Equine Veterinary Journal

Equine Veterinary Journal ISSN 0425-1644
DOI: 10.1111/evj.12497

# Association between sesamoiditis, subclinical ultrasonographic suspensory ligament branch change and subsequent clinical injury in yearling Thoroughbreds

S. PLEVIN*, J. McLELLAN and T. O'KEEFFE†

Florida Equine Veterinary Associates, Ocala, USA
†Rossdales Equine Hospital, Newmarket, UK.

*Correspondence email: mpvets@hotmail.com; Received: 26.03.15; Accepted: 23.07.15

## Summary

**Reasons for performing study:** Sesamoiditis is a common radiological finding in yearling Thoroughbreds. The condition is believed to be associated with suspensory ligament branch injury (SLBI), which is known to affect racing performance. The presence of subclinical suspensory ligament branch change (SSLBC) in untrained yearlings has not been investigated. Associations between sesamoiditis, SSLBC and subsequent SLBI would allow more accurate prognoses to be made regarding the development of SLBI. They could also provide opportunity for intervention and prevention of SLBI.
**Objectives:** To test our hypotheses that untrained yearling Thoroughbreds with sesamoiditis would be more likely to have ultrasonographic findings of SSLBC and those horses with concurrent sesamoiditis and SSLBC would be more likely to develop clinical suspensory ligament branch injury with training.
**Study design:** Prospective, cohort, observational study.
**Methods:** Yearling Thoroughbreds located at a single training centre were evaluated at the onset of their training careers and for the next 9 months. Radiographic and ultrasonographic examination of bilateral forelimb proximal sesamoid bones and suspensory ligament branches was performed.
**Results:** Fifty horses were eligible, resulting in 200 forelimb sesamoid/suspensory ligament branch pairs. A significant relationship existed between possibly significant (PS) sesamoiditis and PS SSLBC ($P<0.001$). The odds ratio of sesamoids with PS sesamoiditis also demonstrating concurrent PS SSLBC was 5.1 (95% confidence interval 2.68–9.70, $P<0.001$). A significant relationship also existed between the concurrent presence of PS sesamoiditis and PS SSLBC and the subsequent development of clinical signs of SLBI ($P<0.001$, odds ratio 11.7, 95% confidence interval 4.1–33.4).
**Conclusions:** The associations identified in this study highlight the importance of ultrasonographic examination of suspensory ligament branches in horses with PS sesamoiditis. This information should allow more accurate prognostic advice regarding potential SLBI development and also provide opportunities for intervention and prevention of clinical SLBI.

**The Summary is available in Chinese – see Supporting information.**

**Keywords:** horse; Thoroughbred; sesamoiditis; suspensory ligament branch injury

## Introduction

Sesamoiditis is a common radiological finding in yearling Thoroughbreds (TBs) that may lead to a decrease in racing performance [1]. The condition is believed to be associated with injury to the suspensory ligament branch at its insertion on the proximal sesamoid bone and may serve as an indicator for subsequent development of clinical suspensory ligament branch injury (SLBI) [2–4]. One study demonstrated that horses with significant sesamoiditis at the time of yearling sales were 5 times more likely to develop clinical signs of SLBI within the first year of training [3]. This association is important because SLBI sustained as a juvenile can have a detrimental effect on a horse's future racing career [2]. It is likely, therefore, that the triad of sesamoiditis, SLBI and decreased performance are related [3,5].

No previous studies have investigated the association between sesamoiditis, and subclinical ultrasonographic suspensory ligament branch change (SSLBC) in untrained yearlings. Moreover, the importance of concurrent sesamoiditis and SSLBC in yearlings on subsequent development of clinical injury has not been documented. The objective of this study, therefore, was to report the prevalence of sesamoiditis and SSLBC in untrained yearling TBs, to determine the significance of any association between the 2 and to identify if the presence of concurrent sesamoiditis and SSLBC increases the risk of subsequent clinical SLBI.

Our hypothesis was that untrained yearling TBs with sesamoiditis would be more likely to have ultrasonographic findings of SSLBC and those horses with concurrent sesamoiditis and SSLBC would be more likely to develop clinical SLBI with training.

## Materials and methods

### Study population

Yearling Thoroughbred horses were evaluated at the onset of their training careers during a 4 week period between October and November 2013. Only homebred horses that had not been selected at public auction were eligible for inclusion. All horses were free from clinical signs of SLBI or other musculoskeletal injuries/conditions. All horses were located at a single training centre in Florida. Horses were observed from arrival at the training facility at the start of September 2013 until the end of June 2014.

The sample size was selected based on *a priori* assumptions that the prevalence of SSLBC would be 10% in normal sesamoids, and at least 20% in sesamoids with sesamoiditis. With a power of 0.8, $\alpha$ of 0.05, and assuming that normal sesamoids would be encountered with twice the frequency of those with sesamoiditis, a minimum sample size of 141 sesamoid/suspensory units was required.

### Examination protocol

During the imaging phase of the study, all horses were in their first month of breaking and training and so for the purposes of this study, were considered as 'untrained'. Initial evaluation included radiographic and ultrasonographic examinations of bilateral forelimb proximal sesamoid bone and suspensory ligament branch pairs. The trainer was blinded to the results of imaging.

After initial imaging evaluation, imaging of the sesamoid/suspensory ligament branch pairs was only repeated if the horse developed clinical signs of SLBI.

### Clinical outcome definition

Clinical SLBI was defined as: the presence of palpable pain and/or avoidance response to direct palpation; visible swelling or palpable thickening of the branch; or focal inflammation, with or without lameness [2]. Diagnosis was confirmed with ultrasonography.

### Radiological evaluation

Radiographs of the proximal sesamoid bones of the forelimbs were obtained using standard technique [6]. Two views, the dorsal 45° medial palmar lateral oblique and dorsal 45° lateral palmar medial oblique were obtained for each horse. The radiographs were independently assessed by two clinicians (S.P. and J.M.) who were blinded to the horses' identity.

The following grading scale was used:

*Grade 0* = no significant findings
*Grade 1* = any number of parallel vascular channels ≤2 mm
*Grade 2* = 1 divergent vascular channel ≥2 mm
*Grade 3* = ≥2 divergent vascular channels ≥2 mm
*Grade 4* = abaxial lucency
*Grade 5* = abaxial border change.

For the purposes of this study, *Grades 2–5* were considered to be representative of possibly significant (PS) sesamoiditis (Fig 1).

### Ultrasonographic evaluation

Ultrasonographic examinations of all 4 forelimb suspensory ligament branches were performed using standard technique [7]. All ultrasonographic examinations were performed using a Logiq E[a] ultrasound machine coupled to a variable frequency high-definition linear array probe, set at 10 MHz with a depth of 4 cm and using a standoff pad. The ultrasound images were transferred to a DICOM workstation for review. Horses were sedated with detomidine[b] (0.01–0.02 mg/kg bwt i.v.). Limbs were not clipped but were cleaned with alcohol before applying coupling gel.

Horses were positioned with weight evenly distributed. Each branch was scanned in its entirety in both transverse and longitudinal planes. Only information from images at the insertion of the suspensory ligament branch onto the proximal sesamoid bone was included in this study.

The images were independently reviewed by two clinicians (S.P. and J.M.) who were blinded to the horses' identity. Any views not considered standard were retaken. A previously reported ordinal grading scale was used to grade each branch [7]:

*Grade 0:* no significant findings
*Grade 1:* regions of mild hypoechogenicity and/or subtle signs of irregular fibre pattern
*Grade 2:* extensive regions of mild hypoechogenicity and/or small focal disruptions of fibre pattern.
*Grade 3:* regions of marked disruption of fibre pattern, large anechoic core defects.

For the purposes of this manuscript *Grades 2* and *3* were considered representative of PS SSLBC (Fig 2).

### Data analysis

Sesamoid/suspensory ligament branch units were evaluated, with a total of 4 units available for analysis per horse. Interobserver agreement for ultrasonographic and radiographic evaluation was assessed using Cohen's κ statistic (weighted for ordinal scales and unweighted for dichotomous scales) and interpreted as previously described [8]. Weighting of κ was as previously described [9].

Associations between sesamoiditis and SSLBC were determined using logistic regression analysis using dichotomous scales. Odds ratios (OR) and 95% confidence intervals (95% CI) were calculated. The influence of yearling sesamoiditis and SSLBC on development of juvenile SLBI was similarly investigated using both Fisher's 2-tailed exact test and bias reduced (Firth's) logistic regression.

Significance was set at $P \leq 0.05$ for all tests.

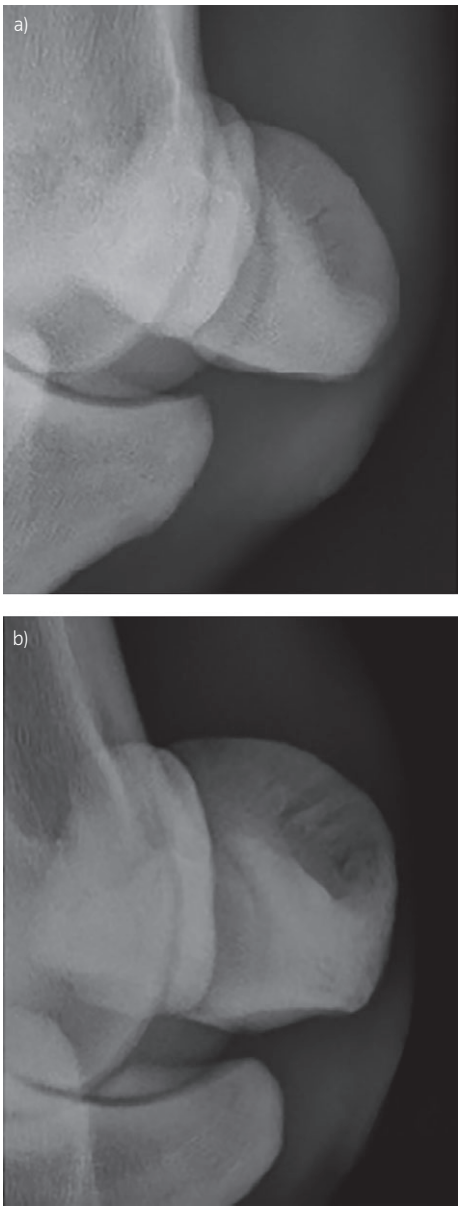


Fig 1: Radiographic view of a normal sesamoid (a). Radiographic image of a sesamoid with possibly significant sesamoiditis demonstrating enlarged vascular channels (b).

All statistical analysis was performed using a commercially available software package (Excel)[c] and an online tool (Statpages.org)[d].

## Results

One hundred and three horses were present at the initiation of this investigation. Fifty-three were excluded: 51 having been selected at public auction; one for extreme conformational abnormalities; and one for pre-existing clinical SLBI.

Therefore, 50 horses met the eligibility criteria (32 fillies, 18 colts) and a total of 200 forelimb sesamoid/suspensory branch pairs were assessed. Interobserver agreement for individual grades of sesamoid change (weighted κ 0.74, 95% CI 0.63–0.84) and suspensory change (weighted κ 0.54, 95% CI 0.3–0.78) were substantial and moderate, respectively. When sesamoids were graded using a dichotomous scale for PS sesamoiditis

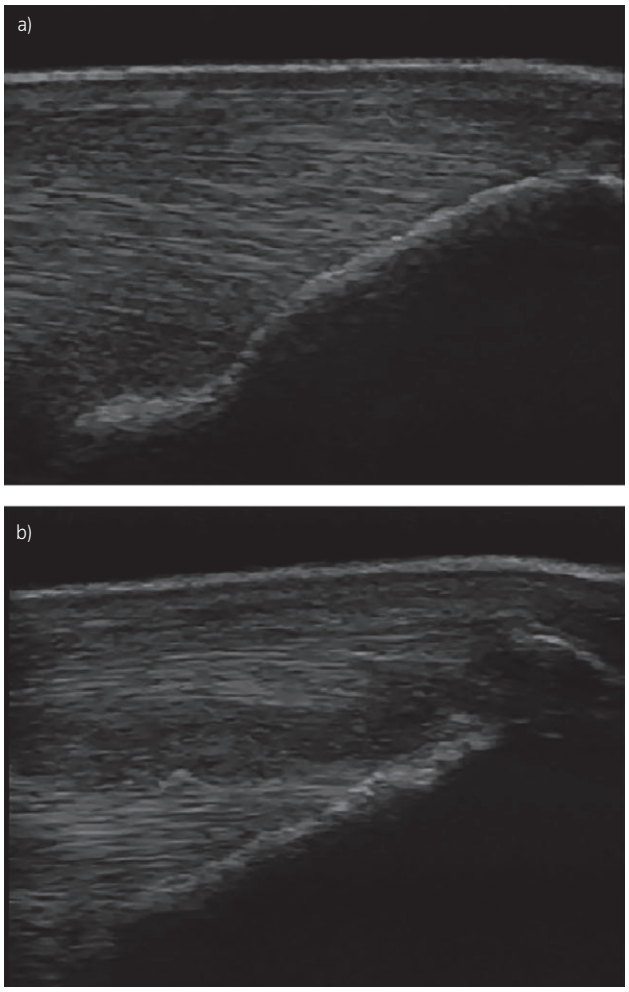


Fig 2: Longitudinal ultrasonographic image of a normal suspensory ligament branch (a). Longitudinal ultrasonographic image of a suspensory ligament branch with possibly significant subclinical change demonstrating regions of hypoechogenicity and disruption of fibre pattern (b).

(*Grade 2* sesamoiditis or higher), interobserver agreement remained substantial (κ 0.75, 95% CI 0.63–0.86). When suspensory ligament branch change was also graded using a dichotomous scale for the presence of PS SSLBC (*Grade ≥2* SLBC), interobserver agreement improved to substantial (κ 0.79, 95% CI 0.68–0.89).

Seventeen horses (34%) exhibited no evidence of sesamoiditis in any sesamoid and 33 (66%) horses demonstrated sesamoiditis in at least one sesamoid. The prevalence of PS sesamoiditis was 20.5% (Observer A) and 23% (Observer B) of all sesamoids. Twenty horses (40%) had no evidence of SSLBC and 30 horses (60%) demonstrated some degree of suspensory ligament branch change in at least one suspensory ligament branch. The prevalence of PS SSLBC was 18.5% (Observer A) and 23% (Observer B) of all suspensory ligament branches.

Although no significant differences were demonstrated between lateral and medial distributions, 65% of PS sesamoiditis cases were medial (P = 0.07; Fisher's 2-tailed exact test) and 35% of PS SSLBC cases were medial (P = 0.08; Fisher's 2-tailed exact test). There was equal distribution of imaged abnormalities between left and right limbs. Sex was not significantly associated with any variable examined.

Adjusting for interobserver effects, a significant relationship existed between PS sesamoiditis and PS SSLBC in untrained yearlings. Twenty-eight percent of sesamoids (13 sesamoids) with PS sesamoiditis had concurrent PS SSLBC compared with 4% of 'normal' sesamoids (OR, 5.1, 95% CI 2.68–9.70, P<0.001). Over the study period, 8 horses (16%) developed clinical signs of SLBI; 5 of these cases (62.5%) had evidence of coexisting PS sesamoiditis and PS SSLBC as yearlings before training. Of the 13 sesamoid/suspensory ligament branch units with concurrent PS sesamoiditis and PS SSLBC, 8 (61.5%) did not develop clinical SLBI over the study period.

All 8 clinical SLBI cases demonstrated deterioration on ultrasound examination, when compared with initial images. This was the case, regardless of whether they demonstrated subclinical change in their untrained state (Fig 3). The presence of PS sesamoiditis alone (P = 0.009) or PS SSLBC alone (P = 0.05) were risk factors for subsequent SLBI. The coexistence of PS sesamoiditis and PS SSLBC significantly increased the potential for subsequent clinical injury (OR 11.7, 95% CI 4.1–33.4, P<0.001).

## Discussion

In this population of 50 Thoroughbred (TB) yearlings, 66% demonstrated some degree of sesamoiditis. This finding is consistent with other studies that have shown sesamoiditis to be a common condition [1–3].

Interobserver agreement for ordinal grades of SSLBC was moderate. Combining *Grades 0* and *1* into 'possibly not significant' and *Grades 2* and *3* into 'possibly significant', however, demonstrated substantial agreement and this dichotomous grading system was used for analysis of the results throughout this study. Ultrasound *Grades 2* and *3* were representative of PS SSLBC: grades that many clinicians would consider to be clinically significant [7]. In clinical practice, it may, therefore, be more appropriate to grade in this way as interobserver agreement is higher, and thus results more consistent. The grading of sesamoiditis was shown to have good interobserver agreement for both ordinal and the dichotomous scale of 'possibly significant' and 'possibly not significant', that was used for analysis of results throughout the study

Previous studies in yearling Thoroughbred horses have determined that sesamoids demonstrating regular parallel vascular channels (*Grade 1* or lower in this study) did not negatively affect racing performance and can, therefore, justifiably be classed as not significant [1]. Sesamoids with sesamoiditis of *Grade 2* or higher were considered 'potentially significant' due to previously reported effects on racing performance [1].

Using dichotomous scales, our first hypothesis was supported: a significant relationship was found to exist between PS sesamoiditis and PS SSLBC in yearlings in this population. The aetiology of sesamoiditis remains contentious [10]. Circulatory disturbances are unlikely to be the primary aetiological factor [10] and sesamoiditis has been most recently defined as inflammation of the proximal sesamoid bone, more accurately, inflammation of the insertion of the suspensory ligament into the proximal abaxial aspect of the proximal sesamoid bone [5,11]. It has been suggested that damage to the suspensory ligament branch insertion creates inflammation. Inflammation in the proximal sesamoid bone causes bone resorption, further weakening the suspensory ligament insertion, ultimately leading to further inflammation in a cyclic progressive manner [5]. This intimate relationship between the sesamoid bone and the suspensory ligament branch insertion likely explains the presence of coexisting sesamoid and suspensory ligament branch changes seen in this study. The current study does not, however, establish causality, merely an association.

Eight horses developed clinical suspensory ligament branch desmopathy during the study period and 5 had concurrent PS sesamoiditis and PS SSLBC at the onset of the study period. The odds of sesamoids with concurrent PS sesamoiditis and PS SSLBC developing clinical SLBI over the study period were substantially higher than all other combinations supporting our second hypothesis. A previous study in yearlings demonstrated as association between significant sesamoiditis and the subsequent development of SLBI but prior concurrent SSLBC was not investigated in that study [2,3]. Further, the horses evaluated in the previous study were purchased at public auction and, therefore, had probably been subjected to selection bias, making the 2 study populations not directly comparable. The results from both these studies, however, suggest that the presence of both PS sesamoiditis and PS SSLBC increase the risk for future SLBI. It should be noted, however, that not all sesamoid units with coexisting PS sesamoiditis and PS SSLBC developed SLBI over

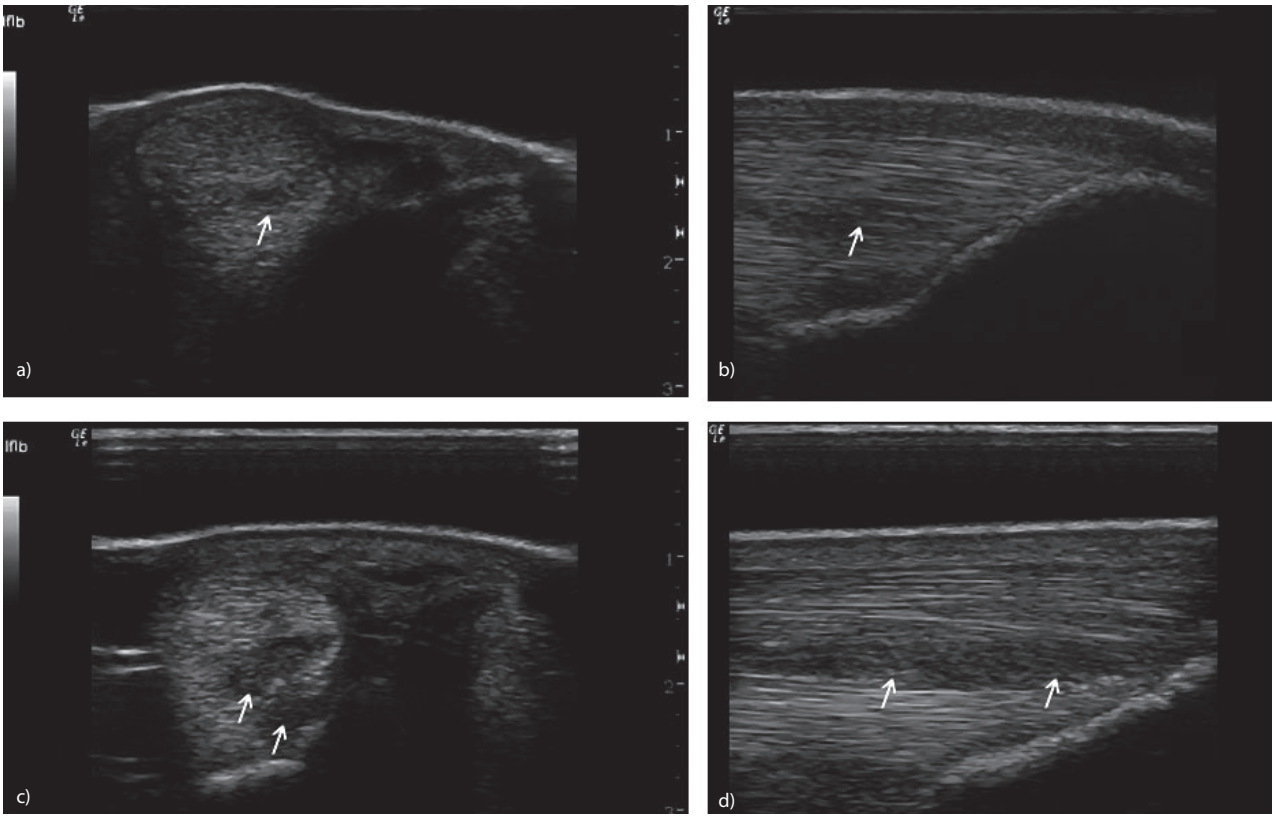


Fig 3: Transverse (a) and longitudinal (b) ultrasonographic images of possibly significant subclinical suspensory ligament branch change in an untrained yearling, demonstrating a small focal area of disruption in fibre pattern (see arrows). Transverse (c) and longitudinal (d) images of subsequent injury of the same suspensory ligament branch as shown in images a and b. Note the increase in core lesion size and loss of fibre attachment once the ligament change became clinically apparent (arrows).

the current study period. It continues, therefore, to be difficult to predict which individuals with subclinical changes will succumb to clinical disease.

A major limitation of the current study was the relatively small study population: in particular, the small number of horses with subsequent clinical SLBI (8 horses). Only homebred horses were eligible for inclusion into this study. Although this selection criteria limited population numbers, inclusion of horses bought from public auction was thought to represent a potential source of bias. Horses purchased were assumed to have already been preferentially selected for their lack of sesamoiditis. Data from larger populations are needed and, as with analysis of any data with low numbers, the current results should be interpreted with caution.

The observation period for this study was also relatively short. Horses were only followed for their juvenile period and, therefore, the development of SLBI on a longer-term basis is unknown.

A further limitation of this study was that ultrasound images were evaluated using static images. It has generally been acknowledged that the diagnostic specificity of static ultrasound image review is inferior to that of real time ultrasound examinations [12]. An inherent limitation of this investigation is that both the sensitivity and the specificity of ultrasound examination for the detection of SLBI have been questioned: it has been reported that, in some horses with clinical features indicative of SLBI, ultrasonography failed to reveal abnormalities [13] and, in contrast, ultrasonographic abnormalities have been shown to exist in a small but significant proportion of horses without clinical indication of injury [7]. In the current study, limbs were not clipped, due to trainer compliance, and this may have compounded the inherent lack of ultrasonographic sensitivity and specificity.

All radiographs were performed over a 2 day period; however, it was not possible to perform all ultrasound examinations during this timeframe. Ultrasound examinations were, therefore, spread out over a 2–4 week period during the first month the horses were in training. During this first month the horses were in the very early stages of ridden exercise, therefore, this time period for image acquisition was considered acceptable. Horses were sedated for their ultrasonographic examinations. However, due to trainer compliance, they were not sedated for the radiographic examination. Any views deviating significantly from standard were re-taken.

Because a relationship between sesamoiditis and insertional SLBI has already been established in the literature, only abnormalities at the insertion of the suspensory ligament branch were analysed [2]. Similarly only 'significant' levels of sesamoiditis and SLBI have demonstrated clinical importance in the literature; therefore, only such changes were analysed in this study [1–3].

For the first time, not only has an association between the radiological findings of significant sesamoiditis and significant SSLBC in a population of untrained Thoroughbred yearlings been established, but also an association between horses with concurrent significant sesamoiditis, significant SSLBC and subsequent clinical SLBI. The relationship found to exist between PS sesamoiditis and PS SSLBC and subsequent SLBI in yearlings in this study further suggests that sesamoiditis and SLBI are aetiologically related and that SSLBC often exists prior to development of SLBI. These documented relationships provide further evidence to suggest sesamoiditis and SLBI are not independent conditions. This information ought to encourage veterinarians to recommend ultrasonographic evaluation of any suspensory ligament branch attached to a sesamoid demonstrating a significant grade of sesamoiditis and *vice versa*. It should ultimately enable veterinarians to offer more accurate prognostic advice to their clients regarding the development of SLBI.

Detection of concurrent PS sesamoiditis and PS SSLBC before the onset of training may provide opportunity for intervention and possible prevention of clinical suspensory ligament branch injuries. This may decrease the amount of time and money lost to rehabilitating horses with

such injuries. Further work using larger populations would provide further insight into these findings.

## Authors' declaration of interests

No competing interests have been declared.

## Ethical animal research

Research ethics committee oversight not currently required by this journal: noninvasive observational study. Owner informed consent was obtained.

## Source of funding

None.

## Authorship

S. Plevin and J. McLellan were jointly responsible for study design. T. O'Keeffe performed data collection. S. Plevin and J. McLellan read and reported all images. J. McLellan performed all interpretation and statistical analysis. S. Plevin prepared the manuscript and approved the final version, as did J. McLellan.

## Manufacturers' addresses

[a]GE Healthcare, Wauwatosa, Wisconsin, USA.
[b]Pfizer Animal Care, New York, USA.
[c]Excel, Microsoft, Redmond, Washington, USA.
[d]Statpages.org, Kissimmee, Florida, USA.

## References

1. Spike-Pierce, D.L. and Bramlage, L.R. (2003) Correlation of racing performance with radiographic changes in the proximal sesamoid bones of 487 Thoroughbred yearlings. *Equine Vet. J.* **35**, 350-353.
2. Plevin, S. and McLellan, J. (2014) The effect of insertional suspensory branch desmitis on racing performance in juvenile Thoroughbred racehorses. *Equine Vet. J.* **46**, 451-457.
3. McLellan, J. and Plevin, S. (2014) Do radiographic signs of sesamoiditis in yearling Thoroughbreds predispose to the development of suspensory ligament branch injury?. *Equine Vet. J.* **46**, 446-450.
4. Vanderperren, K. and Saunders, J.H. (2009) Diagnostic imaging of the equine fetlock region using radiography and ultrasonography. Part 1: soft tissues. *Vet. J.* **181**, 111-122.
5. Bramlage, L.R. (2009) Part 1: Operative orthopedics of the fetlock joint of the horse: traumatic and developmental diseases of the equine fetlock joint. *Proc. Am. Ass. Equine Practnrs* **55**, 96-139.
6. Dyson, S.J. and Genovese, R.L. (2003) The suspensory apparatus. In: *Diagnosis and Management of Lameness in the Horse*, 1st edn, Eds: M.W. Ross and S.J. Dyson, W.B. Saunders, St Louis, Missouri. pp 654-672.
7. Ramzan, P.H.L., Palmer, L., Dallas, R.S. and Shepherd, M.C. (2013) Subclinical ultrasonographic abnormalities of the suspensory ligament branch of the athletic horse: a survey of 60 Thoroughbred racehorses. *Equine Vet. J.* **45**, 159-163.
8. Viera, A.J. and Garret, J.M. (2005) Understanding interobserver agreement: the kappa statistic. *Fam. Med.* **37**, 360-363.
9. Cohen, J. (1968) Weighted kappa: nominal scale agreement with provision for scaled disagreement or partial credit. *Psychol. Bull.* **72**, 323-327.
10. Cornelissen, B.P.M., Rijkenhuizen, A.B.M., Buma, P. and Barneveld, A. (2002) A study on the pathogenesis of equine sesamoiditis: the effects of experimental occlusion of the sesamoidean artery. *J. Vet. Med. A.* **49**, 244-250.
11. Bukowiecki, C., Bramlage, L. and Gabel, A. (1987) *In vitro* strength of the suspensory apparatus in training and resting horses. *Vet. Surg.* **16**, 126-130.
12. Van Holsbeke, C., Yazbek, J., Holland, T.K., Daemens, A., De Moor, B., Testa, A.C., Valentin, L., Jurkovic, D. and Timmerman, D. (2008) Real-time ultrasound vs. evaluation of static images in the preoperative assessment of adnexal masses. *Ultrasound Obstet. Gynecol.* **32**, 828-831.
13. McIIwraith, C.W. (2002) Diseases of joints, tendons and ligaments and related structures. In: *Adams' Lameness in Horses*, 5th edn., Ed: T. Stashak. Lippincott, Williams & Wilkins, Philadelphia, Pennsylvania. pp. 459-644

## Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

**Summary in Chinese**.