Equine vet. J. (2003) **35** (7) 712-714

Short Communication

Third metacarpal bone length and skeletal asymmetry in the Thoroughbred racehorse

K. M. WATSON*, D. J. STITSON† and **H. M. S. DAVIES**

Department of Veterinary Science, University of Melbourne, Victoria 3010, Australia and †*Department of Orthopaedic Surgery, Middlesborough General Hospital, Middlesborough, UK.*

Keywords: horse; metacarpal; length; asymmetry; laterality

Introduction

In man, the dominant right hand is often larger than the nondominant left hand. However, in horses, skeletal asymmetry has not previously been reported. Skeletal asymmetry in the racehorse may influence the way it races and affect the incidence of lameness.

The growth in length of the third metacarpal bone (McIII) in the horse has ceased by age 10 weeks (Fretz *et al*. 1984) and its length should therefore not be affected by subsequent training conditions. Horses are not trained at all until at least age 2 years. This means that measurements of the length of McIII may show any underlying asymmetry in the processes of growth present in racehorses that may affect their performance and the incidence of injury.

The aim of this study was to establish whether there was a consistent difference in McIII length in two independent groups of Thoroughbred racehorses.

Materials and methods

Horses

Forty-six Thoroughbred racehorses at 2 racing yards were used in this study. Thirty-one racehorses were radiographed at a racing yard in Victoria and a further 15 radiographed independently at a racing yard in South Australia. Horses were aged 2–6 years and had raced or were in training at racing speed at the time the radiographs were taken.

Methods

Lateromedial radiographic views of the left McIII and mediolateral radiographic views of the right McIII were taken according to standard methods (Walter and Davies 2001). Two standard portable radiography machines were used (Showa ST 104[1], Atomoscope HF 80[2]) and cassettes with rare earth screens (Lanex regular, Kodak or Agfa Gevaert with curix screens) to expose Konica M G Super Rapid film[3] or Kodak IMG–1 Insight Multi-Exam G Film[4]. The cassettes were aligned perpendicular to the beam and held in contact with the horse's limb.

Measurements

Measurements of the length of McIIIs were taken from 2 sets of radiographs for each horse. A plastic ruler was used to measure (in mm) the length of each McIII, between the most distal point of the proximal joint surface and the most proximal point of the distal condyles, on each radiograph. The mean of the 2 measurements for each horse was used in this study (Fig 1).

Validation of measurement

In order to confirm that length measurement was comparable between lateromedial and mediolateral views, radiographs of right and left McIIIs, in both projections, were taken of a further 12 Thoroughbred racehorses in Victoria. The length of each McIII, in both projections, was measured according to the technique described above. The observer was blinded as to the identity of the horse, the side and radiographic projection, to avoid observer bias. Lengths were compared according to radiographic projection to determine statistically any significant difference in measurement.

Statistical analysis

Data was analysed using SPSS Software (SPSS for Windows, Release 10.0.07)[5]. Differences in mean lengths were assessed using the paired *t* test, adopting significance level $P<0.05$.

Results

Validation of method

Comparison between right lateromedial and right mediolateral measurements showed a difference between the means of 1.4 mm ($P>0.271$). Comparison between the left lateromedial and left mediolateral measurements showed a difference between the means of 1.1 mm ($P>0.341$). The lateromedial projection measured 1.1 or 1.4 mm longer than the mediolateral projection. This demonstrated no significant difference between measurements of length taken from radiographs in either lateromedial or mediolateral projection.

*Author to whom correspondence should be addressed. Present address: Rodel, Church Road, Old Beetley, Dereham, Norfolk NR20 4AB, UK.
[Paper received for publication 18.10.02; Accepted 22.05.03]

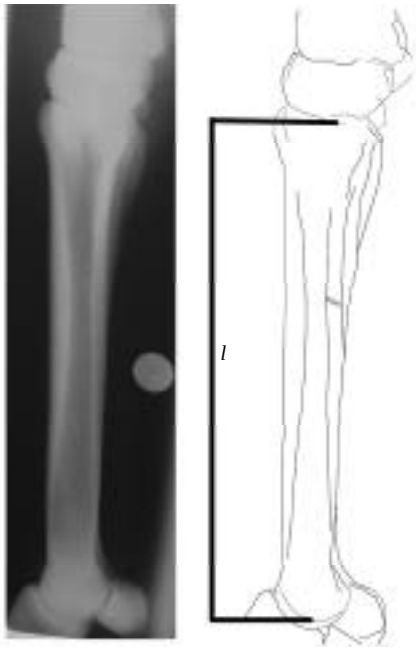

Fig 1: Method of measurement of the equine third metacarpal bone. l = length (mm).

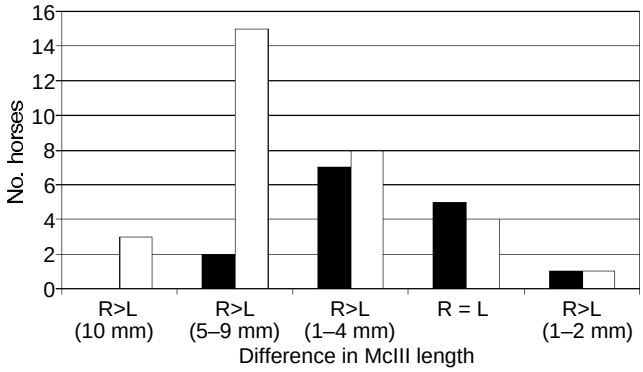

Fig 2: Distribution of differences in length of right and left third metacarpal bone. South Australian horses had signigicantly less difference between their limbs than Victorian horses (P = 0.002). □ *Victorian horses;* ■ *South Australian horses.*

Study results

Mean length of the right McIII was 278.5 mm (range 256–301 mm) and of the left McIII was 274.8 mm (range 250–299 mm).

In 35 horses (76%), the right McIII was longer than the left. In 9 horses (20%), the McIIIs were of equal length and 2 horses (4%) had a longer left McIII. The distribution of length differences is shown in Figure 2. The differences in length between right and left McIIIs was highly significant (P<0.0001).

The Victorian horses had a mean ± s.e. difference in length of 5.1 ± 0.7 mm between the limbs and the South Australian horses a difference of 1.5 ± 0.6 mm. The Victorian horses had significantly more difference between the limbs than the South Australian horses (P= 0.002).

Discussion

In our study, 76% of the horses investigated had a longer right McIII (P<0.0001). This is similar to the 25 out of 30 (83%) horses that had a strong left hindlimb preference in the study by Meij and Meij (1980), with the right McIII being significantly longer than the left in approximately the same proportion of horses that one would expect to be left hindlimb dominant.

The basic mechanics involved in turning and the potential mechanical effect of a longer outside McIII in a turn without camber may mean that horses with longer right McIIIs may have some advantage over horses with less difference between their McIIIs when racing counter-clockwise. In contrast, it seems more probable that there would be a disadvantage in having a longer right McIII when racing clockwise. The South Australian horses were from a stud that selected horses from stock that were raced in both directions and were similarly successful in both directions. Data from these horses were collected to test whether the Victorian horses were being selected for a longer right McIII because of their predominantly counter-clockwise way of racing. The lack of extreme differences in McIII length in the South Australian horses suggests that either some of the more extreme differences between McIIIs in the Victorian horses may have occurred due to this selection pressure, or horses with a large difference were selected against in the South Australian group. The trend, however, was clearly still for a longer right metacarpus regardless of the direction of racing.

Our findings of skeletal asymmetry, combined with the observations of sidedness made by Meij and Meij (1980), may help to explain other manifestations of asymmetry noted by horsemen throughout the ages, such as the tendency for horses to be stiffer to the left and softer to the right, and harder to train (weaker?) to the right. Anatomical asymmetry of the brain has been demonstrated in the great apes, monkeys, cats, rats and birds (Kandel *et al.* 1991) but, as far as we are aware, this study provides the first evidence of skeletal asymmetry related to sidedness in a quadruped. This supports the findings of Plato *et al.* (1980), who reported that there was an inherent tendency for the right metacarpal to have more bone than the left regardless of hand dominance in man. It suggests that the tendency towards a larger hand size in right-handed people may be due to an underlying asymmetry in the processes of growth rather than purely an effect of differences in use. Recently, asymmetric gene expression has been described (Shiratori *et al.* 2001), and this asymmetry may be the root cause of skeletal asymmetry in many different classes of animals, including horses.

This paper reports a simple method of measuring the length of the third metacarpal bones in horses. Differences in bone length between the two sides of the body are likely to have subtle effects on coordination and balance and may be of clinical significance in determining causes and effects of unilateral injuries in all classes of horses, as well as assisting in determination of suitable treatments. Large differences between bones in left and right limbs may affect ability and/or soundness in racing around turns. The difference between the two groups of horses measured in this study suggests that there is a selection pressure against horses that have a large difference between third metacarpal bones (longer right third metacarpal bone) when racing clockwise. This finding may provide a simple measurement that a veterinarian could make to assist a trainer in the selection of suitable races for individual racehorses.

Acknowledgements

Our thanks to Mr T. J. Hughes Snr and Jnr for the use of their horses. Thanks also to Brendan Kehoe, Gabriele Tacchio and the

staff at Mr Hughes' stable for their assistance in taking the measurements and to Racing Victoria for their support.

KW made the initial observation while measuring radiographs for another experiment. The experiments to test this observation were conceived and designed by HD and DS. HD, KW and many others collected the material for the experiments and KW took the measurements. DS performed the statistical analysis and KW wrote the paper, with input from HD and DS.

Manufacturers'addresses

[1]Showa, X-ray Co. Ltd, Tokyo, Japan.
[2]DLC Pty Ltd, Hoppers Crossing, Victoria, Australia.
[3]Konica Minolta Holdings Inc., Tokyo, Japan.
[4]Kodak, Sydney, New South Wales, Australia.
[5]SPSS Inc, Chicago, Illinois, USA.

References

Fretz, P.B., Cymbaluk, N.F. and Pharr, J.W. (1984) Quantitative analysis of long bone growth in the horse. *Am. J. vet. Res*. **45**, 1602-1609.

Kandel, E.R., Schwartz, J.H. and Jessell, T.M. (1991) Localisation of higher cognitive and affective functions. In: *Principles of Neural Science*, 3rd edn., Eds: Eds: I. Kutsermann and E. Irvine, Elsevier Science Publishing Co. Inc., New York. p 836.

Meij, H.S. and Meij, J.C.P. (1980) Functional asymmetry in the motor system of the horse. *S. Afr. J. Sci*. **76**, 552-556.

Plato, C.C., Wood, J.L. and Norris, A.H. (1980) Bilateral asymmetry in bone measurements of the hand and lateral hand dominance. *Am. J. Phys. Anthropol*. **52**, 27-31.

Shiratori, H., Sakuma, R., Watanabe, M., Hashiguchi, H., Mochida, K., Sakai, Y., Nishimo, J., Saijoh, Y., Whitman, M. and Hamada, H. (2001) *T*wo-step regulation of left-right asymmetric expression of Pitx2: initiation by nodal signaling and maintenance by Nkx2. *Mol. Cell* **7**, 137-159.

Walter, L.J. and Davies, H.M.S. (2001) Analysis of a radiographic technique for measurement of equine metacarpal bone shape. *Equine vet. J*. **33**, 141-144.