practices with various equipment. Grossly under- or overexposed radiographs were not included in the study. Collimation had to include at least the proximal third metatarsal to the level of the nutrient foramen. Wider collimation, such as the entire tarsus, did not exclude the case from the study. To be included, radiographs had to meet the above quality requirements and had to be acquired within approximately 1 month (less than 36 days) of the MRI. All MRI images were acquired on the same 3.0 Tesla magnet (Siemens Verio, Siemens Medial Solutions USA, Inc). The minimum sequences required for inclusion were a proton density turbo spin echo (PD-TSE) transverse plane, T1-weighted volumetric interpolated breath hold examination (VIBE) or proton density-fat saturated sagittal, dorsal plane TSE image, and at least one short tau inversion recovery or fat-saturated sequence in at least one plane. Horses with incomplete or non-diagnostic radiographic or MRI studies were excluded from the study.

The hindlimbs included in the study were considered the predominate limb lameness based on medical records from referring clinicians. Clinical parameters, such as pattern of response to diagnostic analgesia or final diagnosis, were not part of the inclusion criteria. Acquired MRI studies of the contralateral hindlimb were not included in statistical analysis, but the researchers had access to these studies for comparison when evaluating images. The intent of the criteria used for inclusion was to select cases in which the sources of lameness arose from both the proximal suspensory and/or distal tarsal joints reduce bias in interpretation while not excluding those horses for which findings of diagnostic analgesia was non-specific.

2.2 | Evaluation of images

The images were retrospectively evaluated by two board-certified veterinary radiologists with equine MRI expertise (MB, KS) and a second-year radiology resident (FH). All were blinded to the patients' signalment and clinical presentation. Scores were made by group consensus. Radiographs and MRI images were evaluated separately, with all radiographic studies evaluated first, then MRIs in differing orders to prevent bias from knowledge of either imaging modality. Radiographs were evaluated using DICOM viewing software (Philips Intellispace PACS) on a dedicated viewing station. MRIs were evaluated using DICOM viewing software (Osirix version 11, Pixmeo SARL) on a dedicated viewing station.

2.2.1 | Individual lesion scoring

Radiographic lesions of the proximal third metatarsals bone evaluated included regions of sclerosis and lucency. Sclerosis was defined as an increased radiopacity with loss or alteration of trabecular bone definition and lucent regions as areas of decreased mineral radiopacity. Magnetic resonance imaging osseous changes of proximal MTIII recorded included endosteal sclerosis, bone marrow lesions (ie bone fluid signal or bone oedema), plantar cortical bone proliferation (enthesophytes) and plantar cortical resorption. Previously established MRI grading criteria for PSD included diffuse enlargement, diffuse or focal alteration in signal intensity, and loss of the fat and muscle bundle architecture.[4,7] The radiographic and MRI lesions were graded as present or absent (0-absent, 1-present), additionally a severity scale (0-3) was applied (Table 1).

The location of pathology was described in four scenarios: only affecting lateral aspect, only medial aspect, only midline or multifocal where pathology was present in at least two regions.

2.2.2 | Lesion severity combination scores

In addition to the graded individual imaging features, the individual lesion severity grades were added together into combined scores for each modality to reflect the overall degree of regional change. These combination scores were used to reflect that image interpretation is unlikely to be based on individual lesions but rather the combination of imaging changes identified. The radiographic combination score was the additive severity scores of sclerosis and lucent regions. Two MRI combinations scores were made: one to reflect changes of the endosteal surface and one to reflect changes of the periosteal surface of the proximal MTIII. The MRI endosteal score summed the sclerosis and bone marrow lesion severities. The MRI periosteal score summed proliferation and resorption severities.

2.2.3 | Clinical data

Clinical data including breed, age, sex, results of diagnostic analgesia performed by the primary veterinarian and AAEP 5-point lameness score at time of MRI were recorded for all available horses. Lameness scores were obtained retrospectively from medical records. Lameness evaluations without diagnostic analgesia were performed immediately prior to the MRI by veterinary staff of the dedicated imaging facility at time of referral for MRI. The primary diagnostic analgesia resulting in clinically significant improvement (>60%) was obtained retrospectively from medical records provided by the referring veterinarian. Diagnostic analgesia was performed at an undetermined time interval prior to referral to MRI.

2.3 | Data analysis

To compare the radiographic and MRI lesions, statistical analysis was performed using the presence or absence of a lesion as ordinal data and the severity scores (individual and combination) as continuous data. Chi square analysis was performed to compare both the presence or absence and the severity of the radiographic and MRI imaging features. Spearman's correlation was used to compare severity grades of imaging features and combination scores. A *P*-value $<.05$ was considered to be significant. Statistical analysis was performed using a commercial software (SAS, SAS Institute Inc, v9.4). Statistical analysis was not performed on lesion location nor clinical data, such as lameness scores or blocking patterns, in relation to the imaging findings due to incomplete data sets and variable times between time of lameness onset and imaging referral.

3 | RESULTS

3.1 | Horses

From 2012 to 2018, approximately 350 hindlimbs underwent MRI of the proximal metatarsus/tarsus. Eighty of the 350 limbs had radiographic images available with only 38 limbs of 36 horses meeting the inclusion criteria of four standard radiographic views within 1 month of the MRI study. Approximately, half of the radiographic studies (18 of 35) were acquired within 7 days of the MRI. One limb was excluded due to an incomplete MRI study. Two limbs were excluded because these limbs represented the contralateral hindlimb MRI study acquired at the same time; either non-lame or not considered the primary lameness. Statistical analysis was performed on 35 limbs from 35 horses.

Of these 35 horses, 32 were Quarter Horses, 1 Paint and 2 Warmbloods. The age ranged from 2 to 16 years with a median age of 5 years, 19 were geldings, 12 mares, 3 stallions and 1 horse with unknown sex status were included. The majority of the horses were used for western performance. Specific discipline and level were not available for many horses, and thus not included in the population data.

3.2 | Lameness scores and diagnostic analgesia

The limbs included were considered the predominately lame limb for all 35 horses. Three of 35 horses had lameness graded as 4 of 5. Four horses had grade 3 lameness. One horse was described as 2.5 of 5 lameness. Eleven horses had grade 2 lameness. Six horses had a grade 1.5 lameness, and 8 horses had a grade 1 lameness. Two horses' lameness score was unavailable.

Twenty-four of 35 horses had results of diagnostic analgesia reported for the affected hindlimb. Twelve of 35 limbs responded favourably to diagnostic analgesia of the proximal suspensory region

TABLE 1 Radiographic and MRI grading criteria of proximal MTIII lesions in 35 limbs

Imaging Finding	Normal (0)	Mild (1)	Moderate (2)	Severe (3)
Radiographic MTIII sclerosis	Normal trabecular pattern; slight diffuse increased opacity of the lateral aspect accepted as normal	Thin linear sclerosis, single mild region of sclerosis <25% of proximal MTIII	Moderate single or multifocal regions of sclerosis 25%-50% of proximal MTIII	Complete loss of trabecular bone pattern due to marked increased bone sclerosis >50% of proximal MTIII
Radiographic MTIII lucency	Normal trabecular pattern	Ill-defined single region mild decreased bone opacity	More well-defined, 1-2 sites of moderate decreased bone opacity	Well-defined >2 sites of marked decreased bone opacity
MRI MTIII sclerosis	Normal low signal cortical bone and high signal medullary bone with crisp demarcation	Decreased signal in both T2- and T1-weighted images of the endosteum affecting <10% of plantar surface	Decreased signal in both T2 and T1-weighted images of the endosteum affecting 10%-30% of plantar surface	Decreased signal in both T2- and T1-weighted images of the endosteum affected >30% of plantar surface
MRI MTIII bone marrow lesions	Normal low signal cortical bone and high signal medullary bone with crisp demarcation	Focal fluid signal affecting <10% of the plantar cortex and endosteum	Fluid signal affecting 10%-30% of plantar cortex and endosteum	Fluid signal affecting >30% of plantar cortex and endosteum
MRI MTIII proliferation	Smooth slightly curvilinear cortical margin	Mild osseous proliferation at one site	Mild-to-moderate osseous proliferation at 2 sites	Moderate-to-marked osseous proliferation at 2 or 3 sites
MRI MTIII resorption	Smooth slightly curvilinear cortical margin	Unilateral mild concave lysis of the plantar cortex	Unilateral moderate or multifocal mild-to-moderate concave lysis	Unilateral marked or multifocal moderate-to-marked concave lysis
MRI PSD	Normal low signal ligament fibres and high signal fat/muscle bundles	Mild enlargement and/or focal mild increased signal of ligamentous portions	Moderate enlargement and/or multifocal or mild diffuse increased signal of ligamentous portions	Marked enlargement and/or diffuse increased signal of ligamentous portions >50% of CSA

Abbreviations: CSA, cross sectional area; MTIII, proximal third metatarsal bone from the tarsometatarsal joint to the nutrient foramen; PSD, proximal suspensory desmopathy.

by either deep branch of the lateral plant nerve or local infiltration of the proximal suspensory ligament region. Six of 35 limbs blocked to a combination of the lower tarsal joints (distal intertarsal and tarsometatarsal), 3 limbs to a combination of both proximal suspensory region and lower tarsal joints and 1 limb to the tarsometatarsal joint alone. Two limbs blocked to a peritoneal-tibial. One limb blocked to the tibiotarsal joint and 1 limb to the digital flexor tendon sheath. The results of diagnostic analgesia were not recorded in 9 of 35 limbs.

3.3 | Imaging findings

Nineteen of 35 limbs (54.3%) had radiographic osseous changes of the proximal third metatarsal bone (MTIII; ie enthesis of the proximal suspensory) (Figure 1). Sclerosis was identified in all 19 affected limbs with 5 limbs categorised as moderate or severe. Sclerosis was most commonly identified on midline being present in 12 of 19 limbs (63%), 6 limbs had sclerosis in the lateral aspect, and 1 limb had a multifocal pattern of sclerosis. No limbs were identified as having sclerosis solely in the medial aspect. Lucent regions were identified in 7 of 35 limbs (20%) with 4 limbs categorised as moderate and none as severe lucent regions. All horses with lucent regions also had sclerosis. The location of lucent regions was most frequently in the medial aspect or as a multifocal pattern with 3 of 7 affected limbs (42%) in each category. One limb had a lucent region on midline. The severity grade distributions of the radiographic and MRI findings are summarised in Table 2.

Evaluation of the MRI studies revealed 14 of 35 (40%) limbs had osseous changes of proximal MTIII. Twelve of 35 limbs (34%) had sclerosis, 9 of 35 limbs (26%) had bone marrow lesions, 12 of 35 limbs (34%) had plantar cortical resorption and 10 of 35 limbs (29%) had plantar cortex proliferation. Sclerosis and bone marrow lesions most frequently occurred in the lateral aspect of the proximal third metatarsal bone, 7 of 12 affected limbs (58%) and 5 of 9 affected limbs (56%), respectively. Plantar cortical resorption occurred most frequently in the medial aspect (7 of 12 limbs: 58%). Plantar cortical proliferation occurred most frequently along the medial aspect and in a multifocal pattern with 4 of 10 affected limbs (40%) in each category.

Fifteen of 35 limbs (43%) had an MRI evidence of proximal suspensory desmopathy (PSD). Six limbs had severe PSD, 2 limbs moderate PSD and 7 limbs mild PSD. Twenty of 35 horses (57%) had no evidence of PSD. MRI signal alteration indicating desmopathy was most commonly found in the dorsal aspect of the proximal suspensory ligament in 10 of the 15 limbs (67%). The proximal suspensory ligament was diffusely affected in four limbs and predominately

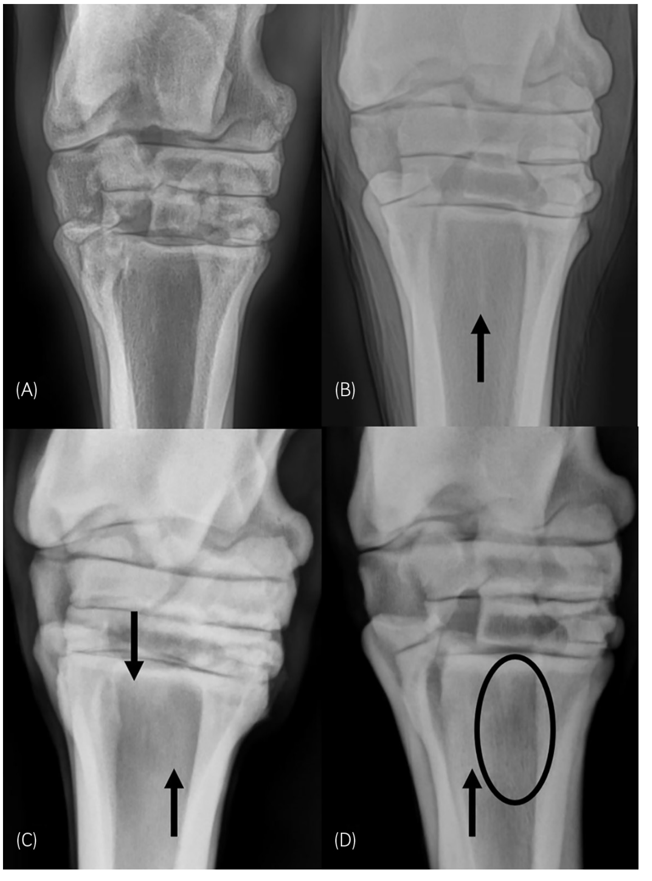

FIGURE 1 Examples of the variable appearance of radiographic changes of the proximal MTIII. A, Normal dorsoplantar radiograph. B, Thin mild linear sclerosis (black arrow). C, Multifocal moderate sclerosis (black arrows). D, Marked lateral sclerosis (black arrow) with moderate lucent region in the medial aspect (black oval)

TABLE 2 Frequency of radiographic and MRI lesion severity scores out of 35 limbs

Imaging findings	# of limbs Normal (0)	# of limbs Mild (1)	# of limbs Moderate (2)	# of limbs Severe (3)
Rad MTIII sclerosis	16/35 (46%)	14/35 (40%)	4/35 (11%)	1/35 (3%)
Rad MTIII lucent regions	28/35 (80%)	3/35 (9%)	4/35 (11%)	0/35 (0%)
MRI MTIII endosteal sclerosis	23/35 (66%)	7/35 (20%)	3/35 (9%)	2/35 (6%)
MRI MTIII bone marrow lesion	26/25 (74%)	6/35 (17%)	2/35 (6%)	1/35 (3%)
MRI MTIII cortical proliferation	25/35 (71%)	8/35 (23%)	1/35 (3%)	1/35 (3%)
MRI MTIII cortical resorption	23/35 (66%)	7/35 (20%)	4/35 (11%)	1/35 (3%)
MRI PSD severity	20/35 (57%)	6/35 (17%)	2/35 (6%)	7/35 (20%)

Abbreviations: MTIII, proximal third metatarsal bone from the tarsometatarsal joint to the nutrient foramen; PSD, proximal suspensory desmopathy.

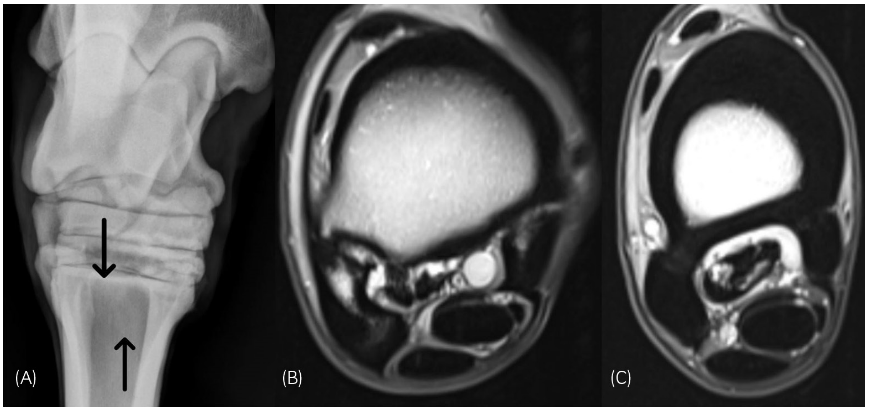

FIGURE 2 A, Dorsoplantar radiographic exhibiting multifocal moderate sclerosis of proximal MTIII (black arrows) with normal proximal metatarsal MRI (B and C, transverse PD images of the proximal MTIII)

FIGURE 3 A, B, Marked lateral sclerosis identified on both the dorsoplantar and lateral radiographs (black arrows). C, D, transverse PD MRI images of proximal MTIII exhibiting marked diffuse sclerosis (white oval) and moderate medial cortical resorption (thin white arrow) with moderate medial lobe PSD (block white arrow)

affected only in the plantar aspect in one limb. PSD was most commonly present in the lateral lobe in 7 of 15 limbs (47%) and present in both lobes in 5 of 15 limbs (33%). The medial lobe was the predominate lobe affected in 3 limbs.

Eleven of 19 limbs (57%) with proximal MTIII radiographic abnormalities had osseous changes on MRI, while 8 of 19 limbs (42%) with radiographic changes did not have corresponding MRI osseous changes. Of the eight limbs that had radiographic changes but lacked osseous changes on MRI, two horses had mild PSD exclusively and six horses had completely normal MRI studies (Figure 2). The six limbs with false positive radiographic lesions identified, but normal MRIs, were described to have linear midline sclerosis (3), lateral sclerosis (1), lateral sclerosis with medial lucency (1) and multifocal sclerosis pattern (1) on radiographs. Ten of 19 limbs (53%) with radiographic changes had indications of PSD on MRI. Five of six limbs with marked desmopathy had radiographic changes, ranging from mild to marked, while one horse with marked PSD did not have radiographic changes. The single horse with marked radiographic sclerosis had marked PSD and marked sclerosis on MRI (Figure 3). One horse with marked PSD had no radiographic changes, but moderate sclerosis and bone marrow lesion on MRI (Figure 4).

3.4 | Correlations and associations between imaging findings

Chi-Square analysis revealed statistically significant associations between the presence of radiographic and MRI sclerosis (P = .01), radiographic combination score and MRI endosteal score (P = .01), and radiographic combination score and MRI plantar cortical score (P = .01). Spearman's correlation revealed statistically significant moderate positive correlation between radiographic combination score and MRI plantar cortical score (P = .006, r = 0.5). The radiographic combination score combined sclerosis and lucency scores and the MRI plantar cortical score combined plantar osseous proliferation and resorption score. No statistically significant association or correlation was found between radiographic sclerosis or radiographic combination score and presence of PSD (P = .3 and P = .7, respectively). Radiographic sclerosis was not statistically associated with proximal metatarsal bone marrow lesions on MRI. Radiographic lucent regions compared with proximal metatarsal plantar cortical resorption approached significance (P = .06).

4 | DISCUSSION

Our results demonstrate that the presence of radiographic changes, including sclerosis and lucent regions, in proximal MTIII

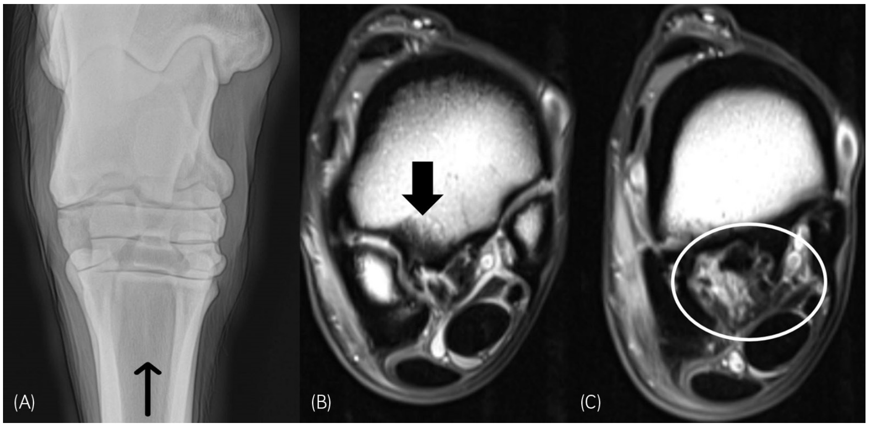

FIGURE 4 A, Dorsoplantar radiograph with mild linear midline sclerosis (thin black arrow). B, C, Moderate lateral sclerosis (thick black arrow) and marked PSD (white oval) on PD transverse MRI images

is not associated with the presence of PSD based on MRI as the clinically applicable gold standard. We hypothesised that radiographic changes of the proximal MTIII would not correlate with the presence of PSD, and thus, the results suggest that radiographic changes in the proximal metatarsus should not be used to signify presence of concurrent PSD. Although radiographic changes were not associated with ligamentous injury, radiographic sclerosis was associated with the presence of sclerosis on MRI. In our population, radiographic sclerosis was most frequently identified on midline with only one limb exhibiting a multifocal pattern of sclerosis. This differed from recent work comparing radiographic changes and ultrasonography where increased radiopacity of proximal MTIII was found to be more frequently located in the lateral aspect.[13] In addition, multifocal radiopacity was more frequent in horses with PSD and not seen in any control horse leading to the conclusion that a multifocal pattern could represent pathognomonic features of PSD.[13] The difference between studies may be due to breed, discipline or age differences of each population. The previous study included predominately Warmblood horses with a median age of 10 years, while the current study had mostly Quarter Horses with a median age of 5 years. Differences in grading designs could also be a source of discrepancy between the two studies. The previous study categorised proximal MTIII sclerosis distribution into seven locations and patterns with subdivisions of lateral, medial, and middle locations and multifocal or diffuse patterns whereas the current study described lesions in four locations (lateral, medial, midline or multifocal) and no distinction between patterns. We consider faint homogenous increased opacity with uniform trabecular pattern in the lateral aspect of the proximal MTIII as a normal finding. This is suspected to be due to an increased dorsoplantar width of the proximal MTIII in the lateral aspect compared with the medial aspect, based on our experience in evaluation of cross-sectional imaging. In our study, horses with slight increased opacity in the lateral aspect were graded as normal, which may have not been considered normal by other researchers.

Radiographic sclerosis could represent some of the traits of enthesopathy. The term enthesopathy encompasses changes at the bone ligament interface including sclerosis, bone marrow lesions, osseous proliferation and resorption. The pathophysiology of enthesopathy remains poorly understood but is considered primarily an inflammatory condition due to biomechanical stressors with plantar cortical bone forming subsequent to focal inflammation at the interface.[15] Bone marrow lesions (oedema) characterised by increased signal on fat suppressed sequences at the suspensory ligament enthesis strongly support the inflammation theory. In our study, the presence of radiographic sclerosis and MRI bone marrow lesions was not significantly associated. Eight of nine limbs with bone marrow lesions on MRI had PSD, including all six limbs with severe PSD. Only six of the nine horses with MRI bone marrow lesions had radiographic change, predominately mild to moderate. Bone marrow lesions could be an indication of the severity of the injury but cannot be detected on radiographs. Another imaging finding of enthesopathy, plantar cortical resorption on MRI, did not result in a significant association when compared with lucent regions on radiographs. Lucent regions were much less common on radiographs than sclerosis. This may represent true plantar cortical bone loss or relative lucent region due to surrounding sclerosis or osseous proliferation on radiographs. The remaining traits of enthesopathy, sclerosis and osseous proliferation were significantly associated with presence of radiographic sclerosis. Given these associations, radiographic changes of proximal MTIII could indicate some of the elements of enthesopathy: new bone formation and increased bone density (sclerosis). Although radiographic changes could represent enthesopathy, radiographic changes remained unassociated with the presence of proximal suspensory desmopathy. An explanation, similar to observations made by earlier publications, is that PSD and metatarsal enthesopathy can occur both concurrently and independently.[8,9] Osseous changes could occur prior to ligamentous injury or osseous changes are residual after the ligamentous injury has healed.

Statistical analysis was not performed on lameness scores and diagnostic analgesia patterns due to the limitations of lack of uniformity between time of diagnostic analgesia and time to referral for MRI with the possibility of rest and treatments in between. Lameness scores in horses with severe proximal suspensory desmopathy varied greatly from 1.5 to 4 on the AAEP 5-point scale. The lameness in horses with severe radiographic and MRI osseous changes also varied from 1 to 3 of 5. Of the three horses with the highest degree of lameness in this study (4 of 5), only one horse had proximal suspensory desmopathy, which was severe. The other two horses with severe lameness had significant tarsal pathology (data not shown). Of the 12 horses that had lameness localised to the proximal suspensory ligament region by diagnostic analgesia, only seven horses had proximal suspensory desmopathy on MRI, but five of the six cases of severe proximal suspensory desmopathy did improve following a suspensory block technique which was considered the primary diagnostic block. In our study, the lameness examination was performed at the time of MRI referral, but diagnostic analgesia was performed at variable undetermined times prior to referral. Any treatment or improvement in lameness between initial injury and referral MRI is not accounted for. Our findings in this study are consistent with our clinical observations that the degree of lameness and severity of imaging findings do not always correlate. Also, the variations in diagnostic analgesia patterns compared with the main diagnosis observed in our population echoes previously reported variable non-specific responses to diagnostic analgesia in the proximal metatarsal region.[1,4,5]

The retrospective nature of the study results in some limitations. Horses with more obvious or severe radiographic or sonographic changes during initial examination may have been less likely to undergo MRI, resulting in selection bias. Radiographs acquired within 1 month prior to and after the MRI were included in this study, whereas ideally radiographs would have been obtained on the same day of the MRI for improved comparison. While dramatic bone change would have been unlikely within a month, stall rest and treatment could potentially result in differences between the radiographic and MRI studies. The population evaluated was low in number and predominately one breed (Quarter Horse) mostly of Western disciplines, although specific disciplines varied. Breed and discipline can play a large role in type and severity of injuries commonly sustained by the equine athlete. The findings of this study may only be applicable to Quarter Horses and/or Western disciplines. Timing of diagnostic analgesia, lameness score and referral for MRI varied greatly, thus we believe these data would result in inaccurate analysis of the true clinical presentation and precluded these findings from statistical analysis.

In conclusion, our data suggest that radiographic changes of proximal MTIII may not indicate the presence or severity of proximal suspensory desmopathy but may be correlated with bony metatarsal enthesopathy in a Quarter Horse population. These findings are important particularly in the context of the pre-purchase examination in which radiography is the predominate imaging modality. The presence of radiographic changes warrants additional diagnostic assessment of the region prior to making conclusions about the proximal suspensory ligament. Further work is required to evaluate whether these observations on diagnostic imaging and their relationships between lameness or response to diagnostic analgesia are possibly breed or discipline specific.

ETHICAL ANIMAL RESEARCH

Research ethics committee oversight not required by this journal: retrospective study of clinical records.

INFORMED CONSENT

Explicit owner consent for animals' inclusion in the study was not stated.

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CONFLICT OF INTERESTS

No competing interests have been declared.

AUTHOR CONTRIBUTIONS

M. Barrett and F. Hinkle contributed to study conception and design. M. Barrett, F. Hinkle and K. Selberg acquired data. M. Barrett, F. Hinkle and D. Frisbie are responsible for data integrity and accuracy of data analysis. D. Frisbie, M. Barrett, F. Hinkle and K. Selberg contributed to data analysis and interpretation. F. Hinkle drafted the manuscript. M. Barrett, F. Hinkle, K. Selberg and D. Frisbie revised the article for intellectual content. All authors gave their final approval of the manuscript.

PEER REVIEW

The peer review history for this article is available at https://publons.com/publon/10.1111/evj.13562.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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