Equine Veterinary Journal

Equine Veterinary Journal ISSN 0425-1644
DOI: 10.1111/j.2042-3306.2012.00573.x

The use of intrathecal analgesia and contrast radiography as preoperative diagnostic methods for digital flexor tendon sheath pathology

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Summary

Reasons for performing study: The sensitivity of ultrasonography for the diagnosis of *manica flexoria* (MF) tears within the digital flexor tendon sheath (DFTS) is lower than for diagnosis of marginal tears of the deep digital flexor tendon (DDFT). Additional diagnostic tools would assist in appropriate decision making for either conservative or surgical management.
Objectives: To evaluate the improvement in lameness of horses with MF or DDFT tears following intrathecal analgesia and to assess the sensitivity and specificity of contrast radiography for the diagnosis of these tears.
Methods: The case records of horses presented to a referral clinic over a 7-year period that underwent intrathecal diagnostic analgesia, or intrathecal analgesia and contrast radiography, of the DFTS with subsequent tenoscopy were examined.
Results: Fifty-three limbs had intrathecal diagnostic analgesia performed and 23 contrast tenograms were assessed in horses undergoing DFTS tenoscopy. Horses with DDFT tears were significantly more likely to respond positively to intrathecal diagnostic analgesia than those with MF tears ($P = 0.02$). Using contrast radiography, tears of the MF were predicted with an overall sensitivity of 96% and specificity of 80%; marginal tears of the DDFT were predicted with an overall sensitivity of 57% and specificity of 84%.
Conclusions: The results of intrathecal analgesia of the DFTS in combination with contrast radiography have a high sensitivity for predicting MF tears. The sensitivity of contrast radiography for predicting tears of the DDFT is lower but the specificity remains high.
Potential relevance: Contrast radiography performed at the same time as intrathecal analgesia provides useful information regarding the presence of MF tears and DDFT tears, which can assist in the decision of whether to manage the lameness conservatively or with tenoscopic evaluation.

Keywords: horse; tenosynovitis; intrathecal analgesia; contrast radiography

Introduction

The digital flexor tendon sheath (DFTS) extends from the distal third of the metacarpal/metatarsal region to the palmar/plantar pouch of the distal interphalangeal joint and contains the superficial digital flexor tendon (SDFT) and deep digital flexor tendon (DDFT). In the region of the metacarpo-/metatarso-phalangeal joint, the DFTS is enclosed by a relatively inelastic canal created by the proximal sesamoid bones and intersesamoidean ligament on the dorsal surface and the palmar/plantar annular ligament on the palmar/plantar surface [1]. Proximal and distal to the metacarpo-/metatarso-phalangeal joint, the medial and lateral borders of the SDFT give rise to the *manica flexoria* (MF) and digital *manica*, respectively, which surround the DDFT.

Noninfected tenosynovitis of the DFTS is common and can be either primary due to inflammation of the DFTS itself [2] or, more commonly, secondary to damage to one of the structures within, or immediately adjacent to, the DFTS. Tendonitis of the SDFT and DDFT [3], tears of the DDFT or MF [4–6] desmitis of the palmar/plantar annular ligament [7], complex tenosynovitis [8] and desmitis of the proximal digital annular ligament [1] may all be causes of tenosynovitis. Of these, the most common are tears to the lateral border of the DDFT [6] or of the MF [5].

There appears to be an absence of an intrinsic mechanism for debridement of the torn tissue necessitating a surgical approach. Tenoscopic debridement aims to optimise conditions for second intention healing, allowing controlled exercise to begin sooner after surgery. However, marginal tears of the DDFT carry a poorer prognosis for a return to work, even after tenoscopic debridement, with one study reporting that only 40% of horses with marginal tears of the DDFT returned to their previous level of performance compared with 73% horses with MF tears [9]. Furthermore, surgical treatment undertaken within 7 weeks of the onset of lameness carried an improved prognosis compared with those cases treated after a longer delay. Therefore, a diagnostic test with improved sensitivity and specificity for diagnosing MF and DDFT tears would support a decision for early surgical intervention and, from the accurate determination of the lesion, inform on prognosis.

Distension of the DFTS is a frequent, but nonspecific, finding on clinical examination. Likewise palpation of synovial hypertrophy, nodular masses or tendon thickening with an associated pain response are commonly reported but poorly correlated with specific structural pathology. Accurate location of the site of lameness to the DFTS requires the use of diagnostic analgesia. However, regional analgesia is relatively nonspecific because of the extent of the DFTS, resulting in possible partial responses to the abaxial sesamoid, and even sometimes palmar digital, regional analgesia. Most lamenesses related to the DFTS should be abolished by analgesia of the lateral and medial palmar/plantar nerves immediately proximal to the DFTS. Intrathecal analgesia is believed to be the most specific of the diagnostic analgesic techniques available, although partial responses are common, even when the causative pathology is located within the DFTS [10]. Furthermore, pathology in adjacent structures, such as the distal sesamoidean ligaments, may be improved with intrathecal analgesia of the DFTS [11], although this can be due to direct communication of the lesion with the DFTS synovial cavity [1]. Likewise adjacent structures may be partially desensitised following diffusion of local anaesthetic after a period of time [12] or due to backflow of local anaesthetic from the puncture hole anaesthetising the palmar/plantar nerve [13]. It is not clear why partial responses occur with abnormalities of structures within the DFTS and so we have hypothesised that the response to DFTS analgesia would be most positive in those cases where the pathology was in communication with the sheath cavity.

Ultrasonography has become the principal imaging modality for investigating soft tissue swellings, including that of the DFTS. However, whilst ultrasonography predicts tears of the DDFT in 71% of cases, where echogenic material in the DFTS lateral to the DDFT or an irregular lateral border of the DDFT is identified, tears of the MF are predicted with a sensitivity of just 38% [5]. More recently, Arensburg *et al*. [6] demonstrated a sensitivity of 63% and specificity of 75% for the prediction of longitudinal tears of the DDFT using ultrasonography. However, in that study MF tears represented just 4% of the lesions seen tenoscopically. Overall, ultrasonography has been shown to predict the lesions identified at tenoscopy accurately in only 54% cases [5]. In the absence of demonstrable

pathology ultrasonographically, DFTS tenosynovitis cases may be managed successfully with altered exercise regimens and intrasynovial medication with the decision to undergo tenoscopic evaluation frequently based on a poor response to conservative therapy [10].

Contrast tenography is an alternative method of evaluating the DFTS that can be easily performed at the time of intrathecal diagnostic analgesia. Hago and Vaughan [14] described the normal radiographic anatomy of the DFTS using contrast tenography and evaluated the use of contrast radiography for the investigation of chronic tenosynovitis [15]. They found that by outlining the interior of the cavity, irregularities in the lining layer were demonstrable, as were the presence and size of adhesions, changes in volume and the multilocular nature of the lesion. However, that study was limited by a lack of confirmation of the true pathology within the sheath. Redding [16] investigated the use of cross-sectional contrast radiographs in cadaver limbs to visualise the shape of the flexor tendons within the sheath. It was noted that contrast medium enhanced sound transmission during ultrasonographic examination of the sheath. However, there have been no descriptions of contrast tenography identifying either DDFT tears or tears of the MF because advances in ultrasound technology and operator experience have led to a decline in the use of contrast radiography before these injuries were first recognised with the advent of tenoscopy [4,17].

The purpose of this study was to test the hypothesis that the degree of response to intrathecal analgesia and the use of contrast tenography would be capable of diagnosing DDFT and MF tears preoperatively.

Materials and methods

Case selection

The medical records of all horses referred to the Royal Veterinary College Equine Referral Hospital between April 2004 and January 2011 that underwent either intrathecal diagnostic analgesia, or intrathecal diagnostic analgesia and contrast radiography, of the DFTS with subsequent tenoscopy to determine the primary pathology were examined. Age, breed, gender and affected limb were recorded alongside the lameness grade on a scale of 0–10 [18] where 0 = sound and 10 = nonweightbearing. The lameness grade was assigned by the clinician in charge of the case and was subsequently categorised as follows: 1–3/10 = mild; 4–6/10 = moderate; 7–10/10 = severe.

Intrathecal diagnostic analgesia

Mepivicaine hydrochloride (10 ml; Intraepicaine)[a] was injected into the affected DFTS via a 20 gauge 2.5 cm needle introduced into the distal pouch between the proximal and distal digital annular ligaments in the distal pastern region. The response to intrathecal analgesia after 10 min was recorded as negative, partial or positive.

Contrast radiography study

A subgroup of the population of horses included in the intrathecal analgesia study underwent contrast radiography of the DFTS. This was performed at the same time as intrathecal analgesia with the addition of 5–7 ml sodium meglumine diatrozoate (Urografin 370)[b]. The horse was walked 4–5 strides to distribute the contrast medium within the DFTS before a lateromedial radiograph was performed of the distal limb to include the proximal and distal extremities of the DFTS. In each case this was performed before the horse's lameness was assessed 10 min after injection.

Determination of sensitivity and specificity

The contrast tenograms were randomised and reviewed by 5 evaluators (3 board certified equine surgeons, one equine medicine resident and one

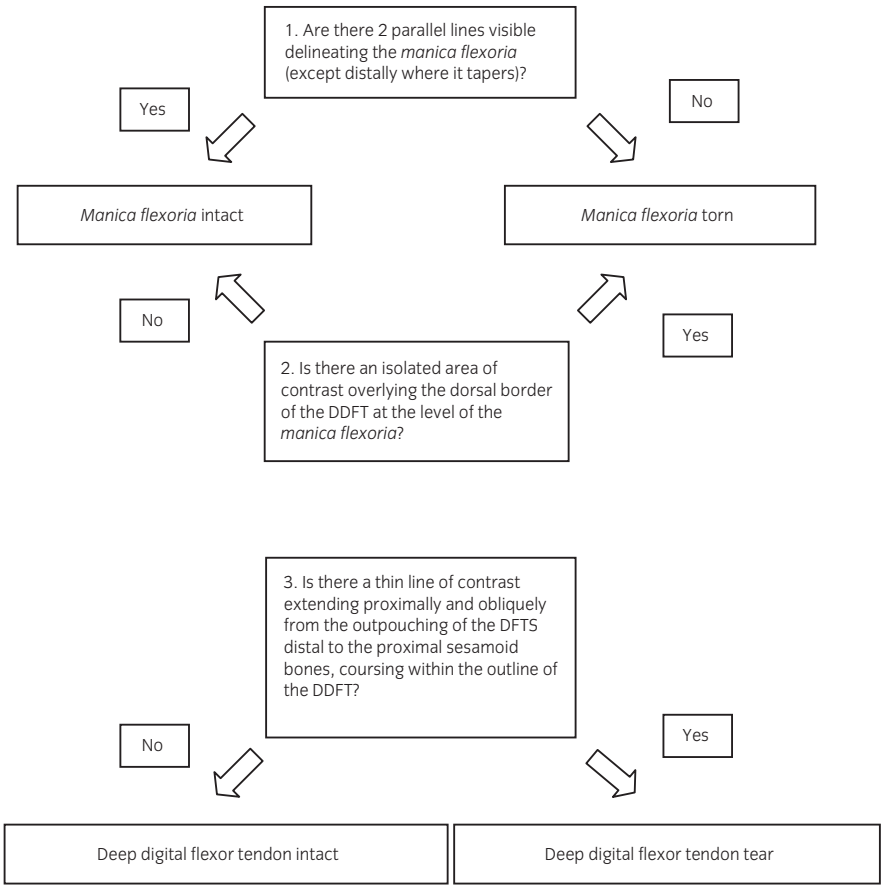

Fig 1: Flow chart from which the diagnosis of a *manica flexoria* tear and/or deep digital flexor tendon (DDFT) tear was made. DFTS = digital flexor tendon sheath.

equine surgery resident) blinded to the results of the intrathecal analgesia, limb and tenoscopic diagnosis. Each evaluator was given a flow chart (Fig 1), which gave the criteria from which a diagnosis of a MF or DDFT tear was to be made. A normal contrast tenogram was made available (Fig 2a).

Tenoscopic evaluation

All horses subsequently underwent tenoscopic evaluation of the DFTS under general anaesthesia in dorsal recumbency. The affected limb was exsanguinated with an Esmarch bandage before a tourniquet was applied proximal to the carpus/tarsus. Tenoscopy was performed using a 4 mm 25° forward oblique arthroscope[c] inserted between the palmar/plantar annular ligament and the proximal digital annular ligament [17] and lesions were categorised as: 1) DDFT tear; 2) MF tear; or 3) other intrathecal lesion.

Data analysis

An analysis of intrathecal analgesia data was performed using Fisher's exact test for categorical data. Specifically, the association between binary outcome measurements (negative or partial vs. positive response to intrathecal diagnostic analgesia) and tenoscopic finding (MF tear and DDFT tear) was determined. Similarly, Fisher's exact test was used to determine the association between tenoscopic finding and limb

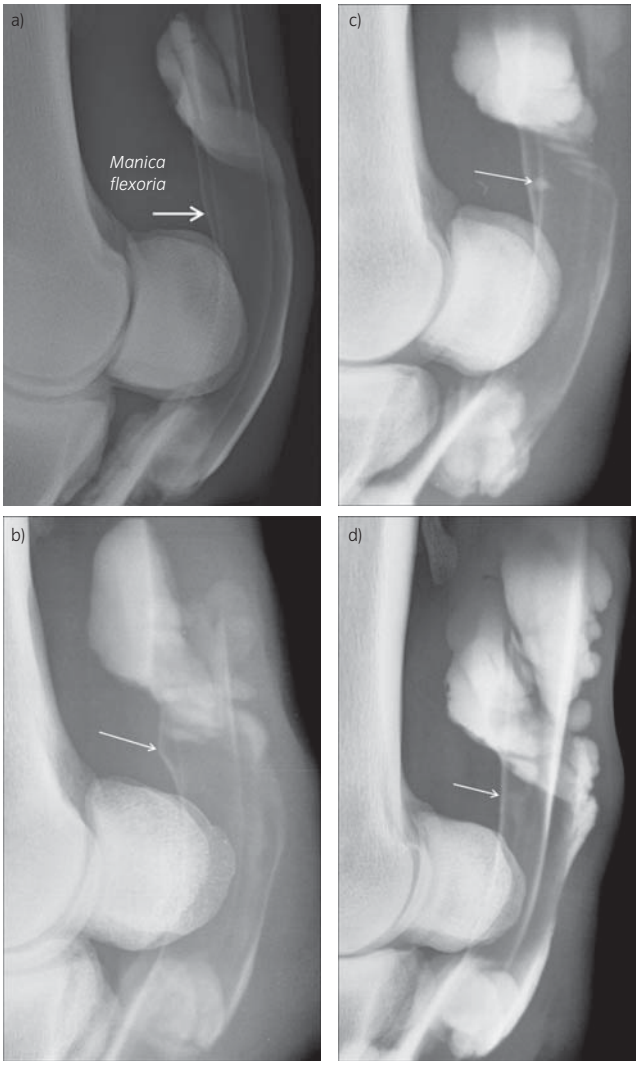

Fig 2: Contrast tenograms showing the *manica flexoria* (arrowed): a) in its normal position; b) abnormally orientated; c) with an abnormal accumulation of contrast on its border; and d) not visible.

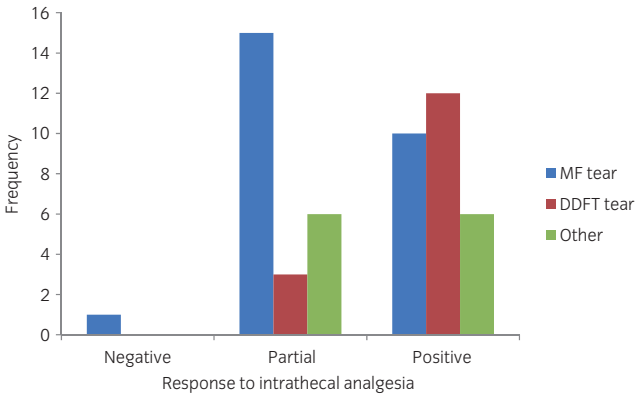

Fig 3: Bar chart showing the response to intrathecal analgesia in horses with *manica flexoria* (MF) tears, deep digital flexor tendon (DDFT) tears or other forms of digital flexor tendon sheath pathology.

affected. The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of the contrast radiography as a test for diagnosing MF and DDFT tears was measured using the tenoscopic findings as the gold standard. This was performed using an internet-based statistics calculator[d].

Results

Case details

Fifty-five limbs fulfilled the inclusion criteria for the intrathecal analgesia study and 23 had contrast radiography performed. There were 28 geldings, 21 mares and one stallion, consisting of 8 Thoroughbreds, 18 Warmbloods/sport horses, 17 cobs and 7 ponies.

Intrathecal analgesia

Two limbs that were subsequently found to have both a MF tear and DDFT tear were excluded from the intrathecal analgesia study. Likewise, horses with other lesions including DFTS wall tears, palmar/plantar annular ligament constriction, intrathecal adhesions and those horses where no specific lesion was identified were excluded from the intrathecal analgesia study. Only horses with solitary MF or DDFT tears were included in the analysis. Manica flexoria tears and DDFT tears were seen in 26 of 53 (49%) and 15 of 53 (28%) limbs respectively. Eleven out of 15 (73%) limbs with DDFT tears were found in the forelimbs while 24 out of 26 (92%) MF tears were found in the hindlimbs. This association was statistically significant ($P<0.0001$). The lameness grade for horses with both MF and DDFT tears ranged from 1–4/10, with no significant difference between the 2 diagnoses. Intrahorse variation in lameness grade was also identified during separate examinations prior to surgical intervention. The results of intrathecal analgesia in 53 limbs are shown in Figure 3. Horses with DDFT tears were significantly more likely to respond positively to intrathecal analgesia than horses with MF tears ($P = 0.02$).

Contrast radiography

Contrast agent was accurately injected into the DFTS, delineating its outline, in all 23 tenograms. The proximal recess was predominantly located dorsal to the DDFT and immediately distal to this, the MF, DDFT and SDFT were visible as filling defects with contrast outlining their borders as parallel lines both sides of the digital flexor tendons and as parallel lines that joined distally at the distal end of the MF (see Fig 2a).

The area of contrast identified palmar/plantar to the SDFT extending distally through the fetlock canal was variable between horses, with 14 cases showing little or no accumulation of contrast in the region. A consistent accumulation of contrast was evident immediately distal to the proximal sesamoid bones superimposed over the outline of the flexor tendons, which were the collateral pouches: sites for tenoscopic access.

Further distally in the proximal pastern an outpouching of contrast material was seen dorsal to the DDFT, extending three-quarters of the length of the proximal phalanx before forming a palmar/plantar outpouching representing the distal pouch into which the contrast material and local anaesthetic were injected. The contrast extended distally a short distance dorsally midway down the middle phalanx before terminating at the level of the T-ligament.

Either any deviation of the MF from the predetermined 'normal' orientation, or accumulation of contrast overlying the margins of the MF was considered to be indicative of a tear (Fig 2b–d). A radiopaque line extending within the dorsal and plantar margins of the DDFT within the fetlock canal was interpreted as a DDFT tear (Fig 4).

Twenty-three contrast tenograms were assessed for the presence of either a MF tear and/or DDFT tear (Supporting Item 1). Two horses diagnosed with intrasubstance deep digital flexor mineralisation were subsequently excluded from the DDFT tear component of the contrast radiography study as the authors felt it could be confused with a DDFT tear; such a lesion would be very obvious ultrasonographically. Tears of the MF were predicted with an overall sensitivity of 96%, specificity 80%, PPV of 79% and NPV of 96%. Marginal tears of the DDFT were predicted with an overall sensitivity of 57%, specificity 84%, PPV 76% and NPV 69%.

Discussion

In this study, DDFT and MF tears were the most common finding with a greater proportion of DDFT tears found in the forelimbs and MF tears more frequently found in the hindlimbs. This is in keeping with previous reports [4,5,10].

The current study found that horses with DDFT tears were significantly more likely to show a positive improvement in lameness following intrathecal anaesthesia than horses with MF tears ($P = 0.02$). The reason for the partial response most frequently seen in horses with MF tears is unclear. Those cases whose lameness was not completely eliminated by intrathecal analgesia became sound following the addition of palmar/plantar nerve analgesia immediately proximal to the DFTS.

The sensitivity of ultrasonography in diagnosing MF tears has been shown to be poor. In a retrospective analysis of 76 cases of noninfected tenosynovitis Smith and Wright [5] found tears of the MF were predicted with a sensitivity of 38% compared with DDFT tears, which were predicted with a sensitivity of 71%. In another study [10] 11 out of 17 (65%) of DDFT tears were diagnosed ultrasonographically. It should be noted that neither of the aforementioned studies was designed to validate ultrasonography for its ability to diagnose DFTS pathology. Contrast radiography was found to delineate the border of the MF accurately and, with a description of the normal orientation of the MF, evaluators were able to identify an abnormal appearance and therefore diagnose MF tears with a sensitivity of 96%, which exceeds that of ultrasonography. Likewise, evaluators were able to identify DDFT tears, although the sensitivity was lower at 57% vs. 71% with ultrasonography [5]. However the specificity, PPV and NPV (84%, 76% and 69% respectively) were higher than that previously reported with ultrasonography. One horse (*Case 4*), which had a dorsal border DDFT tear, was misdiagnosed as having a MF tear by all 4 evaluators, which may represent a weakness in the technique. However, contrast radiography remains a useful technique for preoperative diagnosis of DDFT tears and when combined with ultrasonography provides an accurate method of diagnosis of MF and DDFT tears. Whilst no prediction of laterality can be made and only the proximodistal extent determined for DDFT tears, this information is best obtained tenoscopically when both sides of the sheath are easily evaluated, and frequently the MF is resected in its entirety irrespective of the length of the tear.

Cobs are frequently afflicted with injuries of the DFTS. These heavy breeds frequently have feathering and thickened skin over the palmar metacarpus/metatarsus and pastern region. This can make ultrasonographic image acquisition difficult and thus reduce the sensitivity of the examination. The skin thickness has no significant impact in the quality of the contrast radiograph and therefore should not affect the sensitivity and specificity. A different population of horses in which cob breeds are less represented may affect the results and in particular the sensitivity of ultrasonography for the detection of DFTS lesions.

Fig 4: Contrast tenogram demonstrating a deep digital flexor tendon tear (arrowed).

Likewise, an operator trained in the ultrasonographic detection of, in particular, MF tears would also improve the sensitivity of this imaging modality.

Contrast tenography performed as described required no further intrasynovial injections and radiographs could be obtained whilst the local anaesthetic was given time to work. Furthermore, it also provided the opportunity to obtain a synovial fluid sample. Many tears are associated with intrathecal haemorrhage brought on by minimal exercise, such as that performed immediately prior to diagnostic analgesia. One limitation of the technique is that the radiograph has to be taken with the horse unsedated to avoid confounding the results of the subsequent gait evaluation. Waiting until after the initial gait evaluation, at 10 min, before obtaining the lateromedial radiograph was found to have a negative impact on the quality of the image.

The decision of whether to manage a horse with DFTS tenosynovitis conservatively or surgically is complex. Other factors such as history, clinical evaluation and response to previous treatment must also be taken into consideration. The results of the current study suggest that contrast radiography of the DFTS performed at the same time as intrathecal anaesthesia of the sheath can provide useful diagnostic information on the presence of the 2 most common intrathecal pathologies, MF and DDFT tears. A negative result for either a MF or DDFT tear indicates a high likelihood of these lesions not being present, although it does not necessarily equate to a lesion that is best managed conservatively. However, a positive response is of particular use when a lesion is not visible ultrasonographically as it lends strength to the case for surgical intervention. Whilst it does not negate the requirement for a thorough ultrasonographic examination of the DFTS to identify other pathologies, the combination of the 2 imaging modalities and results of diagnostic anaesthesia allow a more informed decision to be made about the most appropriate management of the case.

Authors' declaration of interests

No conflicts of interest have been declared.

Source of funding

None.

Acknowledgements

The authors are grateful for the assistance of Elizabeth Finding, David Bolt, Justin Perkins and Thomas Witte MsRCVS for their participation in this study.

Manufacturers' addresses

[a]Dechra Veterinary Products Ltd, Shrewsbury, Shropshire, UK.
[b]Bayer plc, Newbury, Berkshire, UK.
[c]Karl Storz GmBH & Co., Tuttlingen, Germany.
[d]Centre for Evidence-Based Medicine, Toronto, Canada.

References

1. Schramme, M.C. and Smith, R.K.W. (2003) Diseases of the digital synovial sheath and palmar and digital annular ligaments. In: *Diagnosis and Management of Lameness in the Horse*, Eds: M.W. Ross and S.J. Dyson, W.B. Saunders, Philadelphia. pp 674-682.
2. Gerring, E.L. and Webbon, P.M. (1984) Fetlock annular ligament desmotomy: a report of 24 cases. *Equine Vet. J.* **16**, 113-116.
3. Barr, A.R., Dyson, S.J., Barr, F.J. and O'Brien, J.K. (1995) Tendonitis of the deep digital flexor tendon in the distal metacarpal/metatarsal region associated with tenosynovitis of the digital sheath in the horse. *Equine Vet. J.* **27**, 348-355.
4. Wright, I.M. and McMahon, P.J. (1999) Tenosynovitis associated with longitudinal tears of the digital flexor tendons in horses: a report of 20 cases. *Equine Vet. J.* **31**, 12-18.
5. Smith, M.R. and Wright, I.M. (2006) Noninfected tenosynovitis of the digital flexor tendon sheath: a retrospective analysis of 76 cases. *Equine Vet. J.* **38**, 134-141.
6. Arensburg, L., Wilderjans, H., Simon, O., Dewulf, J. and Boussauw, B. (2011) Nonseptic tenosynovitis of the digital flexor tendon sheath caused by longitudinal tears in the digital flexor tendons: a retrospective study of 135 tenoscopic procedures. *Equine Vet. J.* **43**, 660-668.
7. Dik, K.J., van den Belt, A.J. and Keg, P.R. (1991) Ultrasonographic evaluation of fetlock annular ligament constriction in the horse. *Equine Vet. J.* **23**, 285-288.
8. Fortier, L.A., Nixon, A.J., Ducharme, N.G., Mohammed, H.O. and Yeager, A. (1999) Tenoscopic examination and proximal annular ligament desmotomy for treatment of equine 'complex' digital sheath tenosynovitis. *Vet. Surg.* **28**, 429-435.
9. Smith, M.R.W. (2006) Treatment results for the causes of digital flexor tendon sheath distension. In: *Management of Lameness Causes in Sports Horses*, Ed: A. Lindner, Wageningen Academic Publishers, Wageningen. pp 27-30.
10. Fortier, L.A. (2005) Indications and techniques for tenoscopic surgery of the digital flexor tendon sheath. *Equine Vet. Educ.* **17**, 218-224.
11. Sampson, S.N., Schneider, R.K., Tucker, R.L., Gavin, P.R., Zubrod, C.J. and Ho, C.P. (2007) Magnetic resonance imaging features of oblique and straight distal sesamoidean desmitis in 27 horses. *Vet. Radiol. Ultrasound* **48**, 303-311.
12. Harper, J., Schumacher, J., Degraves, F. and Schramme, M. (2007) Effects of analgesia of the digital flexor tendon sheath on pain originating in the sole, distal interphalangeal joint or navicular bursa of horses. *Equine Vet. J.* **39**, 535-539.
13. Jordana, M., Martens, A., Duchateau, L., Saunders, J., Oosterlinck, M. and Pille, F. (2011) Distal limb desensitization following anaesthesia of the digital flexor tendon sheath in horses: a comparison of 4 techniques. In: *European College of Veterinary Surgeons Annual Scientific Meeting*, Ghent. p 33.
14. Hago, B.E. and Vaughan, L.C. (1986) Radiographic anatomy of tendon sheaths and bursae in the horse. *Equine Vet. J.* **18**, 102-106.
15. Hago, B.E. and Vaughan, L.C. (1986) Use of contrast radiography in the investigation of tenosynovitis and bursitis in horses. *Equine Vet. J.* **18**, 375-382.
16. Redding, W.R. (1994) Evaluation of the equine digital flexor tendon sheath using diagnostic ultrasound and contrast radiography. *Vet. Radiol. Ultrasound* **35**, 42-48.
17. Nixon, A.J. (1990) Endoscopy of the digital flexor tendon sheath in horses. *Vet. Surg.* **19**, 266-271.
18. Ross, M.W. (2003) Movement. In: *Diagnosis and Management of Lameness in the Horse*, Eds: M.W. Ross and S.J. Dyson, W.B. Saunders, Philadelphia. pp 60-73.

Supporting information

Additional Supporting Information may be found in the online version of this article:

Supporting Item 1: Evaluators' interpretations of contrast tenograms in 23 horses with digital flexor tendon sheath pathology.