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**THE EFFECT OF EXERCISE ON THE
COLLAGEN FIBRIL MORPHOLOGY OF THE
DIGITAL FLEXOR TENDONS OF THE
THOROUGHBRED**

**A thesis presented in partial fulfilment of the
requirement for the
Degree of Doctor of Philosophy
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Abstract

A series of studies was conducted to test the hypothesis that galloping exercise changes the morphology of collagen fibrils in the superficial digital flexor tendon of the equine forelimb. Tendons were examined from three groups of horses, namely wild horses, randomly sourced thoroughbred horses submitted for necropsy, and thoroughbreds from an experimental exercise trial. All tendons examined were from horses with no history of superficial digital flexor tendonitis, and all were macroscopically normal.

Three studies involved the measurement of collagen fibril bundle 'crimp' morphology. The crimp, a planar waveform followed by the fibrils, is believed to determine in part the mechanical behaviour of tendon. The first study involved measurement of crimp angle and period length in central and peripheral regions of tendons from wild ponies ranging in age from two to over ten years, which had obviously never undergone training. Horses of ten years of age or older showed a mean crimp angle in the central region which was lower than that in the periphery. It was concluded that the reduction in central region crimp angle with age in untrained horses is a normal fatigue effect. The second study involved measurement of crimp parameters in central and peripheral regions of tendons from horses of two years and over which had been submitted for necropsy to Massey University. These horses were separated into 'exercised' and 'non-exercised' groups based on whether their most recent function had involved competitive galloping exercise. Five of the eight exercised horses under ten years of age had a lower mean crimp angle and length in the central region than in the peripheral region. No un-exercised horses in this age group showed lower values for either parameter in the central region as opposed to the periphery. It was therefore concluded that rapid high-strain cycling of the tendon occurring during galloping exercise modifies normal age-related changes in the crimp morphology of the superficial digital flexor tendon core. For the third study, crimp angle and length were measured in tendons from five thoroughbreds (39 ± 1 months of age) which had undergone a specific 18 month exercise regime involving galloping on a high-

speed equine treadmill, and from six age- and sex-matched thoroughbreds which had undergone walking exercise only during that period. Central region crimp angle and length were significantly lower in the tendons of exercised horses compared to the controls. Four of the five exercised horses showed a significantly lower crimp angle in the central region than in the periphery, and three of these horses also showed a lower central crimp length. The peripheral angle was significantly greater in the exercised horses than in the controls. This was evidence that a specific and defined regime of high-strain cycling of the superficial digital flexor tendon modified age-related crimp morphology changes in the central region.

Two studies were undertaken to investigate the effect of the above defined exercise regime on collagen fibril diameter distributions in the superficial digital flexor tendons, and in the deep digital flexor tendons and suspensory ligaments from the same horses. Central region fibrils in superficial digital flexor tendons from exercised horses had a significantly lower mass-average diameter than those from the control horses, whereas peripheral region fibrils from the two groups did not differ significantly. In the second study collagen fibril mass-average diameters in both regions of the deep digital flexor tendon and the suspensory ligament were not found to differ significantly in exercised horses compared to controls. It was concluded that the exercise regime had caused breakdown of large diameter collagen fibrils in the core of the superficial digital flexor tendon. The fact that such a change did not occur in the suspensory ligament was suggested to be due to a difference in distribution of load between the suspensory ligament and superficial digital flexor tendon during galloping, or due to differences in distribution of such changes along the lengths of the two structures.

The final study involved an age-related analysis of crimp parameters, collagen fibril diameters and biochemical factors in thoroughbreds from foetuses to 3 years of age. It was suggested on the basis of the limited results, that collagen fibrils in the central region of the superficial digital flexor tendon become mature between one and two years of age.

It is proposed that the observed reductions in crimp morphology and collagen fibril mass-average diameter in the core of the superficial digital flexor tendon in response to galloping exercise represent microtrauma, as they would lead to weakness of the structure and predispose it to overloading and further damage. The mechanisms involved are suggested to involve slippage and/or separation of subfibrils, and a mechanism for the development of tendon core lesions is hypothesized. The use of the present information for the prevention of tendonitis is discussed.

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I would like to dedicate this thesis to my mother,
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