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The application of a radiographic index to the prevention of dorsal metacarpal disease in Thoroughbred racehorses

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Summary

This study was conducted to determine if a radiographic index of bone proportions could demonstrate the response of the equine third metacarpal bone (McIII) to fast exercise (>12m/s), in young racing Thoroughbreds. The index represents the ratio of the dorsal cortical width to palmar cortical width, multiplied by the ratio of cortex to medulla in the dorso-palmar plane. A total of 49 two year old Thoroughbred race horses were radiographed at two weekly intervals, throughout their first racing preparation. None of the horses developed shin soreness during fullpace exercise (16.7m/s) when their index measured 3.28 or greater. Horses that developed shin soreness had a significantly lower index (p=0.007) than horses that did not develop shin soreness during the same work period. This study demonstrated the usefulness of the index in illustrating the response of the McIII to fast exercise and it's potential in the prevention of shin soreness in a clinical race track environment.

Keywords: index, dorsal metacarpal disease, compressive strain, modelling

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Die Anwendung eines röntgenographischen Index in der Prävention der Erkrankung des dorsalen Metacarpus (Schienbeinerkrankung) bei Galopprennpferden

In dieser Studie wurde geprüft, ob ein röntgenographischer Index der Knochenproportionen die Reaktion des Metacarpus (McIII) junger Galopprennpferde auf schnelle Arbeit (> 12 m/s) widerspiegeln kann. Der Index basiert auf dem Verhältnis der Breite der dorsalen Kortikalis zur Breite der palmaren Kortikalis, multipliziert mit dem Verhältnis der Kortikalis zur Medulla in der dorso-palmaren Ebene. 49 zweijährige Galopprennpferde wurden während ihres ersten Renntrainings in zweiwöchigen Intervallen geröntgt. Keines der Pferde mit einem Index größer oder gleich 3,28 zeigte eine Schienbeinekrankung nach maximaler Arbeit (16,7 m/s). Die Pferde, bei denen Schienbeinerkrankungen auftraten, hatten einen signifikant niedrigeren Index (p=0,007) als die Tiere, die in der gleichen Trainingsperiode keine Schienbeinerkrankung zeigten. Diese Studie demonstriert die Brauchbarkeit des Index als Anzeige für die Reaktion des McIII auf schnelle Arbeit und seine mögliche Bedeutung für die Prävention von Schienbeinerkrankungen in einer klinischen Studie auf der Rennbahn.

Schlüsselwörter: Index, Schienbeinerkrankung, Kompressionsbelastung, Knochenumbau (Modelling)

Introduction

Dorsal metacarpal disease or shin soreness occurs in 70–80% of all two year old Thoroughbred racing horses, in Australia, during their first preparation for racing. This syndrome results in substantial financial loss. Although the horses aren't permanently damaged the recuperative period accounts for 12,000 lost training months, and millions of dollars lost income annually. (*Jeffcott* et al 1991, *Buckingham* and *Jeffcott* 1992)

The disease is manifest by considerable subcutaneous inflammation and periosteal response on the dorsal and dorsomedial aspect of the third metacarpal bone (McIII). This area is painful on digital palpation. On radiographic examination there is often periosteal response and cortical lucency. (*Stover* 1987, *Stover* 1992)

The disease occurs when young horses are exercised at speeds greater than 12m/s (*Davies* unpubl.). The under-developed McIII cannot resist the large compressive strain applied to the dorsal cortex resulting in cortical damage, microfractures and remodelling (*Nunamaker* and *Provost* 1991).

Previous work in this laboratory has shown that the width of the dorsal cortex of the McIII is significantly related to the amount of bone growth that occurs in this area in response to exercise. (*Davies* unpubl.)

The aims of this project were to determine if measurements, in the form of an index, taken from a lateral radiograph of the McIII, could be used to illustrate the bone response to training, and therefore predict the onset of shin soreness in the thoroughbred racehorse.

Materials and methods

Thoroughbred Racehorses

The thoroughbred horses in this study were all in their first race preparation, at three commercial stables at Flemington Racecourse, Victoria. Trainers A, B, and C.

All the horses were two years old. There were 20 fillies, 9 colts and 20 geldings. The racehorses were housed in stables throughout the study. Box size varied from 4m x 4m to 4m x 6m. The floor cover was either a deep bed of straw over a dirt floor or deep sand over a dirt floor. All horses were worked six or seven days a week, unless illness was recorded. The majority were hand-walked and given a grass pick daily in the afternoon.

The horses were fed ad lib lucerne, grass or oaten hay (depending on supply in drought conditions) and three feeds daily consisting of oaten and lucerne chaff, oats, barley, sunflower seeds, maize, molasses, and a salt and mineral supplement.

Summarised training program for Thoroughbred racehorses in this study:

Week 1:	1000m trot daily
Week 2 & 3:	1000m trot + 400 to 800m canter (11m/s) daily
Week 4 & 5:	1000m trot + 400 to 800m gallop (11–14.4m/s) 3 times weekly
Week 6 & 7:	1000m trot + 400 to 800m gallop (13.3–14.4 m/s) 3 times weekly
Week 8 & 9:	1000m trot + 600 to 800m gallop (14.4–15.4m/s) 3 times weekly
Week 9 &10:	1000m trot + 600 to 800m gallop (15.4–16.7m/s) 3 times weekly
Week 10&11:	RACING (1000 to 1200m)

Horses were not included in this study if they broke down, or required a period of time off during the study, for any other reason than shin soreness, e.g. joint pain, colic, respiratory infection.

Horses in their second preparation or those who had previously galloped were not included. Horses sold or those which changed trainers were lost from the data base.

Data from horses developing shin soreness during the study was not included after these horses returned to work.

All horses were galloped at Flemington racecourse, Victoria. Pre-training periods, (without galloping) were often conducted away from the racetrack at commercial pre-training farms around Victoria.

All horses were worked at speed at Flemington racecourse, and were galloped on a grass track in an anti-clockwise direction, under saddle. The track riders varied in sex, height, and weight, but all riders were less than 60 kg body weight.

Radiography

The study was conducted over nine months, from July 1994 to March 1995.

The horses in the study had right and left latero-medial McIII radiographs taken throughout the training preparation until the horse raced or developed clinical shin soreness.

Radiographs were obtained at the following intervals:

Pre-training:	whilst the horse was performing walk, trot, and canter work, of varying distances and intensity, without any gallop work. (X-rays were usually taken at the pre-training centres)
First Gallop:	once residing at the racing stables at the stage of the first gallop of speeds less than 13.3 m/s (even time) usually at 1/2 pace (12m/s)
Eventime (13.3 m/s):	at the completion of eventime work of varying distances but with speeds of not more than 15.4 m/s (three quarter pace)
Three Quarter Pace: (15.4 m/s)	at the completion of three quarter pace work of varying distances but with speeds of not more than 16.7m/s (full pace.)
Full Pace and Trialing:	once the thoroughbred was performing consistent full pace gallops (16.7m/s) of varying distances, and/or trialing.
Racing :	once the thoroughbred racehorse was racing.

Radiographs were usually obtained at fortnightly intervals. Full pace work and trialing radiographs were combined into one group as the majority of thoroughbreds followed in this study would trial within two weeks of first starting full pace work.

Training Record

Training records were kept for each horse by the trainer, stable foreman, or stable manager to document the speed and distance of any gallop work, and the trial and race outings.

Any lameness was recorded. The date of onset of shin soreness ascertained by pain on digital palpation of the dorsal surface of the McIII. The limb affected and severity of the clinical signs were documented by the trainer or attendant veterinarian.

Radiographic Index

The radiographic index is a proportional measurement of the cortex and medulla, not a direct measurement. It is measured from an accurate latero-medial radiograph of the equine metacarpus.

Latero-medial radiographs were obtained of the metacarpus (Fig 1). The carpo-metacarpal joint and metacarpo-phalangeal joints

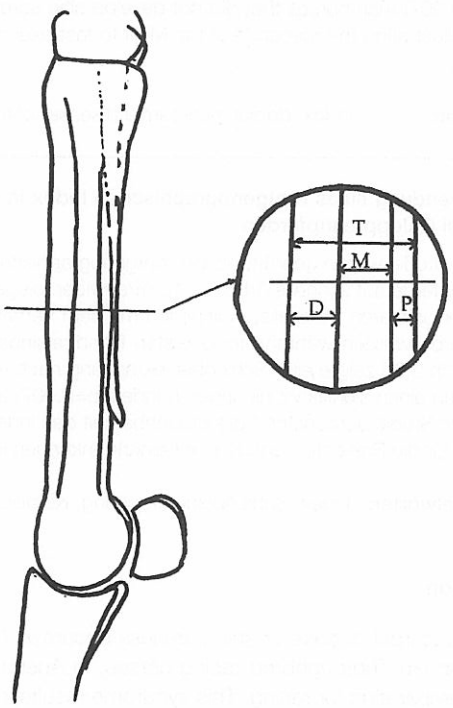

Fig. 1: Schematic line drawing of latero-medial radiograph depicting the measurements obtained at mid point

were points of reference and had to be visible on the radiograph. The X-ray beam was centred on the middle of the McIII with a focal distance of 1 metre. The radiographic plate had to be held at 90° to the McIII not orientated to the carpus, foot, or fetlock joint. Any deviation from a true latero-medial radiograph altered the cortical measurements considerably. 24 x 30 cm Kodak O-Matic extremity cassettes with Lanex fine screens and Agfa Curix Ortho H-T film were used. The x-ray machine was an Atomscope HF 80.

Both the right and left third metacarpus were radiographed.

Radiographic Measurements

The measurements were made directly from the x-ray film. The mid point of the McIII was obtained by measuring along the prin-

ciple longitudinal axis, from the carpo-metacarpal joint surface to the metacarpo-phalangeal joint surface where the McIII condyles articulate with the plateau of the proximal phalanx.
A line perpendicular to the longitudinal axis of the bone was drawn on the film at the mid point. All bone dimensions were measured from this perpendicular line.
Measurements were obtained using electronic callipers, measuring in millimetres, correct to two decimal places.

- T the periosteal surface of the dorsal cortex to the periosteal surface of the palmar cortex.
- M the endosteal surface of the dorsal cortex to the endosteal surface of the palmar cortex.
- D the periosteal surface to the endosteal surface of the dorsal cortex.
- P the endosteal surface to the periosteal surface of the palmar cortex.

$$T=(M+D+P)$$

Calculations

$$X = \frac{(T - M)}{M} \qquad Y = \frac{D}{P}$$

$$Index = X * Y$$

Statistics

Logistic regression (*Hosmer* and *Lemeshow,* 1989) was used to analyse the relationship between the probability of becoming shin sore during a stage of track work and the value of the index before or during the stage of track work, depending on the exercise level. The computer program BMDP (*Dixon,* 1988) was used for calculating the coefficients of the logistic regression.

Results

The index was repeatable. Variability was primarily related to poor x-ray technique and lack of patient compliance.
Horses that developed shin soreness, during full pace and trialing work had a significantly lower index in both limbs (p= 0.007) or in the left limb (p= 0.016) than horses that did not develop shin soreness during the same work period. (Tab. 1) The probability of shin soreness occurring with a particular index value is presented in Table 2.
None of the 49 horses in the study with an index over 3.3 or greater, at or during full pace and trialing work, developed shin soreness at that exercise level or during racing.

Tab 2: Probabilities of the occurrence of shin soreness with respect to various Indices calculated from the appropriate logistic regression equation.

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Both Limbs		Both Limbs	
Index D/ing FP/Trialing	Probability of shin soreness	Index before Full pace	Probability of shin soreness
1.4	0.76	1.4	0.9
1.6	0.7	1.6	0.86
1.8	0.64	1.8	0.81
2	0.56	2	0.74
2.2	0.49	2.2	0.65
2.4	0.41	2.4	0.55
2.6	0.34	2.6	0.45
2.8	0.27	2.8	0.35
3	0.22	3	0.27
3.2	0.17	3.2	0.2
3.3	0.15	3.3	0.17
3.4	0.13	3.4	0.14
3.6	0.1	3.6	0.1
3.8	0.07	3.8	0.06
4	0.06	4	0.05
4.2	0.04	4.2	0.03
4.4	0.03	4.4	0.02
4.6	0.02	4.6	0.01
4.8	0.02	4.8	0.01
5	0.01	5	0.01

Twenty two (22) horses developed shin soreness bilaterally, four (4) developed shin soreness predominantly or solely in the left forelimb, compared to four (4) which developed it predominantly or solely in the right forelimb.

Tab. 1: Descriptive statistics of Index values for shin sore and non shin sore limbs

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Variable	Shin Sore			Not Shin Sore			
Both Limbs	n	Mean	SD	n	Mean	SD	P value
During FP/Trialing	13	2.48	0.54	33	3.09	0.71	0.007
Before Full pace	13	2.60	0.59	37	2.81	0.76	0.36
Left Limb							
During FP/Trialing	8	2.46	0.61	15	3.20	0.66	0.016
Before Full pace	5	2.79	0.73	20	2.90	0.82	0.78

There appeared to be no increased occurrence of the development of shin soreness due to the different trainers in this study. There appeared to be no significant difference in the occurrence of shin soreness in relation to gender.

Discussion

Statistical analysis has demonstrated the usefulness of the index in the prediction of clinical shin soreness. None of 12 horses developed shin soreness at full pace and trialing work when the McIII index had modelled to a value of at least 3.28. There were several horses which raced successfully with indices of less than 3.3 i.e. 2.96, 3.01, 3.18. It is suggested that these horses modelled the McIII most efficiently to withstand the strains of full pace work. There may be little or no secondary bone formation. No attempt was made during the study to classify or identify the type or quality of the bone. The index calculation assumed the McIII of all horses in their first preparation was of uniform high quality.

The index value of 3.3 is only applicable to horses which have not been shin sore. It has been documented previously, and observed during this study, that horses that had previously developed shin soreness had dramatically enlarged dorsal cortices (*Stover* 1987, *Nunamaker* and *Provost* 1991). Indices of 6 or 7 have been measured in our laboratory. The formation of secondary osteonal bone effectively precludes the use of the index in these horses.

The lack of data at speeds less than 16.7 m/s in this study meant that the prescribed index for slower speeds could not be determined accurately. A general trend was observed and suggested a similar relationship between the ability to resist strains applied during a level of exercise and the McIII cross sectional area and dorsal cortical dimension. The suggested index values for the different exercise speeds are illustrated in table 3.

Tab 3: Approximate index values at specific exercise levels

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Level of Exercise	Prescribed Index
First gallop	~ 2.0
Eventime	~ 2.0
Three quarter pace	~ 2.2
Full pace /Trialing	3.3
Racing	3.3

At the end of the study period 41% (20/49) remained sound and raced. 59% (29/49) developed clinical shin soreness. The percentage developing shin soreness was lower than the 80% previously recorded for the Victorian racing environment (*Buckingham* and *Jeffcott* 1992) . Our percentage was artificially low as four horses developing shin soreness at eventime (13.3m/s) work or after 1/2 pace gallops (12m/s) were excluded from this study due to lack of data.

There was no significant difference in the occurrence of shin soreness due to gender. This supports the previous findings (*Moyer* et al 1991, *Stover* 1987).

This study did not address the effect of the track type. All horses were galloped on the grass track with a sand base at Flemington racetrack, Victoria. No horses were worked at speed on the wood fibre. No allowance has been made for the state of the track during the study.

Radiographs were obtained at fortnightly intervals. The assumption was made that the majority of the McIII response to a certain work load would be evident radiographically 2 weeks after the onset of that level of work.

Care was taken to measure only the cortical edge not any periosteal response. Horses which remodelled extensively had a radiolucent dorsal cortical periosteal edge. High quality radiographs of the correct exposure were obtained to enable all McIII dimensions to be measured correctly.

Many young thoroughbred race horses have rotational or angular deformity of some degree. It was important to obtain true latero-medial radiographs of the McIII, not be influenced by the angle of the carpus or pastern.

A focal length of one metre is described. Magnification of the McIII due to a closer focal length did not alter the value of the index or X or Y values significantly. Magnification did alter the exact measurement of the T, M, D and P measurements. Obliqued views altered the index values dramatically.

The study demonstrated the extremely dynamic nature of the immature equine McIII. These authors suggest that the degree of the bone's dynamic properties have not been previously documented in horses. The rapidity of response of the young skeleton should be addressed when exercise regimes and treatments are prescribed. Detraining reduces skeletal mass and strength (*Forwood* and *Burr* 1993). It follows that prolonged rest in the young shin sore thoroughbred would be detrimental to the quality and strength of the McIII.

This study demonstrated the usefulness of the index in illustrating the response of the McIII to fast exercise and it's potential in the prevention of shin soreness in a clinical race track environment.

References

Buckingham, S. H. W. and *Jeffcott L. B.* (1992): Shin soreness: A survey of thoroughbred trainers and racetrack veterinarians. The Equine Athlete 5 (5), 15–19

Davies, H. M. S: The response of the third metacarpal bone to exercise in racing Thoroughbreds. PhD Thesis unpublished.

Dixon, W. J. (1988): BMDP Statistical Software Manual, University of California Press, Berkeley, 941–969

Forwood, M. R. and *Burr, D. B.* (1993): Physical activity and bone mass: exercises in futility? Bone and Mineral. 21, 89–112

Hosmer, D. W. and *Lemeshow, S.* (1989) Applied Logistic Regression, John Wiley, New York.

Jeffcott, L. B., Mc Carthy, R. N., Buckingham, S. H. W. and *Davies, H. M. S.* (1991): Shin soreness in racehorses. The Aust. Equine Res. Found. Publication.

Moyer, W., Spencer, P. A. and *Kallish, M.* (1991): Relative incidence of dorsal metacarpal disease in young thoroughbred racehorses training on two different surfaces. Equine Vet J. 23 (3), 166–168

Nunamaker, D. M. and *Provost, M. T.* (1991): The bucked shin complex revisited In. *Blake-Caddel, L.* ed. Proceedings of the 37th annual conference American Association of Equine Practitioners. San Francisco, California. 37, 757–762

Stover, S. M. (1987): Dorsal metacarpal disease in thoroughbred horses: Development of the third metacarpal bone. PhD Thesis.

Stover, S. M. (1992): Dorsal metacarpal disease In. Bertone A ed. Current Therapy in Equine Medicine. *Robinson N. E.* ed. WB Saunders Company, Philadelphia. 143–146

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