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Is there an association between clinical features, response to diagnostic analgesia and radiological findings in horses with a magnetic resonance imaging diagnosis of navicular disease or other injuries of the podotrochlear apparatus?

Rebecca Parkes [a,1], Richard Newton [b], Sue Dyson [a,*]

[a] Centre for Equine Studies, Animal Health Trust, Lanwades Park, Newmarket, Suffolk CB8 7UU, United Kingdom
[b] Centre for Preventive Medicine, Animal Health Trust, Lanwades Park, Newmarket, Suffolk CB8 7UU, United Kingdom

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ABSTRACT

Previous descriptions of the clinical features of navicular disease occurred before the widespread use of magnetic resonance imaging (MRI) allowed a more definitive diagnosis of foot pain. The objective of this study was to compare the clinical features of horses with lesions of the podotrochlear apparatus with those with other causes of foot pain. It was hypothesised that primary navicular bone disease would be associated with more advanced radiological findings than other diagnoses. A retrospective study was performed of all horses examined at a referral centre with a definitive diagnosis of foot pain based on MRI ± post-mortem examination. Clinical examination findings, response to diagnostic analgesia and radiological grading of the navicular bone were compared among five diagnosis groups: (1) primary navicular bone pathology (NB); (2) lesions of the collateral sesamoidean ligament and/or distal sesamoidean impar ligament (CSL + DSIL); (3) primary deep digital flexor tendon injury (DDFT); (4) navicular bone pathology and other lesions of the podotrochlear apparatus ± DDFT (PTA) and (5) Other.

There were 702 horses (NB, 62; CSL + DSIL, 180; DDFT, 69; PTA, 92; Other, 299). Horses with PTA injuries were more frequently unilaterally lame than other groups ($P = 0.04$). Horses with DDFT injury were more likely to exhibit pain on turning than other groups ($P < 0.01$). There were no associations between response to diagnostic analgesia and diagnostic group, and no association between radiological grade and diagnostic group. Clinical examination findings generally did not discriminate between diseases of the PTA and other causes of foot pain. Overall radiological scores of the navicular bone did not accurately predict navicular bone pathology.

Introduction

Navicular disease is a term used to refer to lameness associated with pain arising from the distal sesamoid (navicular) bone with or without injury of the collateral sesamoidean ligament (CSL) and distal sesamoidean impar ligament (DSIL) (known collectively as the podotrochlear apparatus [PTA]) and/or the deep digital flexor tendon (DDFT) (Widmer et al., 2000; Dyson et al., 2005, 2011a). Previous descriptions of the clinical features of navicular disease were published before the use of magnetic resonance imaging (MRI) (Pryer, 1934; Ackerman et al., 1977; Colles, 1982; Hickman, 1989; Wright, 1993). MRI has permitted more definitive diagnosis of a variety of causes of foot pain, including pathology of the navicular bone and injury of the CSL and/or DSIL (Widmer et al., 2000; Sherlock et al., 2008; Sampson et al., 2009; Biggi and Dyson, 2011; Dyson et al., 2012), primary injuries of the DDFT (Dyson et al., 2003; Mair and Kinns, 2005; Blunden et al., 2009), collateral desmopathy of the distal interphalangeal (DIP) joint (Dyson and Murray, 2004; Zubrod et al., 2005; Dakin et al., 2009; Gutierrez-Nibeyro et al., 2009; Dyson et al., 2010), DIP joint osteoarthritis (Dyson and Murray, 2007a), bone trauma of the middle or distal phalanges (Olive et al., 2010), osseous cyst-like lesions in the middle or distal phalanges (Mair and Sherlock, 2010), injuries of the ossified ungular cartilages and related injuries (Dyson and Murray, 2010; Dyson and Nagy, 2011), injuries as the result of foot penetrations (Boado et al., 2005; Kinns and Mair, 2005), and complex injuries involving several structures (Dyson et al., 2005; Sampson et al., 2009).

The PTA and DDFT are closely related biomechanically. The aims of the current study were to describe the clinical features of horses with foot pain and to compare the clinical and radiological features of different forms of PTA or DDFT injury with a group consisting

* Corresponding author. Tel.: +44 1638 751908.
E-mail address: sue.dyson@aht.org.uk (S. Dyson).
[1] Present address: Structure and Motion Laboratory, The Royal Veterinary College, Hawkshead Lane, Hatfield, Hertfordshire AL9 7TA, United Kingdom.

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of all other injuries of the foot in a referral population of horses. It was hypothesised that horses with navicular disease would have a higher radiological score for the navicular bone than horses with other causes of foot pain.

Materials and methods

Case selection

A retrospective study of all horses examined at the Centre for Equine Studies of the Animal Health Trust (AHT) between January 2001 and December 2010 with forelimb foot-related lameness was performed. Horses with foot pain were defined as those in which pain causing lameness was localised to the foot using diagnostic analgesia. The final diagnosis for foot pain was determined prospectively by response to local analgesia (Bassage and Ross, 2010) and assessment of all imaging findings (radiology [Table 1], ultrasonography ± nuclear scintigraphy ± MRI). A diagnosis of navicular pathology was based on either MRI (Dyson and Murray, 2007b) or unequivocal radiological abnormalities (Dyson, 2011a), which were verified by MRI performed post mortem and post mortem examination.

Horses with foot pain were categorised into groups: (1) primary navicular bone pathology (NB) (i.e., lesions of the navicular bone only); (2) lesions of the CSL and/or DSIL (CSL + DSIL); (3) primary DDFT injury (DDFT) (Schramme, 2011); (4) navicular bone pathology and other lesions of the PTA ± DDFT (PTA), and (5) Other, defined as lesions involving structures within the foot other than the PTA or DDFT. Horses that did not undergo MRI or post mortem examination were excluded from the study. Those with both foot pain and a more proximal source of pain contributing to lameness were excluded from analysis of the clinical findings, but were included in the radiological analysis.

Clinical examination findings pertinent to the foot, including subjective assessment of foot conformation, digital pulse amplitudes, response to hoof testers, distension of the DIP joint capsule or digital flexor tendon sheath (DFTS) and other swellings, response to palpation and digital manipulation, and posture were recorded. Lameness was graded on a scale of 0–8 (0 = sound; 2 = mild; 4 = moderate; 6 = severe; 8 = non weight-bearing) (Dyson, 2011b) at both the walk and the trot in straight lines, and in circles on both soft and firm (gravel ± modified asphalt) surfaces. Horses which were not overtly lame at the trot in straight lines but showed a bilaterally short-stepping gait were recorded. Some horses were also evaluated ridden. Consistency of lameness within and between examinations was documented. Responses to distal limb flexion tests (Ross, 2010a) were recorded. In bilaterally lame horses, clinical features of the lamest limb only were recorded; clinical features of the left limb were recorded in horses with bilaterally symmetrical lameness.

Diagnostic analgesia

Palmar digital nerve blocks were performed immediately proximal to the ungular cartilages (2 × 2 mL mepivacaine [Intra-Epicaine, Dechra Veterinary Products]). Palmar nerve blocks were performed at the base of the proximal sesamoid bones (2 × 2 mL mepivacaine). Palmar (at the junction of the proximal three-quarter and distal quarter of the metacarpus) and palmar metacarpal (distal to the second and fourth metacarpal bones) (2 and 1 mL mepivacaine, respectively) nerve blocks ('low 4 point block') were performed. Intra-articular analgesia of the DIP joint was performed via a dorsal approach (5 mL mepivacaine). Intra-thecal analgesia of the navicular bursa was performed under radiographic or fluoroscopic control (3 mL mepivacaine). Lameness was reassessed 10 min after perineural nerve blocks and 5 min after intrasynovial blocks in both straight lines and circles and graded as no change, slightly improved (<50% improved), improved (>50% < 80% improved), or sound. The response to diagnostic analgesia was recorded for the circumstances under which the horse was most lame.

Table 1
Radiological grading of the navicular bone derived from Dyson (2010) and Biggi and Dyson (2011).

Grade	Radiological findings
0	<7 small, conical-shaped radiolucent zones along the distal border of the navicular bone; good demarcation between the spongiosa and compact bone; small proximal or distal extension of the palmar compact bone of the navicular bone; normal thickness of the palmar compact bone of the navicular bone, being slightly thicker proximally compared with distally.
1	<7 variably shaped and sized radiolucent zones along the distal border; medium-sized proximal or distal extension of the palmar compact bone; mild loss of demarcation between the compact bone and spongiosa; mild uniform thickening of the palmar compact bone or thickening at only one site; small entheseophyte at the insertion collateral sesamoidean ligament (CSL) of the navicular bone.
2	≥ 7 variably shaped small radiolucent zones along the distal border; localised or diffuse increased opacity of the spongiosa; thickening of the entire palmar compact bone; large proximal or distal extension of the palmar compact bone; medium-sized entheseophyte at CSL insertion; periarticular osteophyte on dorsoproximal aspect of navicular bone; distal or proximal border fragment without associated lucency in the distal border.
3	≥ 7 variably shaped radiolucent zones, including some large-sized; osseous cyst-like lesion in spongiosa of navicular bone; radiolucent region in palmar compact bone; new bone formation on palmar compact bone; large entheseophyte at CSL insertion; fracture of the navicular bone or bipartite navicular bone; distal or proximal border fragment with associated radiolucency at the distal border.

Image acquisition

Lateromedial, weight-bearing dorsopalmar, two dorsoproximal-palmarodistal oblique, dorsomedial-palmarolateral oblique, dorsolateral-palmaromedial oblique and palmaroproximal-palmarodistal oblique radiographic images were acquired of the foot of the lame limb(s) according to a standard protocol (Butler et al., 2008). Images from 2005 onwards were acquired using a computed radiography system (Carestream); images prior to 2005 were obtained using conventional film:screen technology.

Ultrasonographic examination of the pastern and collateral ligaments of the DIP joint was performed using a variable frequency (8–12 Hz) linear transducer and a microconvex array 8 MHz transducer. Pool and bone phase dorsal, lateral and solar scintigraphic images of the foot were obtained in selected horses ($n = 434$) (Dyson et al., 2001). Magnetic resonance images of the feet were acquired either in a high-field 1.5 T magnet (Dyson et al., 2003) under general anaesthesia, or in a low-field 0.27 T magnet with the horse sedated (Sherlock et al., 2007).

Image interpretation

A radiological grading system was developed (Table 1), derived from Dyson (2010) and Biggi and Dyson (2011). Radiological analysis was performed by one trained analyst (RP) and a grade between 0 and 3 assigned to each navicular bone. This was performed after the completion of intra-observer repeatability studies by subjectively assessing 10 sets of radiographic images 10 times, to ensure consistency and accuracy of interpretation and measurements (coefficient of variance 2.9%, variance 0.01). Repeatability studies were also conducted during the development of the grading system, with SD and RP each assessing 10 sets of images to ensure inter-observer repeatability and a coefficient of variance of < 2%.

Statistical analysis

All statistical analyses were conducted using Stata12.0 software (StataCorp), with statistical significance set at $P \leq 0.05$. Continuous (duration of lameness) and 0–8 ordinal score (degree of lameness) data were analysed using the non-parametric Kruskal–Wallis rank sum test. For the remaining binary and categorical data contingency tables were analysed using Chi-square (χ^2) or Fisher's exact test (when contingency table cells contained values <5) as appropriate and computationally feasible.

Results

During the study period 4618 horses were examined, of which 702 had front foot pain with a definitive diagnosis. There were 62 horses with NB, 180 with CSL + DSIL, 69 with DDFT, 92 with PTA and 299 with other causes of foot pain.

The median duration of lameness was 4 months (range 0.25–60 months), ranging from 3 months (range 0.25–14 months) for NB, to 4 months (range 0.25–48 for CSL + DSIL; 0.5–48 for DDFT; 0.25–36 for PTA and 0.25–60 for Other). There were no significant differences among groups (Kruskal–Wallis $P = 0.21$). Onset of lameness was defined as sudden or insidious/intermittent. Lameness was sudden in onset in 30.5–36.5% of horses; there were no significant differences among diagnosis groups and the onset of lameness (χ^2 $P = 0.92$).

There were no significant differences among diagnosis groups for subjectively assessed conformational abnormalities of the foot (Fisher's exact $P = 0.05$), with 53.9% of horses having no abnormalities recorded (Table 2). However, a low heel or broken back foot-pastern axis was seen in 24.5% of horses in the NB group, compared with 11.2% in CSL + DSIL, 14.9% in DDFT, 9.6% in PTA and 15.9% in Other. Overall, 4.2% of horses had distension of the DIP joint capsule based on clinical examination. Horses in the PTA group were most frequently affected, with 9.8% of animals having DIP joint