Case Series

Treatment of 29 Cases of Acute and Chronic Equine Tendonitis with Local Laser Therapy and Laser Acupuncture

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ABSTRACT

In this case series, 29 horses ranging in age from 3 months to 26 years old were treated with local laser therapy and laser acupuncture for acute and chronic tendonitis of the superficial digital flexor tendon and suspensory ligament including rupture of the superficial digital flexor tendon in 2 cases. A 904 nanometer (nm) gallium arsenide laser with a 90-watt (W) peak pulse power was used. Laser stimulation was applied both locally over the affected tendon to improve collagen synthesis and aide tissue repair as well as acupoints that stimulated the immune system and decreased inflammation. Resolution of lameness and return to previous use was accomplished in 97% of the cases following treatment. Local laser therapy along with laser stimulated acupuncture points was the only therapy used on the tendons in this case series with no adjuvant therapies such as antibiotics or anti-inflammatory drugs. Continued athletic performance at recheck 1 to several years later of horses included in this case series had a success rate of 90%. This series of cases clearly demonstrates the combination of local laser therapy and laser acupuncture to be an effective healing method in patients with tendonitis and tendon rupture. The importance of choosing the optimal laser for this therapy is highlighted.

Key words: 904 nm pulsed laser, acupuncture, superficial flexor tendon, tendonitis, suspensory ligament, tendon rupture, equine

ABBREVIATIONS

LA	Laser Acupuncture
LLLT	Low Level Laser Therapy
TCM	Traditional Chinese Medicine
mW	Milliwatts
W	Watts
Ns	Nanoseconds
Nm	Nanometer
SDF	Superficial Digital Flexor Tendon
DDF	Deep Digital Flexor Tendon
SL	Suspensory Ligament

Acute and chronic tendonitis rank among one of the most significant problems in equine medicine, accounting for about 10% of lameness in horses.[1] The causes are mainly overwork, lack of proper warm-up or unadjusted work according to the training status of the horse.[2,3] Acute injuries may also occur through pasture and barn accidents resulting from a sudden overstretching of tendon sections with varying severity of fibril rupture.[4] Chronic tendonitis occurs through a temporal sequence of minor traumas progressing to scarring of the tendons.[3] Elasticity is reduced since the repair is carried out through disorderly deposition of fibrils with inappropriate collagen structure.[5] The result is that the remaining normal intact collagenous structures are exposed to ever greater stress resulting in further damage and eventual failure of the tendon unless the process is slowed or stopped.[4]

Known therapeutic options are injections of hyaluronic acid, shock wave therapy, carbon implantation, tendon splitting and treatment with stem cells.[5-10] The results of these treatments are assessed differently by different authors but none of these forms of therapy appears to be optimal as they often do not lead to complete tendon restitution.[3] It still appears that the most consistent rehabilitation of injured tendons and an essential part of therapy is through consistent stall rest over a prescribed length of time with daily hand walking on level firm ground.

With most standard treatment options providing limited return to normal function, local laser therapy or "Low Level Laser Therapy" (LLLT) is an increasingly viable therapy that shows great promise in the treatment of tendonitis. Laser light provides an environment which allows restructure of connective tissue with penetration of new fibers for optimum repair. This leads to more effective healing by underlying mechanisms which are being elucidated as research in this area continues.[10, 11] A 904 nanometer (nm) gallium arsenide laser with a 90-watt (W) peak pulse power was used as it provides high penetration depth in traumatized tissue without creating thermal injury. This type of laser is able to provide direct ATP, high peroxide clearance, restructuring of connective tissue and an increase of production of collagen fibers; all

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key ingredients to provide optimal healing in traumatized tendon tissue.[11-17]

The purpose of this retrospective case series was to evaluate the success rate of tendonitis cases treated over a 2 year period at the author's clinic with LLLT and laser acupuncture (LA). All cases were treated only with laser therapy with no adjunct treatments such as antibiotics or anti-inflammatory medications.

MATERIALS AND METHODS

Twenty-eight client-owned horses with acute or chronic tendonitis, including tendon rupture that presented to the author's veterinary clinic in Melle, Germany over a 2 ½ year period were selected for this case series (Tables 1, 2, 3). All animals presented to the clinic during the study period were included with no exclusions. Animals were classified as acute tendonitis (clinical signs for less than 2 weeks), subacute tendonitis (2-6 wks) and chronic tendonitis (greater than 6 wks). They were evaluated by tendon palpation and observation of movement which was graded on a scale of 1 to 5 with grade 1 horses demonstrating slight lameness only at a trot and grade 5 horses as non-weight bearing on the affected limb. One additional animal (case 28) with complete tendon rupture, which was presented prior to the study period, was included to evaluate LA and LLLT long term therapy success on severely damaged tendons (Table 3).

The Physiolaser Olympic 90 W/904 nm[a] and the Laser pen 40W/904nm[b] were used for LA and LLLT therapy in all cases. Typical treatment protocol for acute tendonitis consisted of 1 to 2 treatments per week for 4 to 6 weeks. Nogier frequencies B' and C' were used for topical LLLT of the tendon. The laser tip was applied directly to the skin surface for 1 min on the medial, palmar and lateral aspect of the tendon defect (6 joules total). Additional acupuncture points stimulated were SP-2, LIV-8, GB-34, and PC-6 (Table 4). Laser acupuncture treatment was also applied to correlating pressure-sensitive points along the spine to treat vertebral pain and local blockage. The Back *Shu* points associated with Liver (BL-18) and Kidney (BL-23), were bilaterally treated by Nogier frequency C' (30 sec, 0.3 joules each point). In addition, the sinew channel of Heart (HT), Pericardium (PC) and Lung (LU) were treated with the corresponding meridian frequencies according to Reininger (Table 5). Each sinew channel was activated by treatment of the *Ting* point, the Tonifying point and the specific Reunion point: PC-9, HT-9, LU-11/9, GB-23. Each point was treated for 30 sec (0.5 joules).

During therapy, stall rest was prescribed with daily 20 minute walks on hard flat ground. No adjuvant therapy was added. At the end of treatment (usually 4-6 weeks), the horse was started with progressive work: walk under

Table 1: Clinical Cases of Acute Tendonitis

Case	Breed	Sex	Age (Yrs)	Tendon Affected	TM No	TM Length (Wks)	Findings TM Start	Treatment Outcome	Long Term Follow-Up
1	Hanoverian	Mare	8	RF Susp	4	4	Grade 1 Lameness	Sound; Increasing Work	2 yrs Dressage; Sound
2	Hanoverian	Gelding	2	RLF SF	3	4	Grade 1 Lameness	Sound both legs; Start Work	Unable to Contact
3	Trakehner	Gelding	12	RF SF	5	3	Grade 1 Lameness	Sound; Increasing Work	2 yrs Dressage; Sound
4	Westphalian	Mare	4	RH Susp	4	4	Grade 3 Lameness	Sound; Increasing Work	2 yrs Dressage; Sound
5	Hanoverian	Gelding	9	LF SF	4	3	Not Lame; Swollen T, Pain on Palpation	Sound; Return to International Competition	2 yrs International Eventing; Sound
6	Westphalian	Gelding	13	RF SF	6	6	Grade 1 Lameness	Sound; Increasing Work	18 mos Dressage; Sound
7	Trakehner	Mare	13	RH Susp	15	3	Grade 2 Lameness	Sound; Start Work	18 mos Dressage; Sound
8	Lusitano	Stallion	12	LF SF	3	3	Not Lame; Swollen T, Pain on Palpation	Sound; Increasing Work	15 mos Dressage; Sound
9	Hanoverian	Gelding	17	LF SF	7	5	Grade 1 Lameness	Sound; Increasing Work	18 mos Dressage; Sound
10	Westphalian	Mare	7	LF SF	4	4	Grade 1 Lameness	Sound; Increasing Work	2 yrs Dressage; Sound
11	Lipizzaner	Stallion	6	LF SF	4	4	Grade 2 Lameness	Sound; Increasing Work	Sold 6 mons later; Passed Vet Exam
12	Trakehner	Mare	16	LF SF	5	5	Grade 3 Lameness	Sound; Returned to Competition	1 yr Jumping; Sound

Table 2: Clinical Cases of Chronic Tendonitis

Case	Breed	Sex	Age (Yrs)	Tendon Affected	TM No	TM Length (Wks)	Findings TM Start	Treatment Outcome	Long Term Follow-Up
13	Icelandic	Gelding	14	RLF Susp	6	3	Grade 3 Lameness	Sound; Increasing Work	1 yr Dressage; Sound
14	Dutch Warmblood	Gelding	21	LF Susp	24	4	3 years Tendonitis; Grade 5	No Improvement	Euthanasia
15	Westphalian	Gelding	26	RF SF	12	8	4 mos Tendonitis; Grade 3 Lameness	Sound; Start Increasing work	18 mos Dressage; Relapsed, Euthanasia
16	Westphalian	Gelding	19	RLF SF	16	6	1 year tendonitis; Grade 3 Lameness	Sound both legs; Start increasing work	2 months training; Relapsed, Euthanasia
17	Hanoverian	Gelding	7	LF SF	2	4	1 year tendonitis; Grade 1 Lameness	Sound; Start increasing work	1 yr working as Jumper
18	Hanoverian	Mare	18	RLF Susp	10	12	6 mos tendonitis; Grade 2 Lameness	Sound both legs; Start light work	15 mos Trail and Dressage
19	Welsh Pony	Gelding	18	RLF SF, DF	13	2	1 yr tendonitis; Grade 1 Lameness	Sound; Start light work	18 mos Dressage
20	Hanoverian	Mare	17	RF SF	3	5	1 yr Tendonitis; Grade 1 Lameness	Sound; Start light work	2 yrs Dressage
21	Hanoverian	Gelding	8	RF SF Susp	6	5	3 yr Tendonitis; Grade 1 Lameness	Sound, Start increasing work	3 yrs Dressage
22	Saxon Horse	Gelding	19	LF SF RLH Susp	11	6	3 yrs Tendonitis; Grade 1 Lameness	Sound all legs; Start light work	4 yrs Dressage
23	Oldenburg	Mare	15	RF DF	10	2	1 yr Tendonitis; Grade 2 Lameness	Sound; Start Hobby dressage	7 yrs Hobby Dressage
24	Andalusian	Gelding	13	LF Susp	9	8	1 yr Tendonitis; Grade 3 Lameness	Almost full recovery, recreational riding	1 yr Recreational Riding
25	Bavarian	Mare	6	LRH Susp	6	2	RH 1 yr Tendonitis; Grade 1 Lameness	Sound in both legs; Start increasing work	1 yr Hobby Dressage

Table 3: Subacute Tendonitis, Tendon Rupture, Congenital Tendon Contraction Cases

Case	Breed	Sex	Age (Yrs)	Tendon Affected	TM No.	TM Length (Wks)	Findings TM Start	Treatment Outcome	Long Term Follow-Up
26	Hanoverian	Mare	22	RH SF	4	4	Subacute Tendonitis; Painful sesamoids Grade 2 Lameness	Start work, pain almost resolved	Return to Dressage Competition
27	Hanoverian	Mare	17	LF	60	8	Acute Tendon Rupture, Grade 4 Lameness	Return to Riding; Walk and short trot sets	1 yr Trail Horse Hobby Dressage
28	Hanoverian Case occurred prior to study start	Mare	8	LF SF	5	5	Tendon Rupture; Sepsis following repair; 3 mos later presented to author, Grade 4 Lameness	Healed; 12 wks later return to training	11 yrs as Competition Jumper
29	Trakehner	Stallion	3 mos Foal	LF SF	5	6	Congenital Tendon Contracture; Club Foot, Grade 4 Lameness	Contraction Reduced; Start work with Grade 1 Lameness	2.5 yrs pasture Recent Started training; No complications

LF- Left Front, RF-Right Front, RH – Right Hind, LH – Left Hind, RLF-Right and Left Front, RLH-Right and Left Hind
T- Tendon
SF-Superficial Flexor, DF-Deep Flexor, Susp-Suspensory
Wks-weeks, Mos-months, Yrs-Years
TM-Treatment, No-Number

Table 4: Acupoints, their indications, treatment time and strength, wavelength and frequencies of the impulse laser used in this study

Acupoints	TCVM indication	PCLAC indication	Laser Strength (Watt)	Laser wavelength (nm)	Pulse Frequency (Hertz)	Treatment time (seconds)
PC-6	Opening point	Stellate ganglion point	90	904	Bahr 5, 9592	30
PC-9	*Ting* point PC	*Ting* point PC	90	904	Rf. PC 530	30
LU-11	*Ting* point LU	*Ting* point LU	90	904	Rf. LU824	30
LU-9	Tonifying point LU	Tonifying point LU	90	904	Rf. LU 824	30
HT-9	*Ting* point HT	*Ting* point HT	90	904	Rf. HT 497	
TH-5	*Luo* point TH and opening point	*Luo* point TH Thymus point	90	904	Rf. TH 732	30
BL-18	Back *Shu* point LIV	Back *Shu* point LIV	90	904	Nogier freq. C' 1168	30
BL-23	Back *Shu* point KID, Yang aspect KID	Back *Shu* point Sympathetic aspect KID	90	904	Nogier freq. C' 1168	30
SP-2	Tonifying point SP	Anabolic master point, Pancreas- Spleen point	90	904	Rf. SP 702	30
GB-23	Reunion point sinew channel	Reunion point sinew channel	90	904	Rf. GB 583	30
GB-34	Master point muscle and tendon	Tonifying point GB	90	904	Rf. GB 583	30
GB-41	Opening point	Prostaglandin E1 point	90	904	Bahr freq. 5, 9592	30
LIV-8	Tonifying point Liver	Liver point	90	904	Rf. LIV 442	30

Nm = nanometers, hertz = cycles per second; Rf.= Reininger (meridian) frequency

Table 5: Comparison, indications and attributes of the Nogier, Bahr and Reininger frequencies used for low-level impulse laser therapy

Nogier Frequencies								
Frequency	**A'**	**A"**	**B'**	**C'**	**D'**	**E'**	**F'**	**G'**
Hz	292	37,376	584	1,168	2,336	4,672	9,344	18,688
Indications	Wounds, inflammation, irritable foci in body and teeth		Tendonitis, arthritis, fractures, organ acupoints	Tendonitis, arthritis, fractures, all body acupoints except feet	Acupoints of the feet	Nerve and spinal cord diseases	Mandibular joint and subcortical brain disorders	Cerebral cortex and mental disorders

Bahr Frequencies							
Frequency	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Hz	599.5	1,199	2,398	4,796	9,592	19,184	38,368
Indications and Attributes	Deep tissue layer, "deep" points (source of illness)	Central tissue layer, hormonal and nervous system	Surface tissue structures, Omega *Ren* Channel	Omega *Du* Channel	Opening acupoints of the Eight Extraordinary Channels	Governing Vessel	Conception Vessel, abnormal foci in teeth

Reininger Frequencies (Meridian Frequencies)												
Channel	**LIV**	**ST**	**HT**	**PC**	**LI**	**GB**	**KID**	**BL**	**SP**	**TH**	**SI**	**LU**
Hz	442	471	497	530	553	583	611	667	702	732	791	834

*Used for treatment of acupoints on specific Channels and topical treatment of related organs; LIV=Liver, ST=Stomach, HT=Heart, PC=Pericardium, LI=Large Intestine, GB=Gallbladder, KID=Kidney, BL=Bladder, SP=Spleen, TH=Triple Heater, SI=Small Intestine, LU=Lung Channels

rider with short trot sections for 6 weeks to strengthen the tendon to its full capacity. In addition to this treatment, the chronic tendonitis cases had TH-5 and GB-41 treated with Bahr frequency 5 (Table 5) for 30 sec (1 joule) each.

The 2 cases with complete tendon rupture received daily laser treatment consisting of a 5 minute exposure of the total wound surface, particularly the tendon ends, to Nogier laser frequencies A" and B' (37376Hz and 584Hz). In addition, a laser cluster probe (5x30 Watt multicluster) was applied to the wound for 5 minutes with the tissue generating frequency B' and anti-inflammatory frequency A".

Acupoints were each treated for 30 seconds daily (Bahr frequency 5) to promote wound healing (SP-2), for tissue repair (TH-5) and control of inflammation and pain (GB-41). The wound was flushed daily (5g ethacridine lactate and 10ml each of Arnica, Echinacea and Calendula tincture, diluted in 1 liter of fluid) and kept bandaged. With the exception of a tetanus vaccination, no additional medications were used (including antibiotics or anti-inflammatory drugs).This same therapy was performed daily for 8 weeks at the clinic. Once the external wound was closed, the horse was sent home with further treatment to be continued by the owner in the same manner. An identical laser device was dispensed to the owner with instructions to continue treatment for 6 more weeks at home. After this period, the tendon was healed and the horse slowly returned to work similar to the chronic tendonitis cases.

Treatment success was considered either return to soundness and former activity level at 6 month recheck after treatment or a decrease of 4 grade levels if the horse was a grade 5 level lameness at study start. Relapse at long term follow-up (1-2 years) was considered a treatment failure. Some horses were placed on maintenance treatment which included intermittent laser treatment (every 2-3 months) after return to work. This was not placed in the treatment failure category as long as the horse maintained the same level of competitive performance enjoyed prior to the their tendon injury.

RESULTS

Among patients with acute tendonitis (n = 12), the superficial digital flexor tendon (SDF) was the most frequently affected (n = 9), followed by the suspensory ligament (SL) (n = 3); with the front legs affected in 10 of the 12 horses (Table 1). All horses remained healty with no adverse side effects from laser therapy. Within 4-15 treatments (average 5.3), along with a further 3 weeks of convalescence, all horses returned to work at their previous levels after a relatively short treatment period of 3-6 weeks (average 4.0 wks). There were no recurrences during the observation period of 3-30 months.

LA and LLLT therapy for chronic tendonitis (n = 13) of the SDF (n = 4), SL (n = 6), deep digital flexor tendon (DDF) (n = 1), SL and SDF (n = 1), SDF and DDF (n = 1) had successful treatment outcomes in 12 of the 13 cases with number of treatments ranging from 2-24 (average 9.8 weeks) and length of treatment ranging from 2 to 12 weeks (average 5.2). Relapses occurred after successful treatment in 2 cases and no improvement with treatment occurred in 1 case with all 3 of these cases resulting in euthanasia (Table 2). One patient suffered a relapse when the horse broke away from his handler and galloped in a deep, sandy bottom. The other patient suffered a relapse after 18 months of training and competitive sport. All other chronic tendonitis patients were able to perform the same level of work as before the injury without relapse. In addition, owners recorded these horses did not suffer from any other diseases during the study or follow-up period.

Additional cases evaluated during the study period included a tendon rupture, subacute tendonitis, and congenital tendon contraction of a 3 month old foal. All 3 of these cases met the criteria for treatment success. The additional case of tendon rupture which was presented prior to study start (case 28) also met case success criteria and at the time of the study had been successfully competing in jumper competitions for 11 years.

CLINICAL CASE EXAMPLES

Case 1: Acute tendonitis

An 8 year old Hanoverian mare (case 1) was presented with acute grade 1 lameness apparent at the trot in the right front limb. The suspensory ligament and the superficial flexor tendon had an abnormally shaped, doughy swelling of the tendons which were very painful on palpation. The treatment protocol was performed once per week for a total of 4 treatments. Topical LLLT of the tendon was performed with Nogier frequencies B' and A" for 1 min on the medial, palmar and lateral aspect of the tendon defect (6 joules). The tip of the laser was put directly on the skin surface. Additional acupuncture points stimulated were SP-2, LIV-8, GB-34 and PC-6. Laser acupuncture treatment was performed on correlating vertebral lesions and blockages which were identified as pressure-sensitive points along the spine. Back *Shu* Association points for Liver and Kidney (BL-18, BL-23) were bilaterally treated by Nogier frequency C' (30 sec, 0.3 joules each point). In addition, the sinew channel of HT, PC and LU were treated with the corresponding meridian frequencies according to Reininger. Each sinew channel was activated by treatment of the *Ting* point, the Tonifying point and the specific Reunion point: PC-9, HT-9, LU-11/9, GB-23. Each point was treated for 30 sec (0.5 joules). When the horse was presented for the 2nd treatment, it was lame free in trot and the swelling was reduced to half. During therapy, stall rest was prescribed with daily 20 minute walks on hard flat ground. No adjuvant therapy was added. After 4 weeks, at the end of treatment, the horse started with progressive work: walk under rider with short trot sections for a further period of 6 weeks to strengthen the tendon to its full capacity. The horse was sold to a dressage rider and passed a veterinary soundness exam as part of the purchase process. The horse performs now as a successful dressage competition horse without any complications.

Case 2: Chronic tendonitis

A 14 year old Icelandic gelding (case 13) was presented with acute exacerbation of a longstanding chronic severe tendonitis of the suspensory ligament in both front legs. The horse was evaluated as having a grade 3 lameness with an irregular large swelling (4cm diameter by 12 cm length) of the entire flexor tendon and sesamoids. It had been previously treated in a veterinary

hospital over a period of one year. Ultrasonography report from this clinic demonstrated complete loss of normal tendon structure in the area of the suspensory ligament and around the sesamoids. The treatment protocol was performed twice a week for 3 weeks at the clinic. After these treatments, there was a period of 5 weeks of daily treatment in the same manner which was carried out at home by the owner. Once daily therapy was completed by the owner, another 3 treatments at the clinic were added.

For topical LLLT of the tendon, the Nogier frequencies B' and A" were applied for 1 min locally on the medial, palmar and lateral aspect of the large tendon swelling. To cover the whole area, 10 spots were used (corresponding to 20 joules total). The tip of the laser was directly on the skin surface. Stimulation of acupuncture points SP-2, LIV-8, GB-34 and PC-6 were included. Laser acupuncture treatment of correlating vertebral lesions and blockages, which were found as very clearly pressure-sensitive points along the spine was performed. In addition, the Back *Shu* points of the Liver (BL-18), and Kidneys (BL-23) were bilaterally treated by Nogier frequency C' (30 sec, 0.3 joules each point). The sinew channel of HT, PC and LU were treated with the corresponding meridian frequencies according to Reininger. Each sinew channel is activated by treatment of the *Ting* point, the Tonifying point and the specific Reunion point: PC-9, HT-9, LU-11/9, and GB-23. Each point was treated for 30 sec (0.5 joules). In addition to this treatment, which is identical to the acute cases, TH-5 and GB-41 are added (prostaglandin E1 point in Pulse Controlled Laser Acupuncture Concept and master point of degenerative disease, respectively).[12, 19] Both are treated with Bahr frequency 5 for 30 sec (1 joule) each.

While treatment was continued at home, the horse gained access to a pasture with deep, sandy ground and suffered a relapse. Nevertheless, at the end of treatment, the horse was lame free, the swelling had been remodeled and the horse had started into progressive work. Ultrasonography perfomed again at the initial clinic to evaluate the horse now showed that after a total treatment time of 8 weeks, the tendon had undergone significant remodeling. This level of tendon remodeling on ultrasound is usually only observed after one year of stem cell therapy. The horse is now working as a hobby dressage and trail horse without any complications for a year.

Case 3: Tendon Rupture

A 17-year-old Hanoverian mare (case 27) sustained a complete rupture of the superficial digital flexor tendon during a pasture accident. Palpation of the open wound identified the ends of the tendon separated by a distance of 6 cm (Figure 1). The age of the wound and contamination precluded surgery; therefore, treatment with laser acupuncture was recommended due to its local control of bacterial growth, anti-inflammatory and wound healing properties. Daily treatment consisted of 5 minute exposure of the total wound surface, particularly the tendon ends, to a strong impulse laser. Nogier laser frequencies A" and B' (37376Hz and 584Hz) were applied which corresponds to applied laser energy of 80 joules. In addition, a laser cluster probe was applied to the wound for 5 minutes with the tissue generating frequency B' and anti-inflammatory frequency A" (Figure 2). Acupoints were each treated for 30 seconds daily to promote wound healing (SP-2, TH-5, GB-41) at Bahr frequency 5. The wound was flushed daily with 5g ethacridine lactate and 10ml each of Arnica, Echinacea and Calendula tincture,

Figure 1: Case 27: A 17 year old Hanoverian mare that presented with complete transection of the superficial digital flexor tendon and sepsis.

Figure 2: Case 27: Treatment of abundant granulation tissue complicating the ruptured tendon wound with cluster probe laser (5 x 30 Watt).

diluted up to 1 liter and kept bandaged. With the exception of a tetanus vaccination, no additional medications were used (including antibiotics or anti-inflammatory drugs). This same therapy was performed daily for 8 weeks at the clinic. At this point, the external wound was closed and the mare was sent home with further treatment to be continued by the owner in the same manner. An identical laser device was dispensed to the owner with instructions to continue treatment for 6 more weeks at home. After this period, the tendon was healed and had returned to former strength (Figure 3). The mare started work at a walk with slowly increasing trot segments and after another 6 weeks entered a full training program again. The horse's progress was followed over a 3 year period. She remained sound and was ridden as a dressage horse (moderate level competition).

DISCUSSION

During both acute and chronic tendonitis of the superficial digital flexor and suspensory ligament, repair occurs by replacement of normal elastic fibers by inelastic connective tissue. This firm connective tissue which is vulnerable to continued injury resists penetration by normal fibers which could restore the original state of elasticity.[5] Local laser therapy or Low Level Laser Therapy (LLLT) plays a very important therapeutic role in the treatment of tendonitis by providing an environment that encourages normal tendon restructure and aides remodeling of inelastic connective tissue. This leads to effective healing of tendons with return to normal function.[10,12]

In-depth studies of infared lasers have demonstrated approximately 70% of laser energy is reflected at the skin surface and 15-20% of the incoming energy is scattered and lost diffusely in the body tissue.[13] Only 5-10% of the laser energy is absorbed. The absorption takes place via a so-called "antenna pigment" (flavoprotein-metal-redox system) which is an important part of the respiratory chain in the mitochondria. The absorbed laser photons (similar to photosynthesis in plants) are directly converted into cellular energy and lead to a direct increase of ATP concentration in the irradiated tissue.[14-16] This energy can be used directly to deal with repair processes, restructuring of pathological tissue and the synthesis of collagen fibers. Similarly, an energy boost in the nerve cells of acupuncture points leads to hyperpolarization of this area and thus stimulation of acupoints at the same strength as needle stimulation. Several studies confirm a dose-response relationship for this absorption where a minimum dose is necessary for an effect but above this threshold, no further effect is achieved. [15]

Figure 3: Case 27: Completely regenerated tendon at the end of 14 weeks of therapy. The horse returned to work without complications.

The type of laser used for LA and LLLT therapy of tendons is critical to obtain optimal results. Superficial structures, such as an acupuncture point, can be stimulated with a laser providing 90 W peak pulse power (pulse laser) at an exposure time of 20-40 sec which corresponds to an applied energy of 0.3 to 1 joule. For deeper structures, as in the treatment of tendonitis, the duration of treatment must be increased to approximately 2-3 min per point. Of particular note are tendon lesions which require a laser type that can provide a sufficient number of laser photons in an acceptable treatment time to the depth of the damaged tissue and an applied energy between 1-10 joules depending on the pulse frequency per treatment area.[11]

In addition to photon absorption, an additional consideration is resonance frequencies. In continuous-wave laser, the specific resonanance frequency is modulated onto the continuous laser beam. In pulse laser, the resonance frequency is achieved by the pulse frequency of the light pulses. There are three major series of resonance frequencies: Nogier, Bahr, Reininger (Table 5).[18-20] The Nogier frequencies relate primarily to certain tissue conditions. The Bahr frequencies relate more to nervous system conditions (sympathetic/parasympathetic). Reininger frequencies relate to the specific resonance frequency for each of the 12 meridians, with which one can intensely stimulate the corresponding meridian points

Generally there are two types of lasers on the market which are considered for use. The first is a continuous wave laser (laser class 3b and laser class 4) that emit uninterrupted laser light. The power of these devices is between 30 and 500 milliwatts (mW) for class 3b and 500mW up to 8 W for class 4 laser. The second type of laser (laser class 3b) is the pulsed laser which emits light pulses of very high intensity with a peak power of 90 W, but only with a very short duration of 200 nanoseconds (ns). These lasers are suitable for tendon therapy equipment, since they apply a sufficient amount of photons at a depth needed for repair of tendon tissue. The 904nm impulse laser has a clear advantage when compared with continuous wave laser (class 3b – up to 500mW and class 4 – from 500mW up to 3-8W). In the continuous wave laser,

energy is absorbed for the most part on the skin surface. In the case of class 4 lasers, they can cause burns of the skin due to the energy density without reaching deeper tissue layers to a sufficient extent. The laser type selected for use on the clinical cases in this series was a 90 W gallium arsenide class 3b impulse laser with a wavelength of 904 nanometers (nm) and 200 ns pulse duration with pulse frequencies preprogrammed according to Nogier, Bahr and Reininger. This equipment provided high penetration depth in the traumatized tissue without creating thermal injury, even at high pulse frequencies (up to 40,000 Hz) in clinical cases.

In the author's experience, acute tendonitis is easily treatable with LLLT and laser acupuncture as evidenced by the cases in this series. There was 100% recovery with an average of 5 treatments and 4 weeks treatment length. In acute cases, only the ruptured tissue needs repair which occurs as new collagen fibers are synthesized. Chronic tendonitis requires significantly more therapeutic effort. In addition to repair of acute damage, there is also marked tendon fibrosis where loosening of the dense scar tissue must take place to allow regrowth of more normal collagen fibers. Laser therapy encourages this process but it is more difficult and takes a longer period. The number of treatments for chronic tendonitis patients in this case series doubled from an average of 5 for acute cases to 10 for chronic cases. In addition, the longest period of time required for an acute case was 6 weeks, whereas the longest treatment length was 12 weeks for chronic cases. The 3 case failures occurred in this category either as no improvement (1 case) or relapse (2 cases). It is interesting to note that success was achieved both short and long term in the 2 tendon rupture cases where fiber growth was successfully stimulated, promoting return to a tendon able to withstand normal use again.

No adjuvant therapy was used in any of the cases. Therapy was similar in both acute and chronic cases with length of treatment varying between the two. Horses have to be stabled and daily moderate movement in hand or under saddle is essential for the rehabilitation of the patient. Chronic scarred tendons were treated more aggressively with daily laser treatment recommended. After 2- 3 weeks, a switch to weekly therapy was instituted until a healthy texture of tendon was detected by palpation and ultrasonography. Following treatment, horses were walked under rider with short trot sections and tendon response was monitored by palpation and ultrasound. Additional training for a period of 4-6 weeks allowed the tendon to reach its full capacity.

The results of this study as well as the author's empirical experience with over 100 practical cases of acute and chronic tendonitis from 2005 to 2013 is that suitable pulse lasers are capable of limiting sepsis, and providing anti-inflammatory effects along with high quality regeneration of tendon fibers, even in massively traumatized tendon tissue. The local effect of the laser is essentially supplemented by a regulating and supportive effect on the immune system by acupuncture. It would be very desirable, especially in the interests of the affected patients and their owners and the long term satifactory

Figure 4: Case 28: An 8 yr old Hanoverian mare who presented with a septic wound 3 months after failed tendon repair after complete rupture. This picture taken of the tendon after 5 treatments within 14 days. The suppurative wound has closed and swelling of the tendon is reduced.

Figure 5: Case 28: This picture was taken after a total of 5 weeks of therapy for tendon rupture and sepsis. There is significant reduction of swelling and pain and the horse has returned to work without lameness. This horse has remained sound and has been competing in jumper competitions for 11 years.

results obtained (Figure 4 and 5); that this therapy in the future gets the attention it deserves. Sackett et al point to the fact that in the context of evidence-based medicine the experience gained through empirical studies, such as this, should be regarded as having a very high priority.[21] The results in the case studies presented show that laser acupuncture consistently represents an excellent option for the treatment of nearly all types of acute and chronic tendonitis in horses.

FOOTNOTES

a. The Physiolaser Olympic 90 W/904nm, Reimers & Jansenn, 14057, Berlin, Germany, Reimers & Janssen, Berlin, Germany
b. Laser Pen 40 W/904nm, Reimers & Jansenn, 14057, Berlin, Germany

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