A descriptive study of stress fractures in competitive event horses in the UK

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Abstract
The impact of stress fractures on competitive event horses in the UK is completely unknown. Ninety-one replies to 450 questionnaires sent to competitive event riders across the UK indicated that 11 horses, representing 12% of the responders, had a confirmed stress fracture. As data on the total number of horses owned or ridden by the riders were not available, the true prevalence of stress fractures in this sample of horses could not be directly assessed. Within the bounds of this study, competitive level of the rider had a significant effect on stress fracture prevalence ($\chi^2 (0.05, df = 2) = 4.74, P < 0.05$), as did years of eventing experience ($\chi^2 (0.05, df = 1) = 7.80, P < 0.01$). Training regime was also influential ($\chi^2 (0.05, df = 1) = 6.30, P < 0.01$). There was a predominance of fractures in geldings ($\chi^2 (0.05, df = 1) = 4.45, P < 0.05$); however, geldings constituted 82% of reported cases. Thoroughbred cross horses had a significantly lower incidence of stress fractures than Thoroughbreds ($\chi^2 (0.05, df = 1) = 0.82, P < 0.01$) but constituted only 18% of the sample. Horses in the oldest age category (9–12 years) had 6% of all stress fractures ($\chi^2 (0.05, df = 2) = 4.54, P < 0.1$). All fractures occurred on the foreleg at the knee or below, with no significant effect of anatomical location. Seventy-three per cent of horses were not competing when diagnosed ($\chi^2 (0.05, df = 1) = 2.27, P < 0.1$). These data indicate that useful preliminary data were yielded by the questionnaire and that further research with a larger sample size is justified.

Keywords: event horses; stress fractures

Introduction
It has been reported that 53–70% of all Thoroughbred or National Hunt racehorses suffer from stress fractures or bucked shins, particularly in the cannon bone. Injuries to the leg bones are an occupational hazard of all horses that gallop and jump. Limb fractures are a serious problem not only in terms of horse welfare, but also for the economy of the Thoroughbred racing industry. There are no published data on the impact of stress fractures in UK event horses.

There is increasing evidence that the development of stress fractures in Thoroughbred racehorses involves chronic fatigue processes. A stress fracture differs from an acute fracture in that it results from the repetition of constant cyclic loading forces on bone, compared with the short-duration high-impact force required to produce an acute fracture. Stress fractures also have predilection sites, particularly in the cannon bone, which are governed by the mechanical forces operating throughout the long bones during locomotion. The design of the bone, the weight of the horse and the manner in which the bone is cyclically loaded during rapid gaits determine these forces. The equine skeleton is pushed to its biomechanical limit in jump racing, despite the vibrational damping advantage conferred by the arrangement of the muscle and tendon in the limbs during galloping and jumping. Stress fractures commonly occur after days or weeks of bone weakening at sites of accumulated micro-damage. Osteoclast invasion clears up debris, and osteoblasts remodel the bone and lay down new Haversian systems. There is evidence that the remodelling of bone is instrumental in the development of more substantial fractures rather than repair, due to a substantial increase in porosity resulting from the initial reabsorptive processes. The resultant decrease in bone stiffness makes it subject to higher strain, and this accelerates the rate of damage accumulation in a vicious circle once the initial micro-damage has occurred.

Given the circumstances mentioned above, it is not surprising that flat racing and National Hunt racing are...
marred by high incidences of stress fractures, especially as racehorses begin training at a relatively young age. Stress fractures commonly occur in young horses during their initial training but can also occur in older horses being submitted to retraining following a prolonged lay-off through ill health or injury. In addition, stress fractures can develop in any horse subjected to a sudden increase in workload, primarily that involving increasing speed. Conversely, they tend not to occur in mature, general-purpose riding horses in regular use.

British Eventing has 7552 horses registered and 8000 members. Eventing competitions comprise dressage, show jumping and cross-country at novice, medium and advanced levels and are regulated by the British Eventing organisation. Although event horses tend to be older and physically mature in comparison with racehorses, and can remain competitive into their teens, there is great variety in their training regimes. Whether this has an impact on the prevalence of stress fractures is unknown.

The aim of the present study was to conduct a preliminary descriptive investigation of the prevalence of stress fractures in a random sample of competitive event horses in the UK. This was achieved by means of a specially designed questionnaire, which was posted to 450 members of British Eventing. In addition, we evaluated whether there were any relationships between the prevalence of stress fractures (confirmed by X-ray) and the age, breed and gender of the horse, level of experience of the horse and rider, anatomical location of the stress fractures and the training regime of the horse.

**Methods**

A pilot questionnaire was sent to 10 advanced riders to ensure lack of bias in the questions. Four hundred and fifty questionnaires were then randomly distributed to riders registered with British Eventing and competing across Britain between June and August 2002. Investigations were confined to stress fractures confirmed by veterinary examination including a confirmatory X-ray.

The questionnaire (see Appendix) was designed to evaluate the influence of sex, age and competitive level of the horse, and competitive experience of the rider, on the prevalence of stress fractures. The questions attempted to account for any factors predisposing a horse to stress fractures including poor conformation, immaturity, perceived lack of physical fitness and constant stress over a long duration.

**Statistical methods**

Descriptive statistics were used to summarize the questionnaire data. The effects on prevalence of stress fractures of competitive level of the horse and rider, breed, age and gender of the horse, anatomical location of the stress fracture, competitive status when diagnosed and training regime were assessed. We used 2 × 2 table \( \chi^2 \) tests where fracture data were available or one-sample \( \chi^2 \) tests where fracture data were not available. A \( P \)-value of \( < 0.05 \) was taken as significant.

**Results**

Ninety-one, or 20%, of the questionnaires were returned. Seventy-two per cent of responders were advanced, 24% were intermediate and 3% were novice riders. Sixty-one per cent of responders had been competing for over 10 years. The riders sampled were predominantly advanced level with over 10 years’ riding experience (Fig. 1).

Eleven per cent of responders, owning 11 horses, reported the occurrence of stress fractures in their horses. Data on the total number of healthy horses currently owned or previously ridden by the 91 responders were not available from the questionnaires; thus stress fracture prevalence reported here is not a true reflection of the potential sample size. Sixty-five per cent of the responders used interval training, 24% used horse-specific training regimes and 12% incorporated hill work as a significant part of their training regime.

There was a significant effect of years of riding experience and level of competition on stress fracture prevalence, where all fractures occurred in horses of riders who had been competing for over 10 years and at advanced level. Fifty-five per cent of stress fractures were attributable to individual, i.e. horse-specific, training regimes. There was a predominance of fractures in geldings; however, geldings constituted 82% of reported cases. Thoroughbred cross horses had a significantly lower incidence of stress fractures than Thoroughbreds but constituted only 18% of the sample. Horses in the oldest age category (9–12 years) had 63% of all stress fractures (Table 1).

All fractures occurred on the forelimb at or below the knee; there was no significant effect of anatomical location. Seventy-five per cent of horses were not competing when diagnosed, which was a significant effect for such a small dataset (\( P < 0.1 \)) (Table 1).

**Discussion**

This study set out describe the prevalence of stress fractures in a random sample of competitive event horses in the UK, and to assess whether there were any significant contributory factors to their occurrence. It was not possible to calculate the precise incidence of stress fractures in the horses of the 91 responding competitors because:

- There was limited evidence in the form of written responses without returned questionnaires to
Stress fractures in competitive event horses

Table 1 Questionnaire data on factors associated with the prevalence of stress fractures in competing event horses

<table>
<thead>
<tr>
<th>Questionnaire variable</th>
<th>Fracture</th>
<th>No fracture</th>
<th>$\chi^2$ test results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riding experience</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 10 years</td>
<td>0</td>
<td>35</td>
<td>$\chi^2(0.05, df = 1) = 7.80, P &lt; 0.01^a$</td>
</tr>
<tr>
<td>&gt; 10 years</td>
<td>11</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Level of riding competition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Novice/intermediate</td>
<td>0</td>
<td>25</td>
<td>$\chi^2(0.05, df = 1) = 4.74, P &lt; 0.05^a$</td>
</tr>
<tr>
<td>Advanced</td>
<td>11</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>Training regime</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interval/hill</td>
<td>5</td>
<td>64</td>
<td>$\chi^2(0.05, df = 1) = 6.30, P &lt; 0.01^a$</td>
</tr>
<tr>
<td>Individual</td>
<td>6</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Competitive level of horse</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-novice</td>
<td>2</td>
<td>–</td>
<td>$\chi^2(0.05, df = 3) = 1.00, NS^b$</td>
</tr>
<tr>
<td>Novice</td>
<td>4</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td>2</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Advanced</td>
<td>3</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Breed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thoroughbred</td>
<td>4</td>
<td>–</td>
<td>$\chi^2(0.05, df = 1) = 0.82, NS^b$</td>
</tr>
<tr>
<td>Thoroughbred cross</td>
<td>7</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1–4</td>
<td>2</td>
<td>–</td>
<td>$\chi^2(0.05, df = 2) = 4.54, P &lt; 0.1^b$</td>
</tr>
<tr>
<td>5–8</td>
<td>2</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>9–12</td>
<td>7</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gelding</td>
<td>9</td>
<td>–</td>
<td>$\chi^2(0.05, df = 1) = 4.45, P &lt; 0.05^b$</td>
</tr>
<tr>
<td>Mare</td>
<td>2</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Bone affected</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pastern</td>
<td>3</td>
<td>–</td>
<td>$\chi^2(0.05, df = 5) = 1.54, NS^b$</td>
</tr>
<tr>
<td>Cannon</td>
<td>2</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Sesamoid</td>
<td>2</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Splint</td>
<td>2</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Knee</td>
<td>1</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Pedal</td>
<td>2</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Competing when injured?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>3</td>
<td>–</td>
<td>$\chi^2(0.05, df = 1) = 2.27, P &lt; 0.1^b$</td>
</tr>
<tr>
<td>No</td>
<td>11</td>
<td>–</td>
<td></td>
</tr>
</tbody>
</table>

NS – not significant.

$^a$ $2 \times 2 \chi^2$ test.

$^b$ One-sample $\chi^2$ test.
suggest that competitors who had had no experience of stress fractures in their horses did not think the study relevant to them, despite being informed about the importance of negative data in a covering letter.

- It was difficult for advanced event riders to remember all the horses they had ever ridden over careers spanning decades.

The estimated incidence of stress fractures reported for racing Thoroughbreds is 53–70% of all competitors. The drive to provide a quick commercial turnover in racing has been implicated in the high degree of wastage on and off the track. The prevalence and incidence of stress fractures in event horses, although incalculable from this study, are presumably significantly lower than those quoted for racehorses. Event horses tend to be significantly older than racehorses, they experience more prolonged and possibly thorough training regimes, and there is not the same pressure for an economic return on their performance.

The questionnaire responses covered a wide range of views and experiences, particularly of event training methods. Specific types of training regime and the number of years spent riding competitively were significantly associated with the occurrence of stress fractures (Table 1, Fig. 1). Time spent competing, particularly at higher levels, with the most rigorous training and competing regimes, seemed of greater influence than the competitive level of the horse or rider per se. None of the novice or intermediate riders reported having horses that had suffered a stress fracture and fractures occurred evenly across all categories of experience of horse (Table 1). There did appear to be some influence of age of horse in that older horses (9–12 years) had 63% of all stress fractures. Similar findings have been reported for steeplechase racing in the UK.

Specific training regimes accounted for 55% of stress fractures despite 24% of the responding population using them. As indicated by the descriptive information on the questionnaires, these are characterized by a wide variation in distance and intensity of work performed by the horse, particularly at higher levels of competition. In studies on stress fractures in racehorses, about 80% are found to be spontaneous and to occur during training in the absence of a specific traumatic event. Variations in training schedules and conditions have been implicated in the cause of microdamage, particularly with regard to management of lame horses and lack of galloping in the training schedule.

The significantly higher number of geldings with stress fractures was almost certainly a reflection of their higher numbers; 82% of reported cases were geldings, they are predominant in the eventing population as a whole and constituted 72% of event horses registered in 2001.

In racehorses, stress fractures have been found to show a high degree of consistency in their morphology, frequently presenting at the same locations as incomplete cracks and often associated with pre-existing pathology. The pastern bone is the most common location for stress fractures in flat racing and the cannon bone in National Hunt racing. There was no preferred anatomical location for fractures in this study, but, as with racehorses, all were confined to the lower forelimb and 75% occurred while training. These facts support the view that the long-term occurrence of micro-damage is the underlying cause of stress fractures in sport horses.

As mentioned above, this study was unable to provide data on total numbers of horses sampled and therefore is not as precise as many of the studies on racehorses, which had direct access to data records from training yards and racecourses. Unsurprisingly, there was a tendency for more experienced riders and older horses to have the highest prevalence of stress fractures. This study also indicates that, although stress fractures are less prevalent in event horses than in racehorses, in common with findings in racehorses, lack of adequate training of the horse, rather than the rider, constitutes a risk factor that needs to be addressed for horses competing at all levels.

A future study with a larger sample size is justified.

References

Appendix: Stress Fracture Questionnaire

Name of Owner/Rider (or Vet) —-------------------------------------------------------------------------------------------------------------------------------
(This can be done anonymously if you prefer)
Experience of Owner —----------------------------------------------------- Level of Owner (Trained/Ridden) —-----------------------------------------------------
Experience of Rider —--------------------------------------------------------- Rider Years Competing BHTA? —----------------------------------------------------------

__________________________________________________________________________

Horse name or ID number
Breed
Age
Sex
Temperament
What level has the horse competed at?
Has the horse previously suffered a limb stress fracture?
How long had the horse been in work when the stress fracture occurred?
Age of horse when stress fracture occurred
Bone affected
Did it occur during competitive circumstances?
Phase of competition when fracture occurred
Did it happen during a training session; if so what were you doing?
Do you feel that a competition had any bearing on the injury?
What was the going like: i.e. hard, good, soft, deep?
What was the grade of the fracture: light, moderate, severe, very severe?
After seeking veterinary advice how was the injury treated?
Has the horse come back into work?
If so, is it competing and at what level?
Has the horse stayed in full work without further related injury?

Do you use a fattening programme? Please describe:

__________________________________________________________________________

How often do you compete your

Pre-novice horses  Novice horses  Intermediate horses  Advanced horses

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How many Three-day Events do you feel it is acceptable to undertake for year?

How many horses have you owned or ridden that have suffered from stress fractures?

Thank you very much for taking the time to complete my questionnaire and for giving up part of your day. If you would like to add anything else then please feel free.

Once again, thank you and good luck for the rest of the season.

Emma Hayton