



**UNIVERSITI PUTRA MALAYSIA**

**ASSESSMENT OF DEGENERATIVE CHANGES IN SUPERFICIAL  
DIGITAL FLEXOR TENDON IN CLINICAL NORMAL HORSES**

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**By**

**SAMER K. TMUMEN**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,  
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## **DEDICATION**

To my parents, Father K. Tmumen, my Mother Allah Yarhamha and my family members who encouraged me to pursue a profession I would enjoy for a lifetime.

To my wife Laila, Nouri Eteriki and my son Mohamed Samer, Taha Samer, Nagham Samer and Gufhran Samer



Abstract of the thesis submitted to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Doctor of Philosophy

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**Chairman : Professor Rasedee Abdullah, PhD**

**Faculty : Veterinary Medicine**

The equine tendon is a highly specialized cord that ensures optimal transmission of movements from muscles to bones. The tendon is elastic, capable of easily resuming its original shape after being stretched and resistant to stretching under physiological condition. Flexor tendons show a high incidence of partial central core rupture preceded by degeneration. Thus, injuries of superficial digital flexor tendon (SDFT) are common in athletic horses.

Equine tendons were isolated from the forelimbs of 45 normal thoroughbreds consisting of 13 young, 22 middle and 10 old aged horses. The sex distribution was not taken into account. The horses were euthanised and forelimb tendon samples obtained. Gross examination showed tendon discolouration suggesting



presence of degeneration in the apparently normal tendon.

Tendon samples were obtained from the central core of the mid-metacarpal region of the forelimb SDFT. The fixed SDFT samples were processed and embedded in wax using a technique modified for the study and stained with haematoxylin and eosin (H&E) stain. All sections were examined under light, confocal laser microscopic and image analysis techniques.

When the degenerative changes in the horse forelimb SDFT were compared, the left SDFT showed more degenerative changes than the right. This reflects the local racing condition which is conducted in anti-clockwise manner. This study also showed that the degree of degenerative changes was higher ( $P < 0.05$ ) in old horses compared to young horse, but not higher than the middle aged horses.

Tendon thickness was compared using the ultrasonography and caliper methods. The mean values for the thickness of the forelimb SDFT obtained using the caliper method ( $23.3 \pm 1.7$  mm) were at least 25% greater than those obtained using the ultrasound method ( $17.2 \pm 2.1$  mm) suggesting an over-estimation of the caliper method. Measurements using the caliper are obviously less accurate because it measures the thickness of the tendon as well as the thickness the skin and the underlying tissues. The width of the SDFT measured by ultrasonography is by transverse scans only.

The rate of healing of SDFT was compared in thoroughbreds and ponies. The SDFTs of five thoroughbreds and five ponies were injured surgically. The healing of each SDFT was monitored for six months. After six months, SDFT in ponies showed a complete healing, whereas in the thoroughbreds, granulation tissue was still clearly evident. The results showed that SDFT of ponies healed faster than that of thoroughbreds.

The tendon and muscle samples of thoroughbreds and ponies were analysed for lactic acid (LA). The tendon of thoroughbreds has a higher resting LA concentration ( $3.04 \pm 0.42$  mmol/L) than the ponies ( $1.45 \pm 0.12$  mmol/L) and increased to ( $7.45 \pm 0.71$  mmol/L) and ( $3.42 \pm 0.89$  mmol/L) in thoroughbreds and ponies. Similarly, the muscle of thoroughbreds had a higher resting LA concentration ( $13.63 \pm 1.33$  mmol/L) than the ponies ( $1.82 \pm 0.09$  mmol/L) and increased to  $27 \pm 3.94$  mmol/L and  $18.91 \pm 5.35$  mmol/L in thoroughbreds and ponies respectively after exercise. The increase of activity in muscle is reflected in a similar increase in the LA content of SDFT suggesting that the accumulation of LA in the tendon was the result of increased muscle LA production from increased activity. The accumulation of LA may render the tendon prone to injury.

This study suggested that tendon degeneration showed a greater intensity in the left than the right SDFT. While thoroughbreds had a greater resting tendon and

muscle LA concentration than ponies. This may be related to the fact that thoroughbreds have a greater muscle mass and higher physical activity than ponies. Plasma creatine kinase (CK) and plasma aspartate aminotransferase (AST) concentrations in horses are not good indicators of the increase in muscle activity.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia  
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**PENILAIAN PERUBAHAN NYAHJANA PADA TENDON FLEKSOR DIGIT  
SUPERFISIAL KUDA NORMAL KLINIKALK**

Oleh

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Tendon ekuin merupakan suatu korda terkhusus yang memastikan pemindahan optimum pergerakan daripada otot kepada tulang. Tendon mestilah anjal, berupaya untuk kembali kepada bentuk asal dan selepas ditarik dan tahan ditarik di bawah keadaan fisiologi. Apa yang telah dicadangkan ialah tendon fleksor menunjukkan insidens tinggi untuk pecah separa pada teras pusatnya dan ini didahului dengan degenerasi. Oleh itu, kecederaan pada tendon fleksor digit superfisial (SDFT) biasa berlaku dalam kuda atletik. Lesi ini lebih kerap berlaku di kawasan metacarpus tengah pada kaki depan.

Tendon ekuin telah diperolehi daripada kaki depan 45 ekor kuda torugbred terdiri daripada 13 muda, 22 pertengahan umur, dan 10 kuda tua. Taburan jantannya tidak diambil kira. Kuda dikorbankan dan sample tendon kaki





depan diambil. Pemeriksaan kasar menunjukkan tendon bertukar warna menunjukkan wujudnya degenerasi dalam tendon yang nampaknya normal.

Sampel tendon diperolehi daripada teras pusat pada kawasan metakarpus tengah pada kaki depan SDFT. Sampel SDFT yang ditetapkan, diproses dan dibenamkan dalam lilin dengan mengguna teknik yang telah diubahsuai untuk kajian ini kemudian diwarnakan dengan pewarna hematoksilin dan eosin (H&E). Kesemua irisan telah diperiksa melalui mikroskop cahaya dan konfokal dan teknik analisis imej.

Apabila perubahan degenerasi pada SDFT kaki depan kuda dibandingkan, SDFT kiri menunjukkan lebih banyak perubahan degenerasi daripada kanan. Ini mencerminkan keadaan perlumbaan kuda tempatan di mana ianya dijalankan secara lawan arah jam. Kajian ini juga menunjukkan yang tahap perubahan degenerasi adalah lebih tinggi ( $P < 0.05$ ) pada kuda tua berbanding kuda muda, tetapi tidak lebih tinggi berbanding kuda separuh umur.

Sukatan ketebalan tendon telah dibandingkan dengan mengguna kaedah ultrasonografi dan kaliper. Nilai min untuk ketebalan SDFT kaki depan yang diperolehi melalui kaedah kaliper ( $23.3 \pm 1.7$  mm) adalah sekurang-kurangnya 25% lebih tinggi daripada yang diperolehi melalui kaedah ultrasonografi ( $17.2 \pm 2.1$  mm) menyaranakan yang kaedah kaliper membawa kepada terlebih anggara/berlebihan. Sukatan mengguna kaliper jelas kurang tepat berbanding

ultrasonografi sebab kaliper menyukat ketebalan tendon termasuk kulit dan tisu di bawahnya sekali. kelebaran SDFT seperti diukur menggunakan ultrasonografi hanyalan pada imbasan transverse sahaja.

Kadar penyembuhan SDFT telah dibandingkan dalam kuda torugbred dan padi. Dalam kajian ini, SDFT daripada lima ekor kuda torugbred dan lima ekor kuda padi dcederakan secara surgeri. Penyembuhan SDFT ini dimantau selama 6 bulan. Selepas 6 bulan SDFT kuda padi sembuh sepenuhnya, sambil dalam kuda torugbred tisu penggranulan masih lagi jelas. Hasil kajian ini menunjukkan yang SDFT kuda padi sembuh lebih cepat daripada kuda torugbred.

Sampel tendon dan otot kuda torugbred dan padi telah dianalisiskan untuk kandungan asid laktiknya. Otot kuda torugbred mempunyai kepekatan asid laktik rihaat ( $13.63 \pm 1.33$  mmol/L) yang lebih tinggi daripada kuda padi ( $1.82 \pm 0.09$  mmol/L) dan meningkat kepada  $27.06 \pm 3.94$  mmol/L dan  $18.91 \pm 5.35$  mmol/L masing-masing dalam kuda torugbred dan kuda padi selepas latihan. Peningkatan asid laktik dalam otot mencerminkan sebagai peningkatan pada masa sama kandungan asid laktik SDFT, menyarankan yang pengumpulan asid laktik dalam tendon merupakan hasil daripada peningkatan asid laktik otot kerana peningkatan aktiviti. Pengumpulan asid laktik mungkin menyebabkan tendon lebih mudah cedera.

Kajian ini meyarankan bahawa degenerasi tendon menunjukkan intensity yang lebih pada SDFT kiri daripada SDFT kanan. Kuda torugbred mempunyai kepekatan asid laktik riha yang lebih tinggi daripada kuda padi. Ini mungkin berhubungkait dengan hakikat bahawa kuda torugbred mempunyai kepadatan otot dan aktiviti fizikal yang lebih tinggi daripada kuda padi. Kepekatan creatine kinase (CK) dan aspartate aminotransferase (AST) bukanlah petunjuk yang baik untuk peningkatan aktiviti otot pada kuda.



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