

***Original Article***

# Using Short Term of High Power Laser Therapy in Horse's Tendon Injuries

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## Abstract

High-power laser therapy has been used as a treatment to cure sports injuries; however, there are no controlled standardized studies on its efficacy. Moreover, high-power laser therapy has been applied for the sport horses field. This study aimed to investigate whether high-power laser therapy can cure tendon disorders and reduce the pain in tendon lesions in injured horses and also to examine the effect of laser therapy on injured horses. This retroactive experiential clinical research was performed on 50 racing horses between 5 and 15 years old. They were diagnosed with neither superficial digital flexor tendon nor deep digital flexor tendon injuries of the suspensory ligament on either hind or front limbs and were medicated with a high-power laser. The high-power laser was used with a maximum output power of 15000 MW and therapeutic effects were assessed using lameness graded and ultrasound the day after laser therapy (week 2) and 4 weeks later (week 6). Results showed that laser treatment was effective and uncomplicated in all injured horses. In addition, significant improvement was observed in ultrasound scores and lameness following high-power laser treatment. There was a progressive correlation between the improvement of lameness and the following parameters; returning tendon survival, normality of tendon tissue and functions in rest, trot, or competition after treatment. According to the results, laser treatment is a good way to eliminate the complications caused by tendon damage.

**Keywords:** Horse, Lameness, Laser therapy, Tendon Injuries

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## 1. Introduction

Tendon and ligaments injuries are normal in horses. The lack of suitable diagnostic and treatment strategies leads to significant reduction in the level of treatment effectiveness and may consequently, lead to career-ending (1, 2). Due to low tendon and ligament tissue turnover, healing was often difficult. The repairing operation with reconstruction patterns of a damaged tendon not only has several complexities, but also is a time-consuming operation that leads to interruption of activity and, in some cases, death (3).

Use of treatment pattern includes systemic or topical application of the following therapies: anti-inflammatory drugs, re-injection with glucocorticosteroids,  $\beta$ -aminopropionitrile fumarate, polysulfated glycosaminoglycans, platelet-rich-plasma plate (4, 5), autologous conditioned serum (6) or stem cells (7, 8), radial pressure wave therapy, tendon decomposition and shockwave medication (9).

Commonly, the response to treatment is variable, and researchers are constantly searching for updated perspectives on the treatment of horse tendon injuries.

Low power laser treatment (output power less than 500 mW) has been used for many years to treat tendon damage in humans and animals (10). The *in vivo* and *in vitro* experiments have indicated the biological effects of this treatment pattern, such as the following: increment in the fibroblast ontogenesis with collagen growing (11), improvement of collagen-fiber equalization (12), enhancement of the strength of tendon tension (13), improvement in angiogenesis and secondary circulation (14, 15), and reduction in the pro-inflammatory factors, like PGE-2, TNF- $\alpha$ , IL-1 $\beta$ , and IL-6 (16).

Studies on the clinical effects of treatment patterns are controversial (Morimoto et al. 2013). This suggests that there is less penetration of laser radiation in the treatment of deep tissues. (17). The high-power laser therapy was applied to cure different human orthopedic disorders, such as tendinopathies (18), whiplash injuries (19), and neck and back pain (20) (output > 500 mW). Recently, the supply of high-power laser tools for veterinary commercialization has increased, but research on its positive effects in treatment is limited.

This study aimed to perform a retrospective clinical trial. For this purpose, the results of treatment in clinical cases of tendon injury in 50 racehorses treated with high-power laser were evaluated. According to the findings of the present research, it was assumed that high-power laser treatment can be effective with less risk. Moreover, the results were consistent with those of other treatment patterns recorded.

## 2. Materials and Methods

### 2.1. Experimental Design

This retroactive experiential clinical research was performed on 50 racing horses between 5 and 15 years old. They were detected with neither superficial digital flexor tendon (SDFT) nor deep digital flexor tendon (DDFT) tendon injuries of the suspensory ligament (SL) on either hind or front limbs and were treated with a high-power laser. Diagnosis of these disorders was made based on visual lameness and ultrasonography of palm injuries. Ultrasonographical assessment and

lameness were repeated two times after the initial examination of admission, and the laser therapy was performed 1 week after admission.

The ultrasonographical assessment was performed on the first day after laser therapy (2<sup>nd</sup> week) and 4 weeks afterward (6<sup>th</sup> week). Moreover, various parameters were recorded, such as age, gender, sport disciplining, performance level, scoring of lameness, type of tendon injury or disorder, scoring of ultrasonography and lesion severity stage, recurrence of primary lesion on the first day, one or more orthopedic disorders, usage of medications over a period of time, the time needed for controlled racing, and time required for returning to the previous level of preparation. Due to changes in previous performance levels among injured horses, "return of competition" was not a suitable parameter in this research.

### 2.2. High Power Laser Treatment

The high-power laser instrument was used at a laser diode with a maximum output power of 15000 MW. Simultaneously, it irradiates laser illumine with four different wavelengths, including 615 nm, 650 nm, 800 nm, and 985 nm. This laser illumine is created by sensors that record the local temperature scale and micro resistance in the irradiated area. The output of the device is controlled by a feedback loop, which is controlled by an internal encrypted algorithm. This algorithm depends on a mathematical pattern and produces laser light emission approximations that penetrate different tissues and are directed to the sensor output (19).

The approximate amount of power provided in every 1 cm<sup>3</sup> of tissue treated is 250 J. Therapy was applied for two days when the horse was clinically diagnosed with either chronic, acute, or sub-acute tendon pathogenesis case recorded in the current research. In cases of additional treatment, laser treatment was started two days after the prescription of additional treatment (e.g., shock wave, surgery interference per- or intralesional injection). The horses were treated within two consistent weeks once every day for 20 min by a qualified technician accompanied by a procedure

prepared for a special anatomical construction by the manufacturing of the laser instrument. The horses were not anesthetized and therapy was administered over a clipping (size of blade 0.5 mm) region over the full length of the line of the injury. The skin was scrubbed and degreased with ethanol and the laser instrument hand piece was retained in the vertical position on the surface of the skin with a distance of 0.5cm with rapid movements. Laser therapy was performed directly on the lesion area.

In the current study, laser therapy was performed alone or in combination with other treatments, such as peri- or intralesional injections of autogenic conditioning plasma, platelet-rich plasma (PRP), hyaluronic acid, fat-derived stem cells, tiludronic acid, bionic cells, and shockwave medication or surgical interference (tendovaginoscopy of check ligament, splint bone fasciotomy) (Figure 1).

### 2.3. Type of Lameness, Grade, Phase, and Tendon Injury Severity

Lameness was scored based on the adaption of the American Association of Equine Practitioners scale scored from 0 to 5. Accordingly, the scores indicated no lameness (zero), tenuous lame in trotting only (one), moderate lameness in trotting only (two), slighter lameness in walking and severe lameness in trotting (three), moderate lameness in walking, and severe lameness in trotting (four), and severe lameness in walking or no weight carrying (five) (21). Lameness was scored on three time points (admittance, week 2, and week 6).

In cases of discrepancies in evaluation, the highest lameness score was maintained for statistical analysis.

The lesion phase was classified into chronic (>6 weeks), sub-acute (3-6 weeks), and acute (<3weeks) categories or depending on the case of history. Categorization of injuries was added by results of clinical investigations, such as (pain, heat, and swelling). Ultrasound results were estimated depending on the recorded pattern to make blind grading possible. Transversal and lengthwise clips were detected from

the lateral and medial sides of the lesion area on an upstanding, flexure limb. They were graded on a semi-numerical gradation (22) to classify the injury severity (severe, moderate, mild, and none). Scores of ultrasonography were applied autonomously on each case. In different states, the worst grade was maintained for statistical aims.

### 2.4. Analysis of Data

At first, the variables of "ultrasound scores" and "lameness scores" were evaluated on day 0 as well as weeks 2 and 6. For each variable result, a lengthwise cumulatively legit model was constructed using the package 'multgee' in the R project statistical software to investigate the correlation between outcome data of the different instances of the same horse. Categorization of substitutability structure was done based on the topic correlation model.

A model of examination time only (days 1 and 2, week 6) was suitable to estimate the time impact on the results. Odds ratios (ORs) were recorded with their appropriating 95% confidence interval (95% CI) for the GEE patterns, where an OR exceeds one for a predictor class of variable announces, such as horses with better and more appropriate ultrasonography or better degree of lameness prediction than other horses. The results of using the "Repolr" package were compared.

The two main variables were 'recurrence time of control training' and 'recurrence time to prior performance stage'. Both outcome data were investigated by application of a Kaplan-Meier evaluator and the log-log conversion for computation of 95% reliance ranges in the 'proclifetest' statement procedure in SAS 9.1. A multivariate Cox regression pattern was designed by application of the procedure of 'phreg'.

Hazard ratios, accompanied with their relevant 95% CI, were approximated for the survivability patterns, where hazard ratios exceeding one for predictor class of variables announced which horses returned to surveillance exercise or prior efficiency stage sooner than horses in the category of that variable class prognosticator. The remaining horses were examined

regarding the overall suitable pattern and the relative hazard suggestion.

The prognostic variables, which were elaborated for collaboration with variable results were 1. tendinopathy type, 2. the disorder level, 3. the day zero disorder is return, 4. usage of further medication, and 5. multiple causes presence for lameness. For every pattern, first, a univariable statistical analysis was devoted. Thereafter, prognostic variables with a p-value of < 0.20 were comminuted in a multivariable pattern. It should be mentioned that significances were adjusted at 5%. The GEE pattern ORs and risk ratios for the survivability patterns were approximated with their equivalent 95% CI. Recurrence injury ratio and rehabilitating periods were compared with those circumscribed in the study.

### 3. Results

#### 3.1. Description of Research Traits

Racing horses (n=50) within the age range of 5-

15 years old were allocated to the following groups: primarily aggressive in jumping (n=16 horses; 32%), dress (n=17; 34%), active in parading (n=5; 10%), relish horses (n=4; 8%), and other fields (riding, western racing, Iceland sports; n=4; 8%). Most of them (n=30; 60%) rival at an international (high) level, 11 (22%) at a median level, and 26 (17%) at an inferior level (less than Germany “L” grade).

The following tendinopathy disorders were detected: SDFT (n=18; 36%), SLB (n=17; 34%), SL (n=9; 18%), and DDFT (n=6; 12%). There were 21 (42%), 12 (24%), and 17 (34%) acute, sub-acute, and chronic cases, respectively. In 9 (18%) horses, the tendinopathy was recurrent (but they were not previously treated with laser therapy). In 22 (44%) cases, another orthopedic disorder, e.g., osteoarthritis, was diagnosed during treatment. Moreover, 19 (38%) horses were treated by laser in association with other therapy patterns (Figure 1).

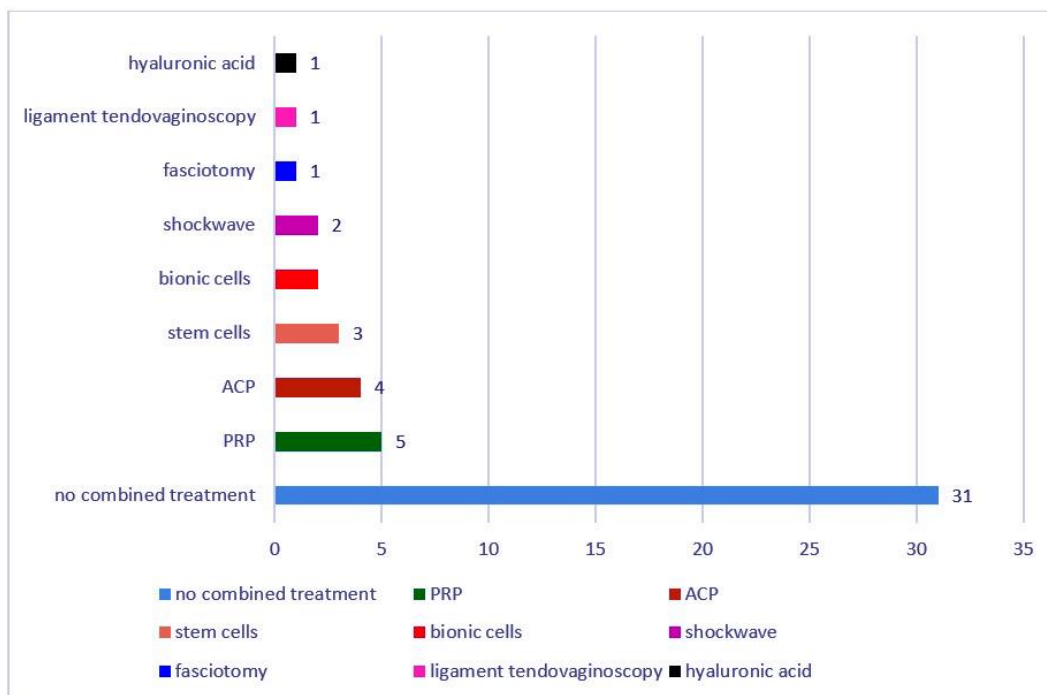


Figure 1. Diversity of tendinopathy treatment patterns ratios.

### 3.2. Data of Short-Term Therapy

Laser treatment was effective and uncomplicated in all injured horses. Data were collected and analyzed from all our experimental horses. A significant improvement was observed in ultrasound scores and lameness following high-power laser treatment (Figure 2 and 3). The results showed that there was a progressive correlation between the improvement of lameness and returning tendon survival. The recorded data showed a gradual reduction in severe and moderate abnormal cases at the end of the therapy after

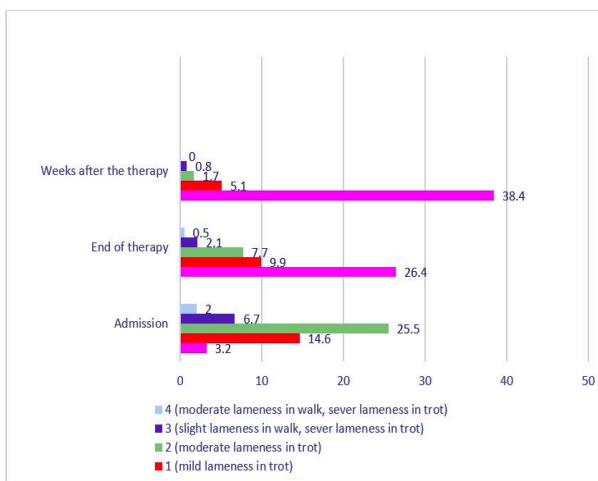


Figure 2. Classification of lameness levels at therapy stages.

### 4. Discussion

The use of high-power lasers in the treatment of horses with damaged tendons has been reported without skin burns, pain interference, or other adverse effects. Therefore, a high-power laser treatment application could be considered a reliable technique in equine therapy patterns. The treatment pattern, which was used in the current study, was associated with a significant improvement in ultrasonography grades and lameness within 2-6 weeks after starting treatment.

Horses with tendon lesions, such as DDFT, SL, and SLB had the highest degree of lameness, compared to other cases of tendon disorders, including SDFT, in clinical observations. The SDFT as tendinopathy is

more annoying than damage to other tendon or ligament tissues. (23). Despite the various degrees of lameness of horses at the beginning of the study, there was a statistically significant increase in ultrasound results and the degree of lameness on the day after laser treatment as well as weeks 2, 4, and 6 in all stages and types of tendon disorders.

This improvement was seen in two groups of horses diagnosed with only one disorder and horses with multiple causes of lameness. The absence of a control group interferes with the illustration of any causation impacts, but these findings can be represented as a suitable method, as the improving evident after a lot shorter period spacing than characterized in publication

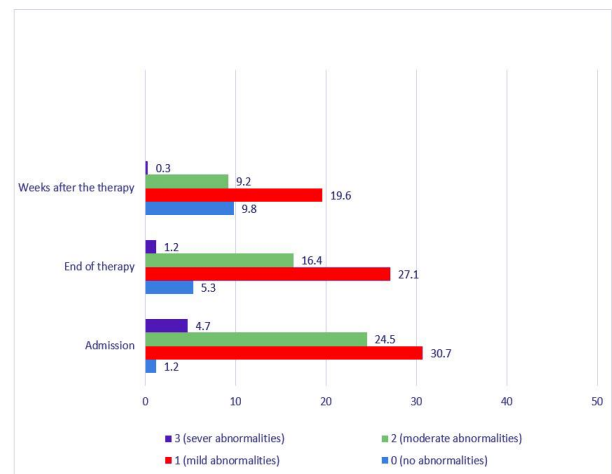


Figure 3. Classification of Tendon Health state levels at therapy stages.

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for other therapy patterns (24). Significant progress of ultrasonography was seen in five cases (clinically-induced SDFT injuries) (25) that had hand walking training for 12 weeks. Significant progress was also recorded in other studies at 8 weeks after PRP treatment (SDFT injury) (26).

Due to the need for retrospective research and analysis of clinical evidence in tendon injuries from similar environments, the tendon injuries treated with other methods were not evaluated. Previously published results were not valid due to high fluctuations in clinical treatment, diagnostic images, and different grading patterns (27). Additional therapy application did not seem salutary in the current research as horses receiving other therapy at terns plus laser treatment was more probable to have a worse lameness score at 6<sup>th</sup> week.

Another explanation is the inflammatory reaction that usually occurs after injection of autogenic conditioning plasma, fat-derived stem cells, PRP, hyaluronic acid, or bionic cells. In the current research, peri- or intra-lesion injections were executed two days before the initiation of laser treatment. This could consequently, expound the higher lame grades shown at week 2 (not significant) and week 6 (significant) due to pain caused by the reaction of inflammation following the injections.

In the group that received only laser treatment, the recorded data showed better results in stronger laminae resuscitation, compared to the group that received laser treatment combined with other methods. According to the present data, it is suggested that laser treatment alone is desirable in treatment. The middle period for horses to return to racing in the current experiment was 6 weeks while returning to previous efficiency level needed 6 six months.

The primary kind of tendon disorder, injury stage, presenting of various orthopedic causative agents, or using of further therapy did not have any significant effects on the return to previous efficiency levels (28). Theoretically, the biophysical features of laser illumination could probably expound on the current

study results. Results of both human and animal studies have indicated that high-power laser treatment has very important impacts on the tissue stage, like excitation of mitochondria with increment in adenosine triphosphate production, microcirculation activation, and analgesic with anti-inflammatory effects (29).

Previously recorded biophysical effects can be related to the same weak recurrence rate in the current research. The studied rabbits and rats have shown positive effects of high-power laser treatment on fiber equalization and stretching tension while tendon healing (30). Fiber equalizing plays an important role in stretching tension, hence their resistance to stress and the risk of re-injury is important.

The recurrent injury ratio in the current research was within very lower ranges than those recorded in another study on patterns of treatment for tendon injuries and disorders. Re-injury ratio of 39 horses (challenging in various methods), which suffered from SDFT in tendons, ranged from 40% to 45% two years after the starting of full training and racing after ultraconservative treatment patterns (exercise under control with or without medications with either polysulphated glycosaminoglycans or hyaluronic acid) (31).

In a study performed by Dyson (1) after the intralesional injection of  $\beta$ -aminopropionitrile, there was an improvement in recurrent injury ratio of approximately 18% (in a study on 65 horses). The PRP has been safely and efficiently used in both SDFT tendon lesions in horses (32). The ratio of re-injury following the stem cell treatment in SDFT tendon lesions was 27.4% in 113 racing horses 2 years after starting the training (9). Godwin, Young (7) showed that in 168 racing horses, 18% of the animals suffered from re-injury following the stem cell treatment in SDFT tendon lesions.

It should be noted that various kinds of tendon pathology levels, such as chronic, sub-acute, and acute tendonitis with various prognosis, etiology, and pathogenicity as well as additional treatment of horses with other medications that were recorded in research

must be considered in the diagnosis and admonishment needs. However, only a few racing horses received any further treatments in the current research (33.3%). If the horses have a history of recurrent tendon lesions at the start of laser treatment, it will take longer for them to return to normal. This was consistent with previous studies showing that horses with recurrent tendon disorders had the worst long-term prognosis (11).

Treatment with a high-power laser could be reliably used in racing horses. In the current research, a significant improvement was observed in ultrasound grades and lameness 6 weeks after the initiation of high-power laser treatment.

The proportion of recurrent injuries was much lower in the present research than in many previous studies with different treatment patterns. However, it must be acknowledged that the current research is the first retrospective clinical trial to demonstrate the therapeutic effects of laser with many limitations. However, results can be considered sufficient to rationalize prospective research protocols and manage experimental studies, which could provide evidence on the biophysical effects of high-power laser treatment in the injured ligament.

#### Authors' Contribution

Study concept and design: S. E. J.

Acquisition of data: A. A. H. A.

Analysis and interpretation of data: S. I. A.

Drafting of the manuscript: S. E. J.

Critical revision of the manuscript for important intellectual content: A. A. H. A.

Statistical analysis: S. I. A.

Administrative, technical, and material support: S. E. J.

#### Ethics

All the procedures were approved by the animal Ethics Committee at the Northern Technical University, Kirkuk, Iraq.

#### Conflict of Interest

The authors declare that they have no conflict of interest.

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