Received: 12 June 2023 | Accepted: 30 November 2023
DOI: 10.1111/evj.14040

ORIGINAL ARTICLE

Equine Veterinary Journal WILEY

Presence and size of synovial masses within the navicular bursa correlate well between magnetic resonance imaging and bursoscopy and have a guarded prognosis

Maria Elisabetta Giorio[1] | Robyn J. Graham[2] | Dagmar Berner[1] | Henry D. O'Neill[3] | Bruce M. Bladon[3]

[1]Equine Referral Hospital, Department of Clinical Science and Services, Royal Veterinary College, University of London, Hatfield, UK

[2]Equine Hospital, Royal (Dick) School of Veterinary Studies, University of Edinburgh, Midlothian, UK

[3]Donnington Grove Veterinary Group, Berkshire, UK

Correspondence
Maria Elisabetta Giorio, Equine Referral Hospital, Department of Clinical Science and Services, Royal Veterinary College, University of London, Hawkshead Lane, North Mymms, Hatfield, UK.
Email: mgiorio22@rvc.ac.uk

Abstract

Background: Focal hyperintense lesions within the navicular bursa emanating from the dorsal border of the deep digital flexor tendon (DDFT) can be recognised on T1-weighted magnetic resonance images (MRI) and have been attributed to lameness in horses. Removal of these lesions, also referred to as synovial masses, by navicular bursoscopy is currently recommended.

Objectives: To investigate the correlation between MRI and navicular bursoscopic findings. It is hypothesised that the prognosis following surgery is proportional to the size of the DDFT lesion.

Study design: Retrospective analysis of clinical records.

Methods: Horses undergoing standing low-field MRI and navicular bursoscopy with >1 year follow-up were included. A grading system was developed to classify the size of synovial mass(es) and lesion(s) of the DDFT on MRI and at surgery. Generalised estimating equations were used to evaluate the association between MRI findings and surgery and between outcome and severity of the tendon injury.

Results: Fifty-nine horses presenting over a 15-year period (2006–2021) fulfilled inclusion criteria. Ninety navicular bursae were examined both on MRI and endoscopically. There was strong correlation between the size of synovial masses and tendon lesions on MRI and bursoscopy ($p < 0.001$, OR: 25.61, 95% CI 8.71–75.29 and $p < 0.001$, OR: 7.34, 95% CI 2.70–19.92, respectively). Size of tendon lesion and synovial mass had no impact on prognosis ($p = 0.3$, OR: 1, 95% CI 1–1 and $p = 0.1$, OR: 1, 95% CI 1–1, respectively), which was guarded (30.5% return to previous level of exercise).

Main limitations: Performance data for conservatively treated horses with MRI-detected synovial masses was not considered, nor was the effect of navicular bursal effusion. Horses were not randomly assigned to treatment protocols.

Conclusion: There is good correlation between MRI and bursoscopic findings of DDFT lesions and synovial masses within the navicular bursa, with no false positives. Size of the synovial masses and DDFT lesions does not influence prognosis following navicular bursoscopy.

KEYWORDS
DDFT, diagnostic imaging, horse, navicular bursoscopy

1 | INTRODUCTION

Deep digital flexor tendinopathy[1] is a common injury reported in horses presenting with lameness localised to the foot.[2,3] Primary lesions are thought to be the result of repetitive overloading, cumulative fatigue microdamage of the tendon matrix[4,5] or an acute onset traumatic tear.[2] The usefulness of MRI in diagnosing DDFT lesions in the foot is well documented[3,6,7] and MRI is considered the most sensitive imaging modality for identifying changes of the DDFT, with multiple studies demonstrating good correlation with gross and histological findings.[8–10] In addition, it provides the added benefit of identifying extra-bursal abnormalities not visible with bursoscopy. Disruption of the bursal surface is difficult to assess accurately by MRI,[7] therefore bursoscopy, in combination with advanced imaging, allows the precise diagnosis of DDFT lesions in the foot. It has been suggested that surgical treatment of DDFT lesions in the navicular bursa might be more successful than conservative management, with 44% reported to return to previous level of athletic performance[11] compared with 28% of cases managed conservatively.[3] Conversely, recent work has shown little difference in outcome with bursoscopy compared with conservative management.[12] Cases with extensive tears are significantly less likely to regain soundness[13]; however, dorsal border lesions of the deep digital flexor tendon appear to have a better prognosis than core lesions or parasagittal splits.[12]

Primary DDF tendinopathy has been reported extensively; however, there is little information correlating synovial masses, described as clumps of collagenous tissue extruding from the dorsal border of the DDFT into the navicular bursa,[13] with MRI or bursoscopic findings. Additionally, prognostic information considering both synovial mass and tendon lesion severity is lacking. In a recent study, tenoscopic assessment of the digital flexor tendon sheath confirmed the presence and location of DDFT injuries previously diagnosed on low-field standing MRI examination, with no additional intraoperative lesions identified.[14] In a different study comparing high-field MRI and tenoscopic examination of the digital flexor tendon sheath, MRI had the highest sensitivity (100%) for the detection of large longitudinal tears of the DDFT; however, the sensitivity for the diagnosis of small tears was only average (66.6%).[15] Similarly, when assessing the presence of adhesions in the navicular bursa on high-field MRI and navicular bursoscopy, the positive predictive value of MRI was 100% for type 3 (large) adhesions, but only 50% for type 1 (small) adhesions.[16]

To date, no study has assessed the significance of DDFT lesions and synovial masses identified on MRI within the navicular bursa, bursoscopic findings and long-term athletic performance. Such information should increase the accuracy of prognosis for return to athletic function dependent on DDFT lesion severity. The aim of this study is to Investigate the correlation between MRI and navicular bursoscopic findings. It was hypothesised that the prognosis following surgery would be proportional to the size of the DDFT lesion.

2 | MATERIALS AND METHODS

2.1 | Case inclusion criteria

Records of all horses undergoing standing low-field MRI of the front or hind feet at Donnington Grove Veterinary Group over a 15-year period (2006–2021) were reviewed. Horses diagnosed with a synovial mass on the dorsal aspect of the DDFT within the proximal recess of the navicular bursa and that subsequently underwent navicular bursoscopy were included. Recommendation for bursoscopic exploration was generally based on the results of lameness examination and MRI findings, with lower numbers presenting for surgery following poor or partial response to conservative treatment. Horses with additional lesions observed on MRI that were deemed to be significantly contributing to the lameness were excluded.

2.2 | Diagnostic procedures

All horses were subjected to lameness examination prior to MRI and showed a positive response to either perineurial anaesthesia of the palmar digital nerves, intra-articular anaesthesia of the distal interphalangeal joint or intrathecal anaesthesia of the navicular bursa.

2.3 | Magnetic resonance imaging

Standing low-field MRI was performed as described by Mair et al.[17] (Hallmarq Veterinary Imaging Ltd©) Sagittal, frontal and transverse MR scans were obtained using T1-weighted (w) 3D and Isotropic Gradient Recall Echo (GRE), T2*w 3D GRE, STIR and T2w Fast Spin Echo (FSE) and Proton Density w sequences, with a slice thickness ranging from 0.7 to 5 mm. To evaluate the DDFT at the level of the proximal recess of the navicular bursa, T1w 3D High Resolution (HR) transverse sequences (1.5 mm thickness, TE: 8, TR: 24, flip angle 45°, matrix 512 × 512) and T2w FSE HR (3.5 mm thickness, TE: 87, TR: 1980, flip angle 90°, matrix 512 × 512) were acquired at a 90° angle to the supra-sesamoidean portion of the tendon. A tendon lesion was recognised as a region of focal, well-defined hyperintensity on T1w GRE sequences protruding dorsally into the proximal recess of the navicular bursa, often associated with concurrent T2w hypointense or intermediate signal, causing alteration of the dorsal contour of the tendon, as described previously.[2,6,7,15] A grading system for evaluation of DDFT lesions was developed (Table 1, Figures 1 and 2).

TABLE 1 Subjective grading of the synovial mass and deep digital flexor tendon lesion size seen on MRI and at surgery.

	Size	MRI	Navicular bursoscopy
Synovial mass	Grade 1	Mild irregularity of the DB of the DDFT, very small focal T1w hyperintense area at the DB of the tendon protruding into the proximal recess of the navicular bursa	Mild DB irregularity and fibrillation of the DDFT
	Grade 2	Focal well defined T1w hyperintense area, (STIR and T2w hypointense or intermediate signal) at the DB of the DDFT protruding into the proximal recess of the navicular bursa measuring up to 2 mm in dorsopalmar thickness	Torn collagenous tissue extruding from the DB of the tendon, organised in small to medium sized clumps
	Grade 3	Large, focal well defined T1w hyperintense area at the DB of the DDFT protruding into the proximal recess of the navicular bursa measuring over 2 mm in dorsopalmar thickness	Torn collagenous tissue extruding from the DB of the tendon, organised in large clumps
DDFT lesion	Grade 1	Small focal T1w hyperintensity or mild erosion of the DB of the DDFT	Minimal erosion and fibrillation of the dorsal border of the tendon
	Grade 2	Focal, moderate sized T1w hyperintensity within the DB of the DDFT (dorsal lesion)	Focal or generalised, moderate surface erosion of the DB of the tendon.
	Grade 3	Significant injury to the DDFT, deep dorsal lesion or parasagittal split	Substantial erosion or presence of a deep cleft in the tendon

Abbreviations: DB, dorsal border; DDFT, deep digital flexor tendon.

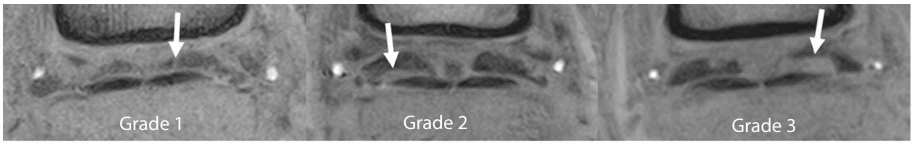

FIGURE 1 T1w 3D HR transverse images of the proximal recess of the navicular bursa showing the synovial mass grading (lateral to the left).

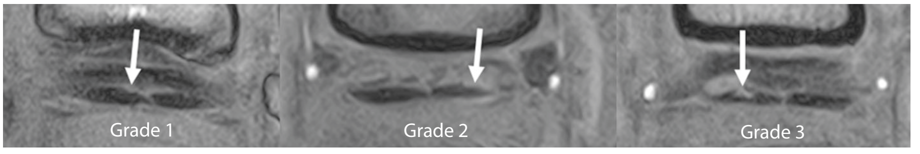

FIGURE 2 T1w 3D HR transverse images of the proximal recess of the navicular bursa showing the tendon lesion grading (lateral to the left).

This was based on T1w 3D (HR) transverse sequences, for their ability to detect smaller lesions not always visible on T2w sequence. All images were blinded and retrospectively reviewed by two observers (BMB and MEG).

2.4 | Surgery

Navicular bursoscopy was performed in all horses under general anaesthesia in dorsal recumbency with an Esmarch bandage and tourniquet applied to the limb(s) of interest. The bursa was entered utilising a transthecal approach as described previously.[18,19] Instrumental access was facilitated by a portal on the contralateral side and further examined using an arthroscopic probe (Dyonics®, Smith and Nephew Endoscopy, UK). Large masses and torn tendon tissues were sectioned using a suction punch (Synergy Pump, Arthrex®) prior to debridement using a motorised synovial resector (Excalibur, Arthrex®) in oscillating mode, with care taken to adopt a conservative approach when removing any damaged tissue. Both the bursa and tendon sheath were lavaged and in select cases, the bursa medicated with precultured equine mesenchymal stem cells (Biobest Laboratories Ltd, UK) (MSC) or interleukin-1 receptor antagonist protein (Orthokine® vet irap 60, Dechra Veterinary Products) (IRAP) prior to closure. The skin was closed using simple interrupted sutures of 3.5 metric monofilament nylon (Ethilon, Ethicon J&J MedTech) and bandaged with sterile dressings. Surgeries were performed predominantly by BMB, the remainder of which were carried out by HON ($n = 5$), B.F. ($n = 3$) and BOM ($n = 1$). A grading system for intrathecal lesion scoring was developed for this study (Table 1, Figures 3 and 4). All tenoscopic images were blinded and retrospectively and independently graded by two of the authors (BMB and HON).

2.5 | Post-operative treatment

Almost all horses underwent a rest and rehabilitation period of 6–12 months post-surgery, following previously established guidelines for treatment of DDFT injuries in the foot.[10,12] Several horses

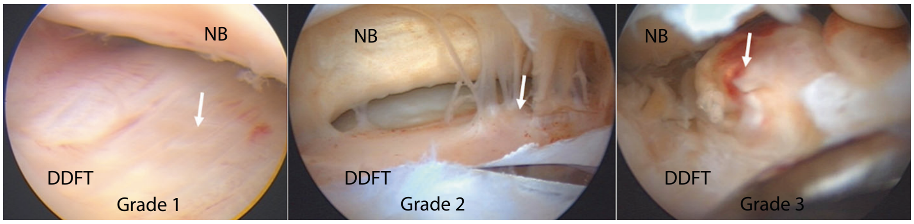

FIGURE 3 Bursoscopy images showing the synovial mass lesion grading (Dorsal to the top, NB: navicular bone).

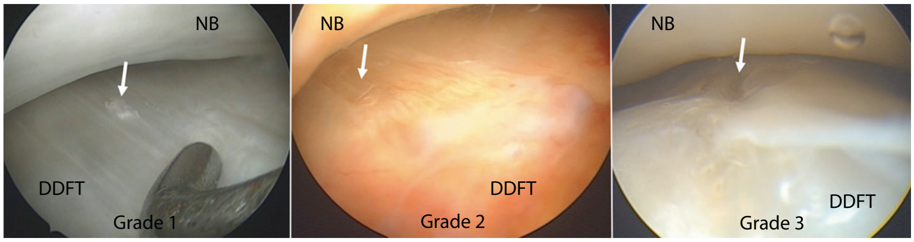

FIGURE 4 Bursoscopy images showing the tendon lesion grading (Dorsal to the top, NB: navicular bone).

received intrathecal medication with MSC approximately 1 month post-surgery. Cases that received MSC were chosen according to the client preference.

2.6 | Follow-up information

Follow-up information was obtained by telephone interview of owners or referring veterinarians, including details of complications, residual lameness, intra-articular or intrabursal medication, current activity and when appropriate, time to return to work (Supplementary item 1). Success of treatment was separated into three categories. Failure, included horses demonstrating persistent lameness requiring regular non-steroidal anti-inflammatory medication for exercise, those that had undergone a neurectomy and those horses that were retired or euthanised as a direct result of an unacceptable level of lameness. Horses that resumed soundness or returned to regular ridden exercise were further categorised into those that returned to a lower level than prior to the injury and those that were performing at the same level or higher post-surgery. Subsequently, horses were categorised into those that were successfully treated and returned to their previous or higher level of athletic function and those that failed to do so.

2.7 | Data analysis

Data analysis was performed using SPSS® (version 28). Generalised estimating equations were used to evaluate the association between surgery finding (dependent variable) and MRI finding (predictor) and the association between outcome (return to previous/higher level of exercise or failure to do so) (dependent variable) and tendon injury (predictor). Ordinal logistic link function was used for all analysis; horse IDs were incorporated as subject variable to account for multiple observations from the same horse; the working correlation matrix was set as exchangeable. Results were presented as odds ratio (OR) and 95% confidence intervals (CI). Type I error rate was set at 5%. A p value of equal to or lower than 0.05 was set as significant. To assess the level of agreement between the two observers in grading the lesions, Cohen's k-coefficient (K) was calculated.

3 | RESULTS

3.1 | Case details

Fifty-nine horses met the study inclusion criteria, with 31 horses (52.5%) undergoing bilateral navicular bursoscopy resulting in a total of 90 navicular bursae included. Age ranged from 6 to 19 years (median 11 years). A number of different breeds were represented in the study population, of which Irish Sport Horse ($n = 17$) and Warmblood ($n = 10$) were most common. In 11 cases the breed was not recorded. There were 41 geldings, 15 mares and sex was unrecorded in three cases.

3.2 | Case selection

A recommendation for exploratory bursoscopy was based on the results of a lameness examination and the MRI findings in 45 horses (76%), with 12 horses (20%) presenting for surgery as a result of poor/partial response to intrabursal corticosteroid medication or recurrence of lameness post intrathecal medication and rest in two horses (3.4%). The interval between MRI examination and surgery ranged from one to 291 days (median 18 days; average 40 days). Thirty-eight horses (64%) underwent surgery within a month from the MRI examination.

3.3 | Magnetic resonance imaging findings

A synovial mass and concurrent DDFT lesion was present bilaterally in 52.5% of cases ($n = 31$). Of the unilateral lesions ($n = 28$), the mass was affecting 15 right forelimbs (RF) (53.5%) and 12 left forelimbs (LF) (42.8%). One horse had lesions present in the right hind (RH) navicular bursa. Synovial masses were recorded on the DDFT involving the lateral lobe ($n = 46$; 51%) medial lobe ($n = 27$, 30%) and both lobes ($n = 17$, 19%). Lesion distribution was similar between the LF and RF feet (LF feet: 22 lesions of the lateral lobe, 13 lesions of the medial lobe and 8 biaxial lesions; RF feet: 24 lesions of the lateral lobe, 13 lesions of the medial lobe and 9 biaxial lesions). The DDFT lesion of the RH foot was affecting the medial lobe of the tendon. A total of 107 synovial masses and 107 DDFT lesions were detected. When a lesion was present in both lobes of the tendon, only the largest lesion was graded, therefore 90 synovial masses (MRI Lesion Grade 1 = 18; MRI Lesion Grade 2 = 31; MRI Lesion Grade 3 = 41) and 90 DDFT lesions (MRI Lesion Grade 1 = 29; MRI Lesion Grade 2 = 34; MRI Lesion Grade 3 = 27) were recorded. There was very good agreement between the gradings of the two observers ($K = 1$ for both tendon and synovial mass grading, significance <0.001).

3.4 | Bursoscopy findings and intra/post-operative medication

Bursoscopy confirmed the location of the synovial masses and concurrent tendon lesions in all cases. Horses that underwent bilateral bursoscopy had bilateral lesions, in keeping with MRI findings. A total of 107 synovial masses and 107 DDFT lesions were detected. When a lesion was present in both lobes of the tendon, only the largest lesion was graded, therefore 90 synovial masses (Bursoscopy Grade 1 = 29; Bursoscopy Grade 2 = 17; Bursoscopy Grade 3 = 44) and 90 DDFT lesions (Bursoscopy Grade 1 = 21; Bursoscopy Grade 2 = 47; Bursoscopy Grade 3 = 22) were recorded. There was very good agreement between the gradings of the two observers for tendon lesion ($K = 0.963$, significance <0.001) and for synovial mass grading ($K = 0.928$, significance <0.001). Twenty horses received intrathecal medication with MSC (five treated intraoperatively and 15 four weeks post-surgery). One horse was medicated with interleukin-1 receptor antagonist protein (IRAP) intraoperatively.

3.5 | Correlation of MRI and surgical findings

There was a strong correlation between the size of the synovial masses identified on MRI examination and during navicular bursoscopy ($p < 0.001$, OR: 25.61 with 95% CI 8.71–75.29). The correlation between tendon lesion size graded on MRI and at surgery was similarly strong ($p < 0.001$, OR: 7.34 with 95% CI 2.70–19.92). Every lesion on MRI corresponded to a lesion at surgery therefore MRI yielded no false positive results. Furthermore, when a synovial mass was identified either with MRI or surgery, a concurrent lesion to the DDFT was always present. There was, however, a poor correlation between the size of the synovial masses and the outcome ($p = 0.1$, OR: 1, 95% CI 1–1) and between the tendon lesions size and the outcome ($p = 0.3$, OR: 1, 95% CI 1–1).

3.6 | Long-term outcome

All the horses had follow-up information, sourced at least 1 year post-surgery. A total of 29 horses (49.1%) did not respond to treatment, 12 (20.4%) returned to a lower level of exercise and 18 (30.5%) resumed their previous level of activity. Although 50.9% of horses returned to soundness post-surgery, treatment was considered successful in only 30.5% horses.

There was no significant difference in outcome between the groups which underwent bilateral vs. unilateral navicular bursoscopy. Of the 31 horses with bilateral lesions, 10 (32%) recovered successfully and 21 (67.7%) did not. Similarly, of the 28 horses with unilateral lesions 8 (28.5%) recovered successfully and 20 (71.4%) did not (Supplementary item 2).

Of the 20 horses that received intrathecal medication with MSC, six resumed their previous level of exercise. In other words, of the 18 horses that recovered successfully from the treatment, six (33.3%) received at least one dose of MSC intrathecally, one was treated with IRAP and one with corticosteroids.

The interval of time required for these 18 horses to return to their previous level of athletic activity ranged from 3 to 18 months, with 55.5% of these horses ($n = 10$) requiring more than 6 months of rest and rehabilitation.

4 | DISCUSSION

This study describes a good correlation between the size of DDFT dorsal border lesion detected on MRI and the size of the same lesion identified during navicular bursoscopy. Additionally, irregularities of the contour of the dorsal border of the DDFT, visible as focal T1w hyperintensities at the level of the proximal recess of the navicular bursa, were always visible at surgery and represented a DDFT injury. Magnetic resonance imaging did not produce any false positive results, with every lesion detected on MRI also visualised bursoscopically. Therefore, abnormalities of the dorsal surface of the DDFT detectable on low-field MRI should be interpreted as a tendon lesion. Furthermore, synovial masses were always concurrent with a DDFT lesion, confirming that these masses are the result of torn collagenous tissue extruding into the navicular bursa.[1,13]

Our study showed that the presence of detectable abnormal tissue in the navicular bursa on MRI can be confirmed during bursoscopy; however, very small abnormalities of the dorsal border of the DDFT may not be seen on MRI. In fact, cases with no detectable synovial masses on MRI were not included, because in these cases navicular bursoscopy was not recommended and performed. Therefore, the sensitivity of navicular bursoscopy vs. standing low-field MRI for the detection of very small dorsal border lesions or synovial masses not visible on MRI could not be established. The presence of mild fibrillation of the dorsal border of the DDFT could still potentially explain lameness in horses with non-detectable MRI findings.

In a previous study[16] PDw, T2w and STIR sequences were primarily used for the detection of adhesions in the navicular bursa, using a high-field MRI system. In the current study, following a preliminary short observation, it was found that, although T2w images provided superior tissue contrast, T1w sequences were able to show smaller lesions not always visible on T2w sequence, due to smaller slice thickness and better spatial resolution.

The good correlation between MRI and surgical findings would suggest that there was no appreciable improvement or deterioration of the lesions during the time interval between the two procedures. However, this interval was relatively short as horses in this study population often underwent surgery soon after MRI (mean interval = 40 days, median interval = 18 days) and the decision for surgery was predominantly based on the MRI findings and presence of lameness localised to the foot.

There was no statistically significant association between the size of the synovial mass or the size of the tendon lesion and the prognosis. Therefore, neither MRI or bursoscopic assessment of the synovial mass size or tendon lesion size had any prognostic value. Horses with bilateral lesions had a comparable prognosis to the horses with unilateral lesions. According to this study the prognosis for returning to exercise was lower than previously reported.[13] Smith and Wright reported that 60% of the horses undergoing navicular bursoscopy for treatment of lesions within the bursa returned to ridden exercise, 40% of which returned to their previous level of activity. In the current study, 50.9% of horses undergoing navicular bursoscopy returned to soundness, but only 30.5% resumed the previous level of athletic activity. This was similar to the previously reported success rate of those horses managed conservatively,[3,12] suggesting that surgical treatment of lesions within the navicular bursa may not be advantageous over conservative treatment. Marsh et al.[20] reported that 35% of horses diagnosed with navicular syndrome on high-field MRI, the majority of which had deep digital flexor tendinopathy, returned to their intended use following medication of the navicular bursa with corticosteroid and hyaluronan. This result is similar to that described by the current authors, suggesting that conservative treatment should be considered before surgery. In the current study, bursoscopy was carried out in 76% of horses as a first line treatment before any conservative treatment was attempted, with 64% of horses undergoing surgery within a month from the MRI diagnosis. It has been shown that dorsal lesions of the DDFT at the level of the navicular bone have a better prognosis compared with core lesions and parasagittal splits,[12] with 73% of horses returning to some athletic activity following conservative management, of which 35% returned to their previous level of the activity. It has also been suggested that dorsal lesions of the DDFT may improve over time,[12,21] therefore surgery might be more appropriate for those cases which are refractory to conservative management.

The authors acknowledge this study is not without limitations. Only horses undergoing navicular bursoscopy were included and performance data for horses treated conservatively with MRI-detected synovial masses was not considered. A previous study reports proliferative changes within the navicular bursa secondary to bursoscopy, although these changes did not appear to correlate with the degree of lameness at subsequent examinations.[21] In the study by Hoaglund and Barrett, all cases where the lameness had improved post-surgery, the DDFT lesions had also improved, despite the presence of proliferative bursitis.

The presence of effusion within the navicular bursa could potentially emphasise and highlight the presence of subtle intrabursal lesions. It has been shown that magnetic resonance bursography involving intrabursal infiltration of saline can improve accuracy in detecting adhesions within the bursa and fibrocartilage erosions on the palmar aspect of the navicular bone.[22,23] The effect of any navicular bursa effusion was not considered in this study. Additional limitations of this study, namely incomplete history record and follow-up with potential recall bias, are intrinsically linked to its retrospective nature.

In conclusion, this study showed that there is good correlation between MRI and bursoscopic findings of DDFT lesions and synovial masses within the navicular bursa, with no false positives. The size of the synovial mass or tendon lesion did not influence the prognosis following navicular bursoscopy. The prognosis for returning to full athletic function is guarded and worse than previously reported.

AUTHOR CONTRIBUTIONS

Maria Elisabetta Giorio executed the study; however, all the authors substantially contributed to the conception and design of the manuscript, data collection, drafting and review of the article. Maria Elisabetta Giorio had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

ACKNOWLEDGEMENTS

We thank Yu-Mei Chang for statistical analysis support.

FUNDING INFORMATION

Funding for R. Graham's surgical residency was kindly provided by the Horserace Betting Levy Board.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA INTEGRITY STATEMENT

New data were created or analysed in this study.

ETHICAL ANIMAL RESEARCH

Ethical committee oversight not required by this journal: retrospective case series.

INFORMED CONSENT

Explicit informed consent for this research was not stated.

PEER REVIEW

The peer review history for this article is available at https://www.webofscience.com/api/gateway/wos/peer-review/10.1111/evj.14040.

DATA AVAILABILITY STATEMENT

Data are available from the author on reasonable request: Open sharing exemption granted by the editor for this retrospective case series.

ORCID

Maria Elisabetta Giorio https://orcid.org/0009-0006-6849-8345
Robyn J. Graham https://orcid.org/0000-0002-7561-0570
Dagmar Berner https://orcid.org/0000-0001-6442-3449
Henry D. O'Neill https://orcid.org/0000-0002-6899-027X
Bruce M. Bladon https://orcid.org/0000-0001-9204-725X

REFERENCES

1. Schramme MC. Deep digital flexor tendinopathy in the foot. Equine Vet Educ. 2011;23(8):403–15.
2. Dyson S, Murray R, Schramme M, Branch M. Lameness in 46 horses associated with deep digital flexor tendonitis in the digit: diagnosis confirmed with magnetic resonance imaging. Equine Vet J. 2003;35:681–90.
3. Dyson S, Murray R, Schramme M. Lameness associated with foot pain: results of magnetic resonance imaging in 199 horses (January 2001–December 2003) and response to treatment. Equine Vet J. 2005;37:113–21.
4. Widmer WR, Buckwalter KA, Fessler JF, Hill MA, VanSickle DC, Ivancevich S. Use of radiography, computed tomography and magnetic resonance imaging for evaluation of navicular syndrome in the horse. Vet Radiol Ultrasound. 2000;41:108–16.
5. Mair TS, Kinns JEN. Deep digital flexor tendonitis in the equine foot diagnosed by low-field magnetic resonance imaging in the standing patient: 18 cases. Vet Radiol Ultrasound. 2005;46:458–66.
6. Busoni V, Heimann M, Trenteseaux J, Snaps F, Dondelinger RF. Magnetic resonance imaging findings in the equine deep digital flexor tendon and distal sesamoid bone in advanced navicular disease—an ex vivo study. Vet Radiol Ultrasound. 2005;46:279–86.
7. Murray RC, Roberts BL, Schramme MC, Dyson SJ, Branch M. Quantitative evaluation of equine deep digital flexor tendon morphology using magnetic resonance imaging. Vet Radiol Ultrasound. 2004;45:103–11.
8. Murray RC, Blunden TS, Schramme MC, Dyson SJ. How does magnetic resonance imaging represent histologic findings in the equine digit? Vet Radiol Ultrasound. 2006;47:17–31.
9. Whitton R, Buckley C, Donovan T, Wales AD, Dennis R. The diagnosis of lameness associated with distal limbpathology in a horse: a comparison of radiography, computed tomography and magnetic resonance imaging. Vet J. 1998;155:223–9.
10. Sherlock CE, Mair TS, Ireland J, Blunden T. Do low field magnetic resonance imaging abnormalities correlate with macroscopical and histological changes within the equine deep digital flexor tendon? Res Vet Sci. 2015;98:92–7.
11. Smith MRW, Wright IM, Smith RKW. Endoscopic assessment and treatment of lesions of the deep digital flexor tendon in the navicular bursae of 20 lame horses. Equine Vet J. 2007;39:18–24.
12. Cillán-García E, Milner PI, Talbot A, Ticker R, Hendey F, Boswell J, et al. Deep digital flexor tendon injury within the hoof capsule; does lesion type or location predict prognosis? Vet Rec. 2013;173(3):70.
13. Smith MRW, Wright IM. Endoscopic evaluation of the navicular bursa: observations, treatment and outcome in 92 cases with identified pathology. Equine Vet J. 2012;44:339–45.
14. Van Veggel ECS, Selberg KT, van Der Velde-Hoogelander B, Vanderperren K, Cokelaere S, Bergman HJ. Deep digital flexor tendon injury at the level of the proximal phalanx in front limbs with tendon sheath distension characterized by standing low-field magnetic resonance imaging in horses: 13 cases (2015–2021). Front Vet Sci. 2021;8:734739.
15. ELKhamary AN, Keenihan EK, Schnabel LV, Redding WR, Schumacher J. Leveraging MRI characterization of longitudinal tears of the deep digital flexor tendon in horses using machine learning. Vet Radiol Ultrasound. 2022;63:580–92.
16. Holowinski ME, Solano M, Maranda L, Garcia-Lopez JM. Magnetic resonance imaging of the navicular bursa adhesions. Vet Radiol Ultrasound. 2012;53:566–72.
17. Mair TS, Kinns J, Jones RD, Bolas NM. Magnetic resonance imaging of the distal limb of the standing horse. Equine Vet Educ. 2005;17:74–8.
18. Denoix J-M, Busoni V. Ultrasonography of joints and synovia. In: White NA, Moore JN, editors. Current techniques in equine surgery and lameness. 2nd ed. Philadelphia: WB Saunders; 1998. p. 643–54.
19. McIlwraith CW, Nixon AJ, Wright IM. Bursoscopy. In: McIlwraith CW, Nixon AJ, Wright IM, editors. Diagnostic and surgical arthroscopy in the horse. 4th ed. Amsterdam: Elsevier; 2015. p. 387–406.
20. Marsh CA, Schneider RK, Sampson SN, Roberts GD. Response to injection of the navicular bursa with corticosteroids and hyaluronan following high-field magnetic resonance imaging in horses with signs of navicular syndrom:101 cases (2000–2008). J Am Vet Med Assoc. 2012;241(10):1353–64.
21. Hoaglund EL, Barrett MF. Magnetic resonance imaging changes of the navicular bursa following navicular bursoscopy in seven horses. Equine Vet Educ. 2021;33(10):531–8.
22. Schramme M, Kerekes Z, Hunter S, Nagy K, Pease A. Improved identification of the palmar fibrocartilage of the navicular bone with saline magnetic resonance bursography. Vet Radiol Ultrasound. 2009;50:606–14.
23. Maher MC, Werpy NM, Goodrich LR, McIlwraith CW. Positive contrast magnetic resonance bursography for assessment of the navicular bursa and surrounding soft tissues. Vet Radiol Ultrasound. 2011;52:385–93.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Giorio ME, Graham RJ, Berner D, O'Neill HD, Bladon BM. Presence and size of synovial masses within the navicular bursa correlate well between magnetic resonance imaging and bursoscopy and have a guarded prognosis. Equine Vet J. 2023. https://doi.org/10.1111/evj.14040