

Evaluation of Tensile Strength of the Superficial Digital Flexor Tendon in Horses Subjected to Transcutaneous Electrical Neural Stimulation Therapeutic Regimen

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Abstracts: We would like to sincerely express our gratitude to the university of Tehran and faculty of veterinary medicine research council for approval and financial support for this extensive evaluation of tensile strength of the superficial digital flexor tendon in horses subjected to Transcutaneous Electrical Neural Stimulation (TENS) therapeutic regimen **Problems statement:** The purpose of this study was to determine the effect of TENS on the tensile strength of experimentally traumatized SDFT in horses. **Approach:** Eight adult castrated horses between 4-9 years-old and 310-395 Kg body-weight were considered. The left fore-limb superficial digital flexor tendon of each horse was splitted longitudinally in the middle portion in full thickness of 10 cm in length using B.P. blade (15 Times strike), then the connective tissue and skin were approximated using No 2 Nylon. Horses were divided into two groups of control and treated with 4 horses each. No treatment was given to control one, whereas treated group was subjected to the transcutaneous electrical neural stimulation (Newtens 900c) therapeutic regimens 10 min daily with intensity of 80 μ s, 100 Hz frequency for 14 days. After 60 days, the full length of SDFT (20 cm) was removed from the right normal countralateral and left traumatized tendon of control and treated limbs of all horses to be subjected to test of tensile strength using Zwick/Roell MDTL Machine with speed of 0.07 mM sec⁻¹ having Proportional Integral Deferential (PID) controller. In assessing the variation obtained data was analyzed using paired-t-test. **Results:** Data of the tensile strength was revealed an average 0.6625 KN for normal SDFT, 0.6375 KN for treated tendon and 0.6175 KN for control tendon. There was significant improvement in regaining tensile strength in treated tendons comparison to control ones in **Conclusion:** TENS significantly accelerated healing and remodeling of traumatized tendon to regain its tensile strength.

Key words: Tensile strength, SDFT, horse, splitting, TENS

INTRODUCTION

The superficial digital flexor tendon is one the strongest tendon in the horse body and possesses great tensile strength and low extensibility which serves primarily as a force transmitter and acts as a dynamic amplifier during rapid muscle contraction^[5]. The greatest risk of tendon rupture is when the tendon is obliquely loaded, the muscle is contracting maximally and tendon length is short^[6,16]. This usually occurs as results of pushing off with the foot against resistance and is very common in males in the fourth decade. As hence, the rupture of this tendon is very frequent and

begins to disrupt after 3% increase in length and will rupture when it is about 8%^[3,4]. The ideal tendinous repair must besides morphological reconstitute the injured tissue and preserve the sliding function of the tendon^[9], helping to maintain the movement capacity and regain the tensile strength^[3,7,8]. Despite of frequent application of TENS to subside the clinical inflammatory signs in human athletes and even companion animals referred cases, there is controversy about the actual positive effect of TENS in healing of tendinous tissue and increasing its tensile strength in human and animal cases^[5,14], that is why we investigated the ultimate strength to failure point and

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the pattern and effect of TENS on repair of severely traumatized tendon and its gained tensile strength too between two groups.

MATERIALS AND METHODS

Using 8 adult castrated horses having 310-395 Kg body weight with 4-9 years of age. The mid part of left fore-limb superficial digital flexor tendon was splitted longitudinally in full thickness of 10 cm in length using B.P. blade (15 Times strike) under deep surgical anesthesia .the connective tissue and skin were approximated using No 2 Nylon. Horses were divided into two groups of control and treated with 4 horses each. No treatment was given to control one (untreated tendon), whereas treated group was subjected to the transcutaneous electrical neural stimulation (New tens 900c) therapeutic regimens for 10 min daily with intensity of 80 μ s, 100 Hz frequency during 14 days.

On the 60 day after traumatizing tendons, the full length of SDFT (20 cm) was removed from the right countralateral normal tendon, the left control tendon and left treated one in all horses to be subjected to test of tensile strength using Zwick/Roell MDTL Machine with speed of 0.07 mm sec⁻¹ and Proportional Integral Deferential(PID) controller ,the both cut ends of each tendon were grasped and tightly secured with dentition compansment (Fig. 1 and 2). In assessing the variation of tensile strength collected data were analyzed using paired-t-test (p>0.02.).



Fig. 1: Fixation of both ends of tendon with clips of Tensile machine



Fig.2: Disruption of tendon

Post operative care: Extensive care of daily wound dressing till removal of sutures on 12th day was employed. Intramuscular injection of Vetacoid (dexamethasone 0.05 mg kgbw⁻¹, Aburaihan Co. Iran) Intravenous injection of Vetanyl %2 (Phenylbutazone 4.4 mg kgbw⁻¹ Aburaihan Co. Iran) Intramuscular injection of Vitamine AD3E 10 mL total body weight. Interchemie. Holland) and intramuscular injection of Penicillin G, Benzathine, Procaine and Potassium 2:1:1,500IU kgbw⁻¹. Nasr Fariman Co. Iran for 5 days was used.

RESULTS

The mean ultimate tensile strength was 0.6625 KN, 0.6375 KN and 0.6175 KN for normal, treated and control tendon, respectively (Fig. 3-5). This study revealed that, there is significant difference in ultimate strength between normal, treated and control tendon (Fig. 6 and 7).

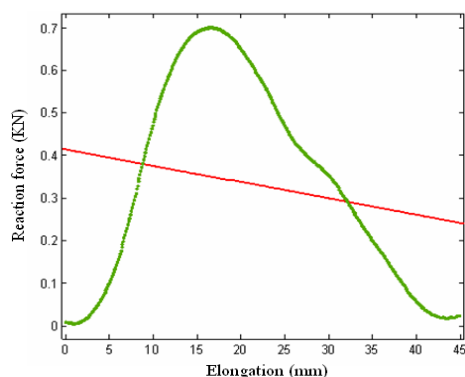


Fig. 3: Normal tendon (Lo = 20cm). (Note that green line is the curve that given with machine and red line is the average force given by Mat Lab software)

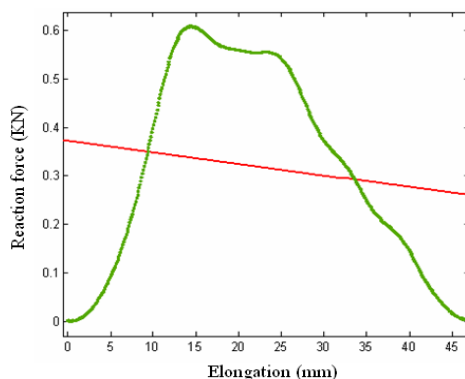


Fig. 4: Control tendon (Lo = 20 cm). (Note that green line is the curve that given with machine and red line is the average force given by Mat Lab software)

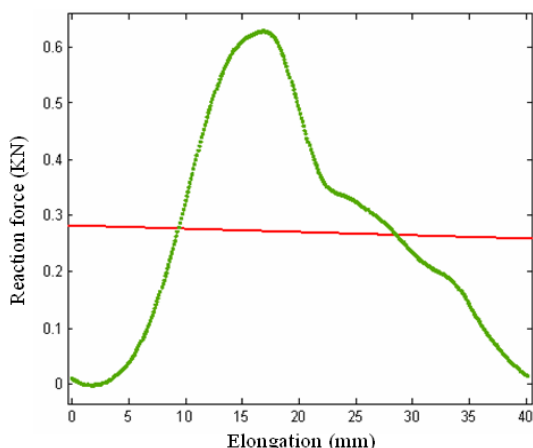


Fig. 5: Treated tendon (Lo = 20cm). (Note that green line is the curve that given with machine and red line is the average force given by Mat Lab software)

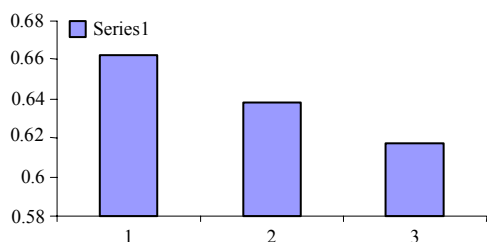


Fig. 6: Comparative (Means±SE (SE = 0.001KN)) of tensile strength in normal (1), treated (2) and control tendon (3) (force via KN)

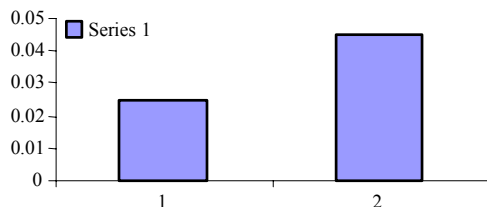


Fig. 7: Comparative differences (Means±SE (SE = 0.001KN)) of tensile strength in control (1) and treated (2) with that of normal tendons (force via KN)

DISCUSSION

The goals of rehabilitation following tendon reconstruction are to restore strength (muscle force-generating capacity) without subjecting the horse to excessive forces that may hinder healing or rupture the repair [18]. Tendons and ligaments must withstand high

tensile stress forces and therefore contain a high proportion of type I collagen molecules [4,6,15] which is responsible for the excellent tensile properties of tendons tissues. Large fibers predominate in normal tendon, but 3 distinct sizes (small, medium and large) have been identified [17]. Small fibers are weaker than large fibers, so tendons with increased proportions of small fibers, as found in the early stages of repair, are structurally inferior as healing progresses, fibril diameter increases and, along with increasing cross-links, are responsible for the acquisition of strength by healing tendon. The mechanical behavior of equine tendon has been investigated and data have been reported for strain, modulus of elasticity and estimates of *in vivo* loading [3,10-12]. The superficial digital flexor tendon which tensile strength is about 600-750 N⁻¹ mM (1.2) Loads of more than 12000 N rupture the equine superficial digital flexor tendon. Tensile strain at failure for this tendon varies from as low as 10-20% (3). The crimp pattern in the central core of the superficial digital flexor tendon of older horses differs from the pattern in the peripheral fibers [5,8] with loading, these fibers when subjected to increased strain, may be increase rupture of fiber so recent findings could explain the characteristic of the core lesion in tendonitis.

Injury to tendon results in damage to its cells and matrix, which incites an inflammatory response. The early fibrovascular tissue filling the tendon defect is a poorly organized mass of immature collagen that possesses little tensile strength [19,20]. In the remodeling phase of repair the immature collagenous structure is replaced with type I collagen fibrils contained within fiber bundles which were oriented longitudinally along the lines of tension. Tensile strength of the healing tendon increases by factor of 3 from week 8 to week 12 [13]. By 24 weeks after injury, repair tissue developed into a mature scar with longitudinally oriented tendon fiber bundles composed of primarily type I collagen fibrils. However, some immature collagenous tissue is retained, which is inferior to normal tissue and may be predisposing the area of the tendon scar to reinjury. According to our findings TENS showed to have positive effect on the reorganization of collagen fibers in treated tendons, in addition accelerating tensile strength compared to that of control tendons.

CONCLUSION

TENS beside being useful to reduce clinical signs of inflammation is quite effective in reorganization of the collagen bundles.

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