A Randomized Controlled Blinded Clinical Trial of Electro-acupuncture Administered One Month After Cranial Cruciate Ligament Repair in Dogs

Justin Shmalberg DVM, DACVN, Jessica Burgess DVM, Wendy Davies CVT

ABSTRACT

Electro-acupuncture (EA) treatments are commonly used for post-operative or musculoskeletal pain in dogs, but few randomized controlled trials have examined the acute and chronic effects of such treatments. Eighteen client-owned dogs presenting for surgical recheck 1-month post-cranial cruciate ligament repair were randomized to a control group or EA group that received 30 minutes of EA at a frequency of 2-100 Hz at ST-36, ST-34, GB-34, GB-30, BL-40, GV-20 and *Bai-hui-E*. A blinded evaluator collected goniometric range of motion values and gait analysis data before and immediately after treatment. Enrolled dogs had decreased stance time, weight-bearing and tarsal range of motion in the affected limb, compared to the contralateral pelvic limb, prior to treatment. The EA procedure resulted in a statistically significant reduction in the stance time of the affected limb, whereas there was no change in the control group. No range of motion and gait analysis benefits of 1 EA treatment was found in this study. Additional studies with larger sample sizes are needed to evaluate the delayed effects of EA, the influence of different acupuncture points and protocols and the effect of multiple treatments.

Key words: Electro-acupuncture, cranial cruciate repair, acupuncture, traditional Chinese veterinary medicine

ABBREVIATIONS

CCLR	Cranial cruciate ligament rupture
CCWO	Cranial closing wedge osteotomy
EA	Electro-acupuncture
ST%	Stance time percent; the proportion of the time a given paw is in contact with the ground relative to the total gait cycle time
TPI	Total pressure index; the sum of peak pressure values recorded from sensors activated by each paw divided by the total pressure during a gait cycle
TPLO	Tibial plateau leveling osteotomy

An increasing number of veterinarians provide acupuncture treatments for small animals, and questions from owners regarding such therapy are frequently encountered in clinical practice.[1] The mediation of pain by acupuncture is incompletely understood, but may include increases in regional blood flow, neuroinhibition of pain fibers *via* inhibition of C-fibers or nociceptive neurotransmitters, synaptic plasticity, a release of endogenous opioids, modulation of immune cells and stimulation of the autonomic nervous system.[2] The electrical stimulation of acupuncture needles using milliamp current, known as electro-acupuncture (EA), produces frequency-dependent releases of endogenous opioids that attenuate pain. Low frequency (2 Hz) EA increases met-enkephalin concentration in cerebrospinal fluid and higher frequencies (15 and 100 Hz) elevate dynorphins. This effect is greater than with manual acupuncture and equivalent to that of transcutaneous electric nerve stimulation (TENS).[3] Acupuncture treatments are included in a range of canine rehabilitative protocols including those for cranial cruciate ligament rupture, intervertebral disk disease, and osteoarthritis.[4] Previous studies suggested positive responses in grade 3 and 4 canine intervertebral disk disease and minimal effects in elbow osteoarthritis.[5,6] A systematic review of available acupuncture literature demonstrates the need for rigorous controlled veterinary acupuncture trials.[7]

Cranial cruciate ligament rupture (CCLR) is one of the most common causes of pelvic limb lameness in the dog, and has a complex pathogenesis.[8] Surgical options for stabilization include extracapsular, intracapsular and tibial osteotomy techniques.[9] Tibial osteotomies, and in particular the tibial plateau leveling osteotomy (TPLO), are commonly elected in surgical referral practice.[9-11] However, osteoarthritis, decreased range of motion, surgical trauma and muscle atrophy may all contribute to the persistent lameness that generally occurs in the recovery period from such procedures.[11-15] Early physiotherapy improves post-surgical stifle and pelvic limb function.[16] Electro-acupuncture (EA) protocols

From: The Department of Small Animal Clinical Sciences, College of Veterinary Medicine, University of Florida, Gainesville, Florida

have also been recommended for canine stifle injuries, but not scientifically evaluated.[17]

Human patients benefit from acupuncture for knee arthritis and following knee replacement surgeries.[18,19] Unilateral and bilateral needle acupuncture improved knee scoring, exercise tests, and visual analog scores (VAS) in both randomized and non-randomized clinical studies of severe knee degenerative joint disease.[18,19] A single 2 Hz EA treatment using acupoints near the knee improved VAS, gait speed and step length as compared to a sham group.[20] Repeated needle acupuncture treatments, following knee replacement, reduced pain, decreased stifle swelling and improved post-operative range of motion faster compared to a control group.[21] A randomized controlled trial of the stimulation of a single acupuncture point (ST-34) compared to a sham point found improved gait parameters using a pressure-mat system during geriatric rehabilitation protocols.[22]

The purpose of this randomized, blinded, and controlled study was to evaluate the response of dogs, with previous CCLR and subsequent tibial osteotomy, to a single EA treatment. Dogs were randomly assigned to groups at the 1-month post-operative surgical recheck. It was hypothesized that the treatment group would demonstrate improvements in gait parameters using a pressure mat system and in range of motion as measured by goniometry.

MATERIALS AND METHODS

Eighteen client-owned dogs with unilateral CCLR repaired with a tibial osteotomy were recruited and enrolled from an internal surgical referral caseload between February and June of 2013. Inclusion criteria for the study included body weight of greater than or equal to 8 kg, an age of at least 2 years, uncomplicated surgical correction of CCLR with a TPLO or cranial closing wedge osteotomy (CCWO), the absence of complicating co-morbidities (endocrine disorders, multifocal osteoarthritis, unrelated gait abnormalities) and owner consent on an institutionally-approved study consent form. The owners agreed to fast the enrolled dogs and to not administer concurrent analgesics or sedatives for 24 hours prior to presentation. All dogs were presented in the 5th week following surgical repair. An Institutional Animal Care and Use Committee (IACUC) approved the study.

This study was a controlled, blinded, and randomized clinical trial. Dogs were assigned to a treatment or control group using a software-generated randomization sequence[a] immediately before a 1-month post-operative surgical recheck with a board-certified veterinary surgeon. Joint angles were assessed following group assignment with a plastic goniometer,[b] using standard measurement techniques, by a blinded certified veterinary technician, who was also certified in canine rehabilitation. Maximal flexion and extension angles (in degrees) of the hock, stifle, and hip of each pelvic limb were recorded with the patient in lateral recumbency and with each assessed limb in a non-recumbent position.

Dogs in each group were walked across a pressure-sensitive portable walkway and gait analysis system[c] by the same, blinded rehabilitation technician. Dogs were walked on the mat until they appeared comfortable walking at a constant velocity on a loose leash. The gait-analysis system software then recorded sequential passes in both directions, each of which included at least 3 gait cycles. The first 6 passes meeting inclusion criteria were recorded with at least three passes in each direction. The inclusion criteria included a uniform velocity between 60 and 90 cm/second, the absence of any steps outside the active mat area, no significant deviation of the head from midline, and the lack of tension on the leash. The stance time percentage for each limb, the total pressure index (%) and the total pressure index (TPI) ratio for the affected pelvic limb divided by the unaffected pelvic limb were recorded.

The same certified veterinary acupuncturist administered acupuncture or control treatments, following baseline data collection. The EA treatment group received bilateral acupuncture with standardized needles[d] at the following points: ST-34, ST-36, GB-30, GB-34, BL-40, GV-20, and *Bai-hui-E* (Table 1). The EA was performed at a frequency of 2-100 Hz for 30 minutes with the aid of a commercial electrostimulatory device[e]. Wire leads were connected between the following pairs of points: GV-20 to *Bai-hui-E*, GB-30 to GB-34 (bilateral), ST-34 to ST-36 (bilateral), and BL-40 (right) to BL-40 (left). The treatment amplitude was never greater than 2 mA in any of the patients, and it was less if an amplitude was reached before 2 mA whereby mild focal muscle contractions were observed. Dogs in the control group received palpation of the acupuncture points, but without needle placement. The points were palpated only for identification, and no intentional acupressure was applied. The duration of palpation was less than two seconds and only the minimum pressure needed to identify the point was applied. The dogs were restrained in a similar position as the treatment group and were placed in the same room with the EA equipment present.

Gait analysis immediately followed the 30-minute treatment session, and employed the previously described technique. The same rehabilitation technician then evaluated goniometric angles. Dogs were returned to their owners after the completion of the study.

The differences in goniometric and gait analysis values between affected and unaffected limbs before treatment were assessed using a t-test and commercially available statistical software[f]. The pre- and post-treatment effects within each group, and the comparison of the percent change after treatment between groups, were assessed using the same statistical test. Statistical significance was established if the probability of error was less than 0.05.

Table 1: Anatomic descriptions of acupuncture points treated in the study

Acupuncture Point	Anatomic Description
ST-34	1/10 of the distance proximal from the patella to the greater trochanter of the femur in the vastus lateralis muscle (caudolateral to the cranial aspect of the pelvic limb)
ST-36	Immediately lateral to the tibial tuberosity in the proximal aspect of the cranial tibial muscle
GB-30	Located in the sciatic groove caudal to the greater trochanter of the femur and cranial to the ischiatic tuberosity
GB-34	Craniodistal to the head of the fibula in the interosseous space between the tibia and fibula and between the long and lateral digital extensor muscles
BL-40	Caudal to the stifle in the center of the popliteal crease with the needle directed cranially towards the patella
GV-20	Located in a small dorsal midline depression immediately cranial to the occipital protuberance
Bai-hui-E	Located in the depression of the lumbosacral space on dorsal midline

RESULTS

There were no statistically significant differences in age, weight, or body condition between groups. Patient age ranged from 2-11 years, and weights ranged from 8.4kg-43.7kg. Fifty percent of dogs were overweight (n=9) with a body condition score (BCS) >5 on a scale from 1 to 9. The remaining dogs were in normal body condition (BCS = 4 or 5/9). Multiple breeds of dogs were enrolled given the limited numbers and included mixed-breeds (4), Labrador retrievers (3), Rottweilers (2), Boxers (2), an American Staffordshire terrier (1), American pit bull terrier (1), Chesapeake Bay retriever (1), American Eskimo dog (1), Golden retriever (1), Border collie (1), and Scottish terrier (1). All but 1 dog received surgical correction with a standard TPLO. The remaining dog randomly assigned to the control group received a CCWO.

Measured joint angles between pre-treatment affected and unaffected pelvic limbs were statistically different only for tarsal flexion (p=0.004) and extension (p=0.045) (Table 2). The control group displayed significantly reduced tarsal extension following restraint (p=0.034), but this was not significantly different to the effect seen in the treatment group. No other pre- or post-treatment effects were identified, nor were any statistical differences observed between groups (Table 3).

No pre-treatment differences were identified between the thoracic limbs (Table 2). There was, however, reduced stance time (ST% of gait cycle) in the affected pelvic limb compared to the contralateral pelvic limb (p=0.003). Enrolled dogs also displayed reduced weight bearing on the affected limb, as measured by the comparative pressure applied to that limb divided by the total pressure exerted by all four limbs, referred to as the Total Pressure Index (TPI, %) (p=0.005).

Effects on gait parameters in the same patient following placebo or treatment interventions were noted in both groups. The control group experienced increased ST% and TPI on the contralateral thoracic limb (p=0.037 and 0.026, respectively) (Table 3). The treatment group displayed decreased ST% on the affected pelvic limb following EA (p=0.047) as compared to pre-treatment values. A decrease in TPI was noted but was not statistically significant (p=0.22). No other changes reached statistical significance.

Several treatment effects were significantly different when comparing the magnitude of these effects to placebo. The EA group experienced decreased ST% on the affected pelvic limb (p=0.020) and on the contralateral thoracic limb (p=0.026) as compared to the control group (Table 3). The total pressure indices were not different however. The ratio of pressure applied to the affected pelvic limb versus the unaffected hind limb decreased by an average of approximately 6% in the EA group and increased 1% in the control group, but a wide range and standard deviation were observed so the finding was not significant.

All animals completed the study protocol and no adverse effects were noted during treatment in either group. All dogs cooperated with goniometric assessment and permitted sufficient passes along the gait analysis unit to facilitate data collection.

DISCUSSION

The present investigation is the first study of the effects of EA in a naturally occurring canine model of

Table 2: Pre-treatment goniometry and gait analyses

Goniometry						
	Tarsal Flexion*	**Tarsal Extension***	**Stifle Flexion**	**Stifle Extension**	**Hip Flexion**	**Hip Extension**
Affected Limb (degrees)	56±13 (28-71)	166±6 (148-172)	44±10 (21-65)	153±7 (143-172)	58±8 (37-68)	157±7 (148-168)
Unaffected Limb (degrees)	47±13 (29-69)	169±3 (161-174)	43±9 (26-65)	150±6 (138-163)	60±12 (27-80)	157±7 (145-168)
Normal Values (degrees)[27]	32±2	196±2	42±2	162±3	50±2	162±3
Gait Analysis						
	Ipsilateral Thoracic Limb	**Contralateral Thoracic Limb**	**Affected Pelvic Limb**	**Unaffected Pelvic Limb**		
Stance Time (%)	61±3.9	62±3.6	56±5.2[a]	59±5.0[b]		
Normal Stance Time (%)[40]	55.6	55.6	50.3	50.3		
Total Pressure Index (%)	31±2	30.5±1.7	17.7±2.9[a]	20.9±3.9[b]		
Normal TPI (%)[40]	27.1	27.1	16.9	16.9		

All values are expressed as mean +/- standard deviation followed by the range in parentheses; * values are significantly different between affected and unaffected limbs (p<0.05); affected and unaffected hind limbs with different letters are significantly different (p<0.05)

impaired range of motion and gait following CCLR. The selected EA protocol did not immediately improve gait or goniometric measurements; thereby the study hypothesis was rejected. Moreover, the EA treatment decreased the percentage of time the affected limb made ground contact, as compared to the sum of contact by all 4 limbs in a gait cycle, possibly suggesting impaired post-treatment function. The reported changes are unlikely to be clinically apparent. From a practical perspective, the selected acupuncture protocol does not produce any immediate effects on the lameness and range-of-motion restrictions present 1 month after surgical repair of a CCLR.

Previous standardized human studies of stifle acupuncture used a diverse range of points including ST-31, ST-32, ST-34, ST-36, ST-38, SP-6, SP-9, SP-10, BL-23, BL-25, BL-37, BL-57, BL-60, KID-3, GB-31, GB-39, GB-40, GB-41, GB-42, LIV-3 and LI-4. The number of points per treatment ranged from 1 to 16 in these studies.[18-22] A previous study of EA in dogs with elbow arthritis used bilateral stimulation of 11 points.[6] The canine point system is transposed from human acupuncture nomenclature and anatomy, so controversies exist over the existence and appropriate placement of acupuncture points.[23] The acupuncture points in the present study were based on published recommendations for the treatment of CCLR and were designed to provide stimulation local to the affected area.[17] It is conceivable that a different treatment protocol would have resulted in other effects given both the local and systemic effects produced by acupuncture**.** Stimulation of acupuncture points on the medial surface, closer to the surgical implants and incision, may prove more beneficial; however, bilateral EA of the medial and lateral surface of the stifle can be challenging in some dogs.

Besides acupoint selection, the frequency,

Table 3: Weight, age and treatment effects of control and electro-acupuncture (EA) groups

Weight and Age		
	Control Group	**EA Group**
Weight (kg)	29.3±10.0	30.1±9.9
Age (years)	6.3±3.2	5.4±3.4
Goniometric Effects (degrees)		
	Control Group	**EA Group**
Affected Limb	**Mean Change**	**Mean Change**
Tarsal Flexion	5.8±9.2	3.7±11.2
Tarsal Extension	2.3±6.5	0.0±6.7
Stifle Flexion	0.6±3.7	2.2±5.4
Stifle Extension	-1.3±7.6	-1.9±8.5
Hip Flexion	-6.9±12	-3.3±8.7
Hip Extension	2.1±9.1	2.2±4.2
Unaffected Limb	**Mean Change**	**Mean Change**
Tarsal Flexion	-2.0±6.0	1.1±10.7
Tarsal Extension	-4.4±5.2**	-3.3±4.8
Stifle Flexion	-1.2±6.6	-1.1±8.5
Stifle Extension	0.9±10.3	1.1±5.4
Hip Flexion	1.7±7.4	-3.3±13.1
Hip Extension	-1.7±4.7	-3.6±11.7
Gait Effects (% change)		
	Control Group	**EA Group**
Stance Time %	**Mean Change**	**Mean Change**
Ipsilateral Thoracic limb	0.9±2.5	-0.4±1.7
Contralateral Thoracic limb *	2.4±2.8**	-0.6±1.9
Affected Pelvic Limb*	1.2±3.0	-1.9±2.4**
Unaffected Pelvic Limb	0.9±1.6	0.6±5.6
	Control Group	**EA Group**
Total Pressure Index %	**Mean Change**	**Mean Change**
Ipsilateral Thoracic limb	-0.3±2.5	0.7±2.3
Contralateral Thoracic limb	1.1±1.2**	-0.7±1.3
Affected Pelvic Limb	-0.2±1.7	-1.4±3.3
Unaffected Pelvic Limb	-0.6±1.6	0.0±0.7
Pelvic Limb Ratio (affected/unaffected)	0.8±10.8	-6.4±13.9

Negative values imply reduced range of motion in the named joint, e.g. an increase in the flexion angle or decrease in the extension angle; * values are significantly different between treatment group and control group (p<0.05);** post-treatment values are significantly different from pre-treatment values (p<0.05) amplitude, and continuity of electrical stimulation influence biologic responses.[3] Previous veterinary studies used frequencies of 2 Hz, mixed 3 and 100 Hz, and modulated 2-100 Hz.[5,6,24] The 2-100 Hz protocol in the current study was designed to release both met-enkephalins and dynorphins, although selection of a continuous 2 Hz protocol may have improved response. A 2 Hz EA protocol improved kinematic and force plate responses in human subjects with knee osteoarthritis.[20]

The duration of treatment selected was also longer than described in other studies, but was selected to maximize analgesic effects because analysis was to immediately follow the stimulation.[6] Positive results were reported in humans with this treatment duration.[20] The opioid-mediated effect of acupuncture is thought to occur 20-40 minutes after needle insertion, and EA appears to exert its maximal effects on pain during and immediately after treatment.[3] Active muscle contraction was produced by EA in some dogs, and therefore the degree to which muscle fatigue affected the results of this study is unclear. No dogs required significant restraint during the procedure, and elevations in respiratory or heart rates were not observed. It is, therefore, unlikely that the dogs experienced significant discomfort from the protocol, but a formal assessment of pain was not performed during the treatment given the previous response of patients to similar protocols. A future study without electrical stimulation may also be necessary, as some human interventions showed positive results with simple needle insertion.[18,19,21]

The immediate measurement of the effects of a single EA treatment only addresses whether a specific protocol is expected to acutely affect a patient's function. No veterinary studies in CCLR patients have yet suggested the long-term nature of any perceived response to EA. Some practitioners anecdotally describe positive effects that occur immediately, after several days, or only with several acupuncture treatments. These are important questions to answer, and which have not yet been scientifically validated. The present study was designed to only examine a single time point, and can be used to better advise owners of what to expect following a treatment protocol as described herein. Additional studies must follow to evaluate whether negative effects persist, whether there is no difference or whether an initial decline in the functional parameters is followed by a more chronic improvement. Some human studies for knee osteoarthritis have relied on serial treatments, while others, including one assessing gait parameters, evaluated immediate effects.[18-21]

The influence of palpation of the acupuncture points in the control group cannot be directly determined within the context of this study. Sham points near the affected area would cause possible stimulation of the intended acupuncture point when EA was applied. Dry needle acupuncture without application of percutaneous electrical current would also be expected to exert a biologic effect.[25] Therefore, palpation of the point, as would be done by the practitioner just prior to needle insertion, was thought to be the most appropriate control, or placebo, treatment. However, acupressure has also been shown in some studies to be therapeutic.[26] It is possible that the control group experienced some clinical benefit from the palpation, although the technique was designed to minimize such effects.

Acupuncture studies are inherently difficult to design if protocols are selected using the methods commonly employed by veterinary practitioners. Traditional acupuncture approaches are often patient-specific and based on a complex clinical assessment, which may include controversial parameters that have not yet been subjected to scientific evaluation (e.g. thermal characteristics and tongue and pulse assessments). Randomized controlled trials, however, must examine only 1 of a potentially infinite number of point combination possibilities. The present study is limited by the testing of only 1 of a multitude of clinical approaches to similar patient populations.

The use of goniometry in the present study is subject to several limitations. Goniometric techniques for objective assessments of range of motion are described for clinically normal Labrador retrievers, but values for other breeds have not been described.[27] In healthy Labradors, this procedure was found to have a median of 3 degrees of variance between measurements, when assessed by the same observer. Goniometric measurements in unsedated dogs agreed with sedated values from the same dogs.[27] Normal values, derived from this previous study, are reported as the mean and standard deviation in Table 2. The mean goniometric angles measured before treatment in the present study demonstrated reduced tarsal flexion and extension, stifle extension, and hip flexion in both pelvic limbs when compared to these normal Labrador values. However, joint angles were not significantly different between the pelvic limbs with the exception of tarsal range of motion, which was reduced in the affected limb. The ranges and standard deviations were larger than expected, suggesting this study is underpowered to detect differences and that goniometry may be a poor outcome measure in acute interventions, where the effect size is likely to be small. For example, 32 dogs would be needed in each group to detect a difference in stifle extension of 5 degrees assuming an alpha of 0.05, a power of 0.8, and calculated standard deviation of about 7 degrees. Poor owner compliance rates on the scheduling and timing of the 1-month recheck along with logistical considerations impaired the ability to achieve these numbers in this trial.

Previous retrospective and prospective studies evaluated goniometry in patients following CCLR repair.[13] Loss of stifle flexion and extension has been associated with increased lameness, with a greater effect noted from impaired extension than from flexion loss. More than 10 degrees of extension loss 1 year after TPLO surgery worsened lameness even from preoperative scores, whereas dogs with motion loss of less than 10 degrees did not differ from those with normal postoperative range of motion. This previous study reported that stifle extension and flexion measurements resulting in lameness 1 year post-operatively were 150±5° and 52±6° as compared to preoperative values of 162±3° and 42±3°.[13] The values measured in the current study were 153±7° and 44±10°, but after only 1 month, suggesting that reduced extension may be responsible for the measured lameness in both groups. Another study of dogs at least 1 year after TPLO reported stifle extension of 155±7° and flexion of 37±7°, with pre-operative values of 160±5° and 29±4°.[12] This data contrasts to values obtained at 1 year following tibial tuberosity advancement (TTA), with a reported stifle extension of 151±8° and flexion of 59±7°.[15] Dogs had similar values at 6 weeks after the TTA, but with a greater standard deviation (151±10° and 58±28°). Therefore, there are significant inter-study discrepancies between joint angle measurements at various time points, and the present study would have been strengthened by an assessment of the pre-surgical range of motion in enrolled animals.

Rehabilitation protocols affect post-operative range of motion. Three physical therapy sessions weekly following TPLO increased stifle extension at 3 and 6 weeks post-operatively, as compared to those dogs receiving at-home exercise protocols.[16] Extension was about 155 degrees in the physiotherapy group, which was improved from pre-operative values, and approximately 140 degrees in the home-exercise control group, which was reduced from pre-operative values. Stifle flexion demonstrated similar trends with values of 40 degrees for physiotherapy enrollees and about 55-60 degrees for control dogs at 3 and 6 weeks following surgery. The dogs enrolled in the present study did not receive rehabilitation. However, the values of 153±7 and 44±10 in the present investigation more closely approximate the physiotherapy group in the cited study. This may suggest more effective post-surgical instructions or differences in the measurement of goniometric angles between studies. The enrolled dogs had no clinically significant changes following treatment or placebo which suggests that a single EA treatment probably does not induce acute improvements in range of motion, although greater numbers would be necessary to reach a definitive conclusion.

This study used pressure platform analysis to assess lameness, although many alternate techniques are described. Force plate analysis is considered the gold standard, and is thought to be less subjective than lameness scoring by veterinary professionals.[28] A previous EA study employed force plate data as did several studies examining post-operative changes following surgical repair of ruptured cranial cruciate ligaments.[6,10,14,28] Force plate data are also commonly employed in the assessment of pain and in the evaluation of therapeutic interventions.[29-30] However, the collection of force plate data requires specialized knowledge and is limited to the evaluation of one limb in each pass. Dogs may also need to trot in order to fully evaluate mild lameness.[32,33] Trotting lame dogs across a force plate to collect data on all limbs could be theorized to increase the lameness and fatigue of dogs. In addition, breed, body weight, velocity, and size affect force plate measurements.[34,35] Kinematic analysis is an alternative to force plate that has been used to determine active range of motion and other parameters in dogs with CCLR.[36-38] Specialized equipment and training is also necessary for this technique as errors in marker location produce changes in the data collected.[39] Many studies still rely on veterinary lameness scoring, but the subjectivity of such scores and the small degree of lameness anticipated in the study population reduced the utility of such an approach in the present investigation.[12,13,15,16]

A pressure walkway system was used to objectively assess all four limbs during gait cycles without the need for kinematic systems. The walkway[c] has been evaluated in healthy Labrador retrievers as well as in humans and utilizes 18,432 encapsulated sensors interpreted by proprietary software.[40] Several variables are calculated based on pressure data. The present investigation utilized the ST%, or the proportion of the time a given paw is in contact with the ground relative to the total gait cycle time. The TPI represents the sum of peak pressure values recorded from sensors activated by each paw divided by the total pressure during a gait cycle. This combination of paw contact time and paw pressure was thought to best correlate to the degree of lameness experienced by each patient. However, other variables could also be significant, including velocity, stride length and the peak force on any given limb. These were not assessed in this study. In addition, the results from a pressure walkway system may be influenced by breed, weight, and muscle distribution.[40] The conclusions of this study would have been strengthened if preceded by a comparison of force plate data to gait analysis parameters, as has been reported for a different walkway used in canine gait analysis.[41]

The measured parameters and study population limit the results of the present investigation. Assessments of function such as postural changes, static weight bearing, pain scores, and lameness scores would offer additional information on post-EA function.[42] In addition, a larger or more uniform study population would have eliminated variability from breed, gait pattern, age, gender and body weight. However, the enrollment of dogs was less than anticipated due to owner compliance and logistical considerations. The same surgeon did not perform surgical repair in the enrolled dogs and this is expected to introduce additional error. A dog with a CCWO was also in the study due to the limited numbers. This procedure produces similar lameness scores 6 weeks post-operatively as the TPLO, but differences may exist in post-operative range of motion.[11,43] The dog with the CCWO was nevertheless included to maintain equal numbers in each group, but this could introduce variability. Further study with a more homogenous population of dogs is therefore required.

CONCLUSIONS

A single 30-minute EA session at 2-100 Hz, using defined points, produced minimal acute changes in stifle function, assessed by goniometry and gait analysis, one-month post-CCLR repair as compared to a control group. This study confirms, however, the persistent impairment at the same time point in affected versus unaffected stifles, as measured by stance time percentage and total pressure index percentage. Therefore, the pressure walkway system employed in the present investigation may prove to be an alternative to force plate studies evaluating post-CCLR recovery in future studies. Goniometric angles were not different between affected and unaffected limbs before treatment except for the reduced tarsal flexion and extension, which is of uncertain clinical significance. Goniometric function is unlikely to be a reliable indicator of clinical improvement in short-term evaluations of function unless pre-surgical values are available and study numbers are robust. Further research is required in a larger number of dogs to determine the chronic effect of single or multiple EA sessions on stifle function and to test alternative acupuncture point protocols for the improvement of clinical lameness following cruciate ligament repair.

FOOTNOTES

[a] Microsoft Excel for Mac 2011. Version 14.1.0
[b] HiRes plastic goniometer, Baseline Evaluation Instruments
[c] GAITRite, CIR systems Inc.
[d] 0.25mm x 25 mm spring handle acupuncture needles, Acutek
[e] 12.c PRO Electrostimulator, Pantheon Research
[f] SAS for Windows. Version 9.3

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Small Animal Class Tuition: $1,150

Jan 29, 2015 (On-site)

8:30-10:20: How to Improve Acupuncture Clinical Results

10:30-11:20: Scalp Acupuncture and Auriculotherapy (Demo)

11:30-12:30: Gold Implantation (Demo)

1:30-6:30: Wet Labs

Electro-Acupuncture, Aquapuncture, Moxibustion, Hemo-Acupuncture, Pneumo-Acupuncture

Simple *Tui-na* Techniques

Tongue and Pulse Diagnosis

How to Approach Clinical Cases

Jan 31, 2015 (On-site)

8:30-12:30: Wet Labs

Real Clinical Cases: How to Diagnose and Treat

1:30-5:30: Optional Neurological Module
(additional tuition: $100)

How to Treat *Wei* Syndrome in Small Animals - Dr. Xie

How to Treat *Tan-huan* Syndrome in Small Animals - Dr. Xie

TCVM for Other Neurological Disorders in Small Animals - Dr. Xie

Jan 30, 2015 (On-site)

8:30-12:20: How to Make a TCVM Diagnosis (Rounds & Demo)

1:30-6:30: Wet Labs

Classical Points in the Head (top 23 pts), in the Trunk (top 26 pts) and in the Limbs (top 28 pts)

How to Approach Clinical Cases

Jan 1- Mar 30, 2015 (Online Portion)

Lecture 1-2: Neurological Case Study: Dry Lab - Dr. Chrisman

Lecture 3: How to Treat Skin Problems - Dr. Xie

Lecture 4-5: Small Animal Case Study: Dry Lab - Dr. Xie

Lecture 6-8: Ten Acupuncture Techniques - Dr. Xie

Lecture 9-10: TCVM for Geriatrics - Dr. Xie

Equine Class Tuition: $1,150

Jan 22, 2015 (On-site)

8:30-10:20: How to Improve Acupuncture Clinical Results

10:30-11:20: How to Scan a Horse, Scalp Acupuncture and Auriculotherapy (Demo)

11:30-12:30: Gold Implantation (Demo)

1:30-6:30: Wet Labs

Classical Points on the Head and Neck, Trunk and Tail

Classical Points on the Front Limb and the Hind Limb

Tongue and Pulse Diagnosis in Horses

Jan 24, 2015 (On-site)

8:30-12:30: Wet Labs

Real Clinical Cases: How to Diagnose and Treat

1:30-5:30: Optional Neurological Module
(additional tuition: $100)

How to Treat *Wei* Syndrome in Large Animals - Dr. Xie

How to Treat *Tan-huan* Syndrome in Large Animals - Dr. Xie

TCVM for Other Neurological Disorders in Large Animals - Dr. Xie

Jan 23, 2015 (On-site)

8:30-12:20: How to Make a TCVM Diagnosis (Rounds & Demo)

1:30-5:30: Wet Labs

Electro-Acupuncture and how to Make a TCVM Diagnosis

Simple *Tui-na*, Pneumo-Acupuncture, Moxibustion, How to Needle Points Around Eyes, Abdomen, Feet and Other Special Needling Techniques

How to Approach an Equine Case

Jan 1- Mar 30, 2015 (Online Portion)

Lecture 1: How to Approach an Equine Case - Dr. Pasteur

Lecture 2-4: Lameness and Internal Medicine: Dry Lab - Dr. Xie

Lecture 5-8: Ten Acupuncture Techniques - Dr. Xie

Major Speakers and Instructors

Cheryl Chrisman DVM, ACVIM, CVA | Carla Pasteur DVM, CVA | Stacie Atria DVM, CVA | Shen Xie DVM, PhD

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