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 the sport injuries but controlled standardized studies on its efficacy are lacking. Also, high-power laser therapy has been applied in the sporthorses field. To investigate whether high power laser therapy can cure the tendon disorders and reduce the pain from tendon lesions in injured horses. The current study was designed to investigate the effect of laser therapy on injured horses. Retroactive experiential clinical research involving 50 racing horses between 5 and 15 years-old that 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, were medicated with high power laser. The high power laser used with a maximum output power of 15000 mw and therapeutic effects were assessed using lameness graded and ultrasound the day after laser therapy (second week) and four weeks afterwards (sixth week). Result showed that laser treatment was effective and uncomplicated in all injured horses. Significant improvement was observed in ultrasound scores and lameness following high-power laser treatment and there was a progressive correlation between the improvement of lameness and returning tendon survival and normality of tendon tissue and functions in rest, trot or competition after treatment has been evident. According to the results, laser treatment is a good way to eliminate the complications caused by tendon damage.

Keywords: Laser therapy, Tendon Injuries, lameness, Horse
1. Introduction

Tendon and ligaments injuries are ordinary in horses. The lack of suitable diagnostic and treatment strategies lead to a significant reduction in the level of treatment effectiveness and consequently it may end up to the point of career ending (Dyson, 2004; Gillis, 2016). Because of low tendon and ligament tissue turnover, healing was often difficult. The repairing operation with reconstruction patterns of damaged tendon not only has several complexity, but also it is a time consuming operation, which leads to interruption of activity and in some cases caused to death (Kaneps, 2016).

Use of treatment pattern includes systemic or topical application of the following therapies: anti-inflammatory drugs, re-injection with glucocorticosteroids, β-aminopropionitrile fumarate, polysulfated glycosaminoglycans, platelet-rich-plasma plate (PPP) (Waselau et al. 2008; Bosch et al. 2010), autologous conditioned serum (Arqüelles et al. 2008) or stem cells (Smith, 2008; Godwin et al., 2012), radial pressure wave therapy, tendon decomposition and shockwave medication (Crowe et al. 2004). Commonly, the response to treatment is variable, and researchers are constantly searching for updated perspectives on treating 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 (Demir et al. 2013). In vivo and in vitro experiments have reported the biological effects of this treatment pattern, such as the following: increment in the fibroblast ontogenesis with collagen growing (Guerra Fda et al. 2013), improvement of collagen-fiber equalization (Carrinho et al. 2006), betterment in strengthen of tendon tension (Marcos et al. 2014), improvement in angiogenesis and secondary circulation (Casalechi et al. 2013; Larata et al. 2012), and reduction in the pro inflammatory factors, like PGE-2, TNF-α, IL-1β and IL-6 (Marcos et al. 2012). Studies on clinical effect of treatment patterns are controversial (Morimoto et al. 2013). Which suggests that there is less penetration of laser radiation in the treatment of deep tissues. (Ryan and smith, 2007). The high power laser therapy was applied to cure different human orthopedic disorders such as tendinopathies (Mardh and Lund, 2016), whiplash injuries (Conforti and Fachinetti, 2013), neck and back pain and etc,. (Larkin et al, 2012). (output >500 milliwatt). Recently, the supply of high-power laser tools for veterinary commercialization has increased, but research into its positive effects in treatment is limited. With the aim of performing a retrospective clinical trial, the results of treatment in clinical cases of tendon injury in 50 racehorses treated with high power laser were evaluated. According to research, it is assumed that high-power laser treatment can be effective with less risk and the results are significant at least with the results of other treatment pattern recorded.
2. Materials and Methods

2.1. Experimental Design

Retroactive experiential clinical research involving 50 racing horses between 5 and 15 years-old that 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, were medicated with high power laser. Diagnosis of these disorders was made by observing visual lameness and then using ultrasonography of palm injuries. Ultrasonographical assessment and lameness were repetitive two times after the initial examination of admission, the laser therapy was performed for one week after admission. The ultrasonographical assessment was performed on the first day after laser therapy (2nd week) and four weeks afterwards (6th week). Also parameters such as: age, sex, sports 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, medications taken over a period of time, time needed to under controlled racing, time required to return to previous level of preparation were recorded. Due to changes in previous performance levels among injured horses, "return of competition" is not a suitable parameter in this research.

2.2. High power laser treatment

The high power laser instrument used at laser diode with a maximum output power of 15000mw. Simultaneously, it irradiates laser illumine with four different wavelengths: 615nm, 650nm, 800nm and 985nm, that was 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 that depends on a mathematical pattern and produces laser light emission approximations that penetrate different tissues and are directed to the sensor output (Conforti and Fachinetti, 2013). The approximate amount of power provided in each 1 cm³ of tissue treated is 250J. Therapy was applies two days when made a diagnosis to detected horse in the clinically with either chronic, acute or sub-acute tendon pathogenesis caserecorded in current research. In cases of additional treatment, laser treatment was started two days after prescription of additional treatment (like shockwave, surgery interferenceper-i-or intralesional injection). Treated horses within two consistent weeks one time every day within twenty minutes by a qualified technician accompanied with a procedure prepared for the special anatomical construction by manufacturing of the laser instrument. Horses did not anesthetized and therapy was administered over a clipping (size of blade 0.5 millimeter) region over the full length line of the injury. The skin is scrubbing and degreasing with ethanol and laser instrument hand piece was retained vertical upstanding on
the surface of skin at 0.5cm as distance 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 (ACP), platelet rich plasma (PRP), hyaluronic acid, fat derivate 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
Scoring of lameness was graded on an adaption AAEP scale (0-5): grade zero (no lame), grade one (tenuous lame in trotting only), grade two (moderatelameness in trotting only), grade three (slighterlameness in walking and severlameness in trotting), grade four (moderatelameness in walking, severelameness in trotting), and grade five (severelameness in walking or no weight carrying) (Stashak, 2002). Lameness was graded on every instance (admittance, week two and week six). In cases of discrepancies in valuation, the highest lameness score was maintained for statistical analysis.

Classifying of lesion phase includes: chronic (> six weeks), sub-acute (three-six weeks), acute (< three weeks), or depended on case of history. Categorizing of injuries were additional by clinical investigation 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 side of the lesion area on an upstanding, flexure limb and graded on a semi-numerical gradation (Ramzan et al., 2013) to classify the injury severity (severe, moderate, mild and none). Scores of ultrasonography was applied autonomously on each case. In differences state, 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 the zero day and the second and sixth weeks. For each variable results, a lengthwise cumulatively legit model was constructed using the package ‘multgee’ in the R project statistical software to investigate the correlation account between outcome data of the different instances to same horse. Categorizing of substitutability structure was presumed to the within topic correlation model. A model of examination time only (first day and the second, sixth weeks) was suitable to estimate the time impact on the results. Odds ratios (ORs) were recorded with their appropriating 95% confidence ranging (95% CI) for the GEE patterns, where an OR exceed one for a predictor class of variable announces such as horses with better and more appropriate
ultrasonography or had a better degree of lameness prediction than other horses. Comparison of the results of using the "Repolr" package was tested.

The two main variables were ‘recurrence time of control training’ and ‘recurrence time to prior performance stage’. Both out coming data were investigated by applying 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 applying the procedure of ‘phreg’. Hazard ratios (HRs) accompanied with their relevant 95% CI were approximated for the survivability patterns, where a HR exceed one for predictor class of variables announces which horses returned as soon as to surveillance exercise or priorefficiency stage in comparing with horses in the classified of that variable class prognosticator. The remaining horses were considered to examine the overall suitable pattern and the relative hazard suggestion.

The prognostic variables, which were elaborated for collaboration with variables result, were: (1) Tendinopathy type, (2) the disorder level, (3) the day zero disorder being return, (4) further medication using (5) multiple causes presence for lameness. For every pattern, first a univariable statistical analysis was devoted. Thereafter, prognostic variables with a p-value < 0.20 were comminated in a multivariable pattern. Significances was adjust at 5%. GEE pattern odds ratios and risk ratios for the survivability patterns were approximated with their equivalent 95% CI. Recurrence injury ratio and rehabilitating periods were in comparing with those circumscribed in the study.

3. Results

3.1. Description of Research Traits

Racing horses (n=50), between 5 and 15 years-old were allocated to the following groups: primarily aggressive in jumping (n=16 horses; 32%) or dress (n=17; 34%) the remaining horses are active in Parading (n=5; 10%) or 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%), DDFT (n=6; 12%). There were 21 (42%) acute, 12 (24%) sub-acute and 17 (34%) chronic cases. In 9 (18%) horses, the tendinopathy was recurrence (but they did not treat previously with laser therapy). In 22 (44%) cases, another orthopedic disorders diagnosed, e.g. osteoarthrosis, were also evaluated during treatment. In 19 (38%) horses treated by laser they treated in association with other therapy patterns (Figure 1).
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. 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 the gradual reduction in sever and moderate abnormal cases, which is depicted in figure 3 at the end of therapy after six weeks which were synchronized with decreasing in lameness conditions in walking and trotting of cured horses after treatment (Figure 2).

Figure 2 showed a significant reduction in lameness of injured horses from the beginning to the end of the treatment period after six weeks. These progresses in general tendon health had seen in correlation with increasing in abnormal cases in figure 3. According to the results, the coordination between the level of lameness and the normality of tendon tissue and functions after treatment has been evident.

Figure 1. Diversity of tendinopathy treatment patterns ratio

Figure 2. Classification of Lameness levels at Therapy Stages
Figure 3. Classification of Tendon Health state 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, high-power laser treatment application could be categorized as a reliable technique in equine therapy patterns. The treatment pattern, which used in 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 such as SDFT in clinical observations. SDFT as tendinopathy is more annoying than damage to other tendon or ligament tissues. (Schramme et al. 2010). Despite the wide fluctuations in the degree of lameness of horses at the beginning of the study, a statistically significant increase in ultrasound results and the degree of lameness on the day after laser treatment, the second and fourth week and finally the sixth week, 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. Absence of control group interferes illustration of any inferences about causation impacts, but these findings can be represented suitable method, as the improving evident after a lot shorter period spacing than characterized in publication for another therapy patterns (Stergioulas et al. 2008).

Significant progress of ultrasonography was seen in five cases (clinically induced SDFT injuries) (Xu and Morrell, 2008), that had hand walking training for twelve weeks. Significant progress was also recorded in other studies at eight weeks after PRP treatment (SDFT injury) (Geburek et al. 2016).

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 was not evaluated. Previous published result was not valid due to high fluctuations in clinical treatment, diagnostic images and different grading patterns (Wiegerinck et al. 2012). Additional therapy application did not seem salutary in the current research, as horses obtaining other therapy patterns plus laser treatment were more probably to have a worst lameness score at 6th week. Another explanation is the inflammatory reaction that usually occurs after injection of ACP, fat-derived stem cells, PRP, hyaluronic acid, or bionic cells. In current research, peri- or intraslesion injections were executed two days prior to the initiate of laser treatment and this could consequently expound the higher of lame grades showed at week two (not meaningful) and week six (meaningful) because of pain which caused by reaction of an inflammation following of injections. In the group that received only laser treatment, the recorded data showed better results in stronger lamine 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 payback to racing in the current
experiment was needed to six weeks while to returning to previous efficiency level need to six months. The primary kind of tendon disorder, injury stage, presenting of various orthopedic causative agents or using of further therapy had not any meaningful effect on the return to previous efficiency level. (Marneris and Dyson, 2014). Theoretically, the biophysical features of laser illumination could probably expound the current study results. In both of human and animal researches which reported that high power laser treatment has very important impacts at tissue stage like excitation of mitochondria with increment in ATP production, microcirculation activation and analgesic with anti-inflammatory effects (Pires et al. 2011). Previously recorded biophysical effects can be related to the same weak recurrence rate in current research. Rabbits and rats studies have positive effects of high power laser treatment on fiber equalization and stretching tension while tendon healing (Elwakil, 2007). Fiber equalizing play an important role in stretching tension, and so their resistance to stress and the risk of re-injury is important. The recurrent injury ratio in the current research are very lower ranges than of those recorded in another studies on patterns of treatment for tendon injuries and disorders. Re-injury ratio of 39 horses (challenging in various methods) suffered from SDFT in tendons ranged between 40 and 45% two years after the starting of full training and racing after ultraconservative treatment patterns (exercise under control without or with medications with either polysulphatedglycosaminoglycans or hyaluronic acid) (Tumilty et al. 2010). Following to intrallesional injection of β-aminoproprionitrile, Dyson et al. showed improvement in recurrent injury ratio of approximate 18% (in a research of 65 horses) (Dyson, 2004). PRP has been safely and efficiently used in both SDFT tendon lesions in horses (Castelijns et al. 2011). The ratio of re-injury following the stem cell treatment in SDFT tendon lesions was 27.4% in 113 racing horses two years following of the starting of training (Crowe et al, 2004) while Godwin et al. showed that in 168 racing horses 18% of the animals suffered from re-injury following the stem cell treatment in SDFT tendon lesions (Godwin et al, 2012). 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 and as well additionally treatment of horses with another medications were recorded in research must be considered in diagnosis and admonishment needs. Yet, alone a minor of racing horses obtained any further treatments in the currently 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 (Guerra Fda et al., 2013).

Treatment of high power laser could be reliably used in racing horses. In current research, a significant improvement of ultrasound grades and lameness initiating six weeks following to starting of high power laser treatment may recorded.
The proportion of recurrent injuries was much lower than in many previous studies of different treatment patterns. However, it must be acknowledged that current research is the first retrospective clinical trial to demonstrate the therapeutic effects of laser with many limitations. However, results can be considered supporting sufficient to rationalize prospective researches protocol and managed experimental researches, which could support in receiving more discernment to the biophysical effect of high power laser treatment in injured ligament.

References


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