



FourLegRehabInc

CANINE REHAB EDUCATIONAL RESOURCES

Modalities Update – Part 2

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Electrical Muscle Stimulation

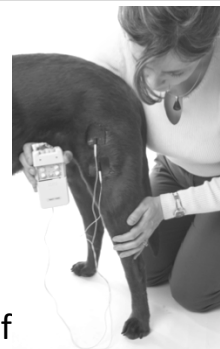


Electrical Muscle Stimulation

- **INDICATIONS**

<ul style="list-style-type: none">▪ Improper muscle firing sequences▪ Joint effusion▪ Muscle disuse atrophy▪ Circulatory disorders▪ Tendon / Fracture healing	<ul style="list-style-type: none">▪ Neurological atrophy▪ Pain▪ Protective muscle spasm▪ Post injury / disease muscle inhibition▪ Dermal ulcers
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Electrical Muscle Stimulation



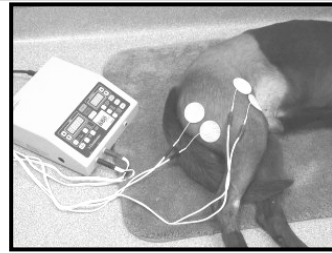
- Electrical Muscle Stimulation
 - PARAMETERS
 - **Phase / Pulse Duration:** (Selections of 100, 200 or 300 microseconds)
 - Humans report that 100 usec is more comfortable. 800 usec will recruit small pain fibers
 - **Amplitude:** the intensity of the machine output. Aim for strong enough to see (and feel) yet tolerable.

Electrical Muscle Stimulation



- Electrical Muscle Stimulation
 - PARAMETERS
 - **Waveform:** who cares! There are no good studies to prove the value of one over the other.
 - **ON / Off Times:** Duty cycle: suggested is 1:2 or up to 1:5.
 - I use 1:1 or continuous if the animal is not working with the EMS
 - I use 1:2 if weight shifting while using the EMS

Electrical Muscle Stimulation



- **PARAMETERS**
 - **Ramp:** the time to get up to and down from a peak contraction. 2 – 4 seconds is suggested for tetanic contractions. I go with 1 second when using 5pps.
 - **Polarity:** the electrodes are either positive or negative. Black is negative (the cathode). Red is positive (the anode). Good to know for Iontophoresis
 - **Treatment time:** Depends on use. Can use for up to 30 mins or more if 'passive', but may only tolerate 7 – 10 mins 'active'. Daily or less.

Electrical Muscle Stimulation

- **PARAMETERS**
 - **Frequency:** (Hertz, Pulses per second, Pulse rate)
 - For tetanic muscle contraction used for strengthening 30 – 60 Hz is recommended. (I use 5Hz!)
 - 20Hz has been shown to prevent atrophy of slow-twitch muscle fibers
 - 30 Hz has been shown to prevent atrophy of fast-twitch muscle fibers
 - 2Hz & 10Hz are best for remediation of disuse atrophy

Dupont Salter et al 2003; Boonyarom et al 2009

Electrical Muscle Stimulation

- **Dosages** in studies

(Sinacore et al 1990)

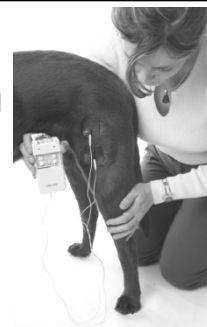
- Type II fibres are most affected with chronic diseases.
- EMS at 50 Hz, 50 reps total, 5 sec on, 2 sec off, 2 second rise, was a viable treatment for disuse atrophy

Electrical Muscle Stimulation

- Electrical Muscle Stimulation

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Electrical Muscle Stimulation

- UTILIZATION

- Co-contractions
- Post-op in first 4 weeks
- Passive modality in animals
 - Early on
- Active – Assisted
 - Later on
- Warm up needed???



Electrical Muscle Stimulation

In the Literature

- The primary use of E-stim is the treatment of muscle atrophy, re-education of muscle function, & muscle strengthening of deconditioned or inhibited muscles
- Baxter & McDonough et 2007
Animal Physiotherapy. Blackwell Publishing.
- E-stim is less effective on its own as compared to E-stim WITH active exercise.
- For strength gains, there is no additional benefit of using E-stim in addition to traditional strengthening methods in NORMAL subjects
- Dehail et al 2008

Electrical Muscle Stimulation

In the Literature

- E-stim, when used in a therapeutic context, superimposed with exercise compensates for volume and muscle strength deficits with more efficiency than programmes using volitional exercise or E-stim separately
 - Paillard et al 2005
- E-stim with Ex induced greater muscular adaptations than volitional contractions whether in sports training or rehabilitation
- Strength loss and atrophy due to trauma or surgery are treated more efficiently with EMS + Ex than volitional Ex alone
- Combined therapies restored more functional abilities than volitional Ex
- Best in early rehab to strengthen and prepare for late stage volitional alone exercise
- Paillard 2008

Electrical Muscle Stimulation

In the Literature

- Dosage for Fracture healing (Park & Silva 2004)
 - Placement: 3cm prox to fracture, second electrode proximal to the first.
 - 4Hz; 50usec; 20sec on, 15 sec off; 5sec ramp
 - 1 Hr / day, beginning 4 days after Sx, x 25 days
 - Increase in mineralized callus
 - Bone had greater torsional parameters for stiffness, maximum torque withstood, & required more energy to failure.

Electrical Muscle Stimulation

In the Literature

- Dosage for Myofascial Trigger Points (Hsueh et al 1997)
 - TENS = 60Hz x 20 min x strong but no muscle contraction
 - EMS = 10Hz, visible contractions, x 20 min
 - TENS is more effective for immediate relief of myofascial trigger point pain than E-stim,
 - E-stim has a better effect on immediate release of muscle tightness than TENS.

Electrical Muscle Stimulation

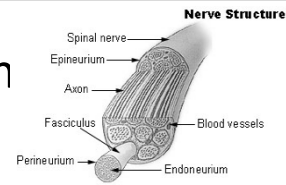
■ ELECTRODE PLACEMENT

- Motor Points:
 - Motor-point-schmotor-point
 - Clinically, just get two electrode over the same muscle = good enough!!!

■ SHAVE or 'Spot Goop'?



Electrical Muscle Stimulation



- **Electrical Muscle Stimulation**
 - USE IN Lower Motor Neuron Lesions
 - **Neuropraxia:** (temporary bruising and inflammation or damage to the nerve)
 - You can stimulate below the lesion to get a muscle twitch
 - **Axonotmesis:** (damage to the axon with severance or blockage, but neural sheath is still intact. Nerve may grow together)
 - Grows at 1mm per day or 1 inch a month for up to 2 yrs
 - You are unable to stimulate a muscle twitch below the lesion
 - **Neurotmesis:** (severance or crushing completely)
 - The nerve will die unless surgically reattached and even then the individual nerve fibers must reconnect
- Pulse Widths of 300 usec might be better at recruiting more muscle fibers and actually get a twitch from a denervated muscle

Electrical Muscle Stimulation

- **Electrical Muscle Stimulation**
 - **IONTOPHORESIS:** The use of an electrical current to drive a medication transdermally into the underlying tissue.
 - Know the polarity of the compound and under which electrode to put it
 - Principle: that 'like' charged ions repel each other...(i.e. Put a positively charged solution under the Red / Positive / Anode.)

Electrical Muscle Stimulation

• CONTRAINDICATIONS



- Near electrical devices
- To the low back / abdomen in pregnant women
- To acupuncture points on pregnant women
- “Anywhere on a pregnant woman”

- To regions of known or suspected malignancy
- To areas of active DVT / thrombophlebitis
- To actively bleeding tissues or persons with untreated hemorrhagic disorders

Electrical Muscle Stimulation

• CONTRAINDICATIONS



- To infected tissues, tuberculosis, or wounds with underlying osteomyelitis
- To the chest in patients with cardiac disease, arrhythmias, or heart failure
- To the neck or head region of patients known to have seizures

- Transcranially w/o specialized training
- To areas near reproductive organs or genitalia w/o specialized training
- To areas near /over eyes
- To the anterior neck / over the carotid sinus
- To open areas of skin

Electrical Muscle Stimulation

CONTRAINDICATIONS	PRECAUTIONS
<ul style="list-style-type: none"> ▪ Areas of impaired circulation ▪ The area unstable d/t recent surgery, bone fracture, or osteoporosis ▪ The chest or the intercostal muscles ▪ The lower abdomen ▪ To recently radiated tissues 	<ul style="list-style-type: none"> ▪ (e.g. clinicians may treat these with caution – lower intensities and/or more monitoring) ▪ Active epiphysis ▪ Over skin conditions (e.g. eczema, psoriasis) ▪ Over areas with impaired sensation ▪ Patients with cognitive / communication problems

Electrical Muscle Stimulation

SAFE

- Over intact skin overlying metal, plastic, or cement implants
- Over inflamed tissues (d/t recent injury or exacerbation of a chronic inflammatory condition)



TENS

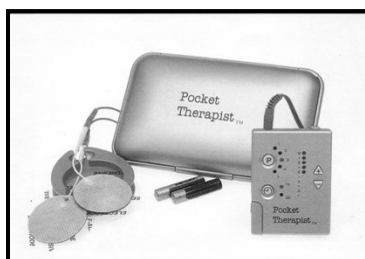
- TENS : Transcutaneous Electrical Neuromuscular Stimulation
 - An electrical current (much like EMS, but utilizing higher or lower frequencies) for pain relief.
 - Analgesic Mechanisms
 - Descending inhibitory pathways
 - Pain Gating at the spinal cord level
 - Release of endogenous opiates



TENS




• SETTINGS

- For Acute Pain: 60 – 200 Hz and lower pulse widths produce a fast acting pain relief. The relief is short lasting however
- For Chronic Pain: 2 – 4 Hz with a higher pulse width produces longer lasting pain relief.



TENS

• HIGH-frequency TENS

- Selectively stimulates larger diameter peripheral nerve fibres which in turn helps to 'block' nociceptive activity in smaller afferents at segmental levels.
-  endorphins in the bloodstream & CSF
-  enkephalins in the CSF
-  release of the excitatory neurotransmitters glutamate and substance P in the spinal cord dorsal horn in animals with inflammation



TENS

• LOW-Frequency TENS (acupuncture-like TENS)

1. Stimulates a release of endogenous opiates
2. Activates opioid, GABA, serotonin, and muscarinic receptors to reduce dorsal horn neuron activity & nociception
3. It has also been shown that peripheral opioid receptors are also responsible for low-frequency (but not high-frequency) TENS analgesia.



TENS

– CONTRAINDICATIONS

- As per Electrical Muscle Stimulation

– CAUTIONS

- Anterior chest wall or lower abdomen
- Areas of impaired circulation

– SAFE

- Over areas unstable due to recent surgery, bone fracture, or osteoporosis
- Areas around or within chronic wounds of known etiology or open wounds with localized infection



TENS

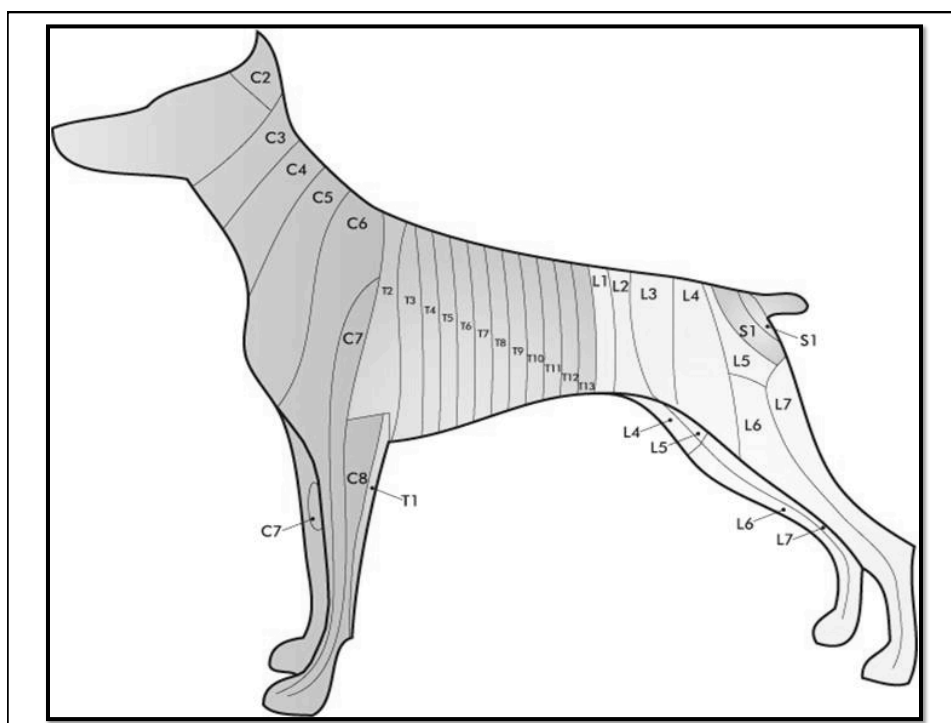
• APPLICATION

- Application of electrode placement is a mix of art and science. Knowledge of the neuromuscular anatomy is helpful.
 - Incorporate acupuncture points
 - Localized areas of pain
 - Over a nerve
 - Over a nerve root (that supplies a dermatome / myotome in the painful area)



TENS

Canine Nerves, Nerve Roots, and Muscle Innervation		
Nerves	Root	Muscles
Radial Nerve	C7 – T2	All extensor muscles of the elbow & carpus & digits, supinator, brachioradialis, APL, EPL
Median Nerve	C8 – T2	Pron. Teres, Pron Quad., FCR, SDF, Radial head of DDF
Ulnar Nerve	C8 – T2	FCU, Ulnar & Humeral heads of DDF, Lumbricals, Interossei & elbow jt
Musculocutaneous Nerve	C7 (C8)	Coracobrachialis, biceps, brachialis
Axillary Nerve	C7, (C6 & C8)	Teres major, teres minor, deltoid (and subscapularis)
Subscapular Nerve	C6 – C7	Subscapularis
Suprascapular Nerve	C6, (C7)	Supraspinatus & infraspinatus
Pectoral Nerve	C7, C8	Superficial & deep pectorals
Thoracodorsal Nerve	C8, (C7, T1)	Latissimus dorsi
Femoral Nerve	L4 – L6, (L3)	All of the Quadriceps complex, iliopsoas, Sartorius
Sciatic Nerve Tibial Peroneal Supf & Deep	L6, L7, (S1, S2)	Hamstrings, quadratus femoris, gemelli, obturator internus, gastrocs, popliteus, tibialis posterior, tibialis anterior, digital flexotrs and extensors, Fibularis brevis, EHL, muscles of the foot
Obturator Nerve	L5, L6	Obturator externus, pectineus, adductor, gracilis
Anterior Gluteal Nerve	L7, S1	Glutei, TFL, capsularis
Posterior Gluteal Nerve	S1 – S3	Biceps femoris, Middle & Superficial glutes



Microcurrent

- Aka: MES, MET, MENS, MCT, or CES
 - Electrical current at very low levels – often at below perceivable levels
 - Current less than 1 mA / 1000 μ A



Microcurrent

This device has been used successfully to treat many kinds of pain.

Additionally, via earclips, transcranial electrical stimulation (CES) has been shown to aid in depression, anxiety, insomnia, cognitive dysfunction (lack of mental clarity subsequent to alcoholism, post-traumatic amnesia), fibromyalgia, & addiction.

Microcurrent



- Microcurrent
 - Shown to be beneficial for:
 - Resistant trigger points over head, neck, & face
 - TMJ disorders
 - Epicondylitis & shoulder peritendinitis
 - Low back disorders
 - Wounds / Ulcers
 - Neuropathic pain / Post-operative pain

Microcurrent



- Microcurrent
 - In the literature:
 - Reduction in DOMS (applied immed post-Ex) – Curtis et al 2010
 - Use of Microcurrent as part of a treatment (MET & stretching) for infant torticollis yielded better results and less crying than traditional therapies (US & Stretching) (Kim et al 2009)
 - MET 0.5Hz x 1000muA x 20 mins/d x 7 days= better than TENS & helps with bruxism pain – Rajpurohit et al 2010

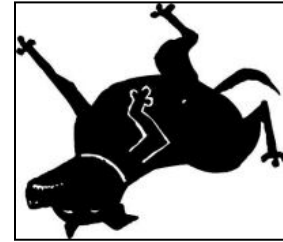
Microcurrent

- Microcurrent
 - In the literature:
 - Use of Microcurrent following THR reduces the amount of fentanyl required post-operatively & improved wound healing compared to controls. (Sarhan & Doghem 2009)
 - Improved function after TKR at 3 mo mark following immed post-op MENS Rx x 10 apps (Rockstroh et al 2010)
 - Microcurrent decreases the time to wound closure after split-thickness skin grafting (Huckfeldt et al 2007)

Microcurrent

- Microcurrent
 - In the literature: (Rexing et al 2010)
 - Cold compress, MET with bandage, or cold compress with bandage = ALL were effective in reducing swelling 72 hours post CCLR in dogs vs bandage alone.
 - MET – Alpha Stim 600uA used a) crossing the joint in a large X, crossing in a small X and crossing both rear limbs. 0.5Hz (50% duty cycle, bipolar asymmetrical rectangular wave).
 - Using 2 probes (2 pairs with small X, 3 pairs with large X, and 3 pairs) 30 – 45 sec per pair with a total time of 5 – 7 minutes.

Microcurrent



- Microcurrent
 - In the literature:
 - Cranial Electrical Stimulation (CES = Microcurrent delivered via earclips to affect the brain) resulted in significant decrease in pain intensity in pts with SCI. (Tan et al 2006)
 - 100uA - 500uA x 1 hr/day x 21 days (Alpha-Stim)
 - CES was as effective as relaxation training (and both were better than control) for patients with anxiety. (Gibson et al 1987)
 - Alpha-Stim
 - CES significantly improved mood in closed head injury pts better than controls. (Smith et al 1994)
 - 45 min daily, 4 days a week for 3 weeks

Microcurrent

- *This is definitely something to think about!!*

Magnetic Field



- Magnetic Field Therapy
 - To create a magnetic field a current must flow through a conductor such as wire.
 - When current flows through a wire a magnetic field is induced at right angles to the wire.

Magnetic Field



- Pulsed Electromagnetic Field Therapy (PEMF)
 - Theoretic Mechanism of Action
 - Damaged / Diseased cells have altered rest potentials (permeability to Na^+ and K^+). The rest potential of the cell is proportional to the ion exchange occurring at the cell membrane.
 - Ions are affected by the rhythm of the pulsation when introduced to a PEMF
 - Ion exchange is responsible for O_2 utilization of the cell
 - Lack of O_2 utilization is a problem with delayed healing and arthritic joints

Magnetic Field



- Pulsed Electromagnetic Field Therapy

- EFFECTS OF PEMF

- Enhanced cartilage repair
 - Stimulation of chondrocytes
- Increase in collagen synthesis
- Increase in osteogenesis



Magnetic Field

- Pulsed Electromagnetic Field Therapy

- INDICATIONS

- | | |
|--|---|
| <ul style="list-style-type: none"> ▪ Bone Healing ▪ Inflammation ▪ Muscle Spasm ▪ Pain ▪ Disorders of the Neuro system ▪ Rheumatology ▪ Coronary / Circulatory diseases ▪ Post-Operative | <ul style="list-style-type: none"> ▪ Degenerative diseases of the musculoskeletal system ▪ Infection ▪ Poor circulation ▪ MS ▪ Parkinsons ▪ Post-trauma ▪ Burns & Wounds ▪ Tendon healing |
|--|---|



Magnetic Field

- Pulsed Electromagnetic Field Therapy
 - CONTRAINDICATIONS

- Hemorrhage
- Electrical implants
- Cancer



Magnetic Field

- Pulsed Electromagnetic Field Therapy
 - PARAMETERS
 - Magnetic field is measured in Gauss (G) or Tesla (T)
 - PEMF have a maximum power of 100 G and utilize DC current. (This is far less than external field powers that can have a negative biological effect such as cell phone, power lines, transformers, appliances and medical devices which utilize AC)
 - Static Magnets are at least 500G

Magnetic Field

- PEMF

- PARAMETERS

- Frequency Cycle (Hertz)
 - 0.5 Hz may cause vasoconstriction
 - 18 Hz may cause vasodilation

Centurion PEMF settings	Respond PEMF settings
2Hz (acute)	5Hz (acute)
15Hz (subacute)	15Hz (subacute)
30Hz (chronic)	30Hz (chronic)



Magnetic Field

- PEMF

- PARAMETERS

- CARTILAGE**

- In the Literature: (Fini...2005; Zorzi...2007)
 - PEMF x 3 months x 6hr/day x 75Hz x 1.6mT = increased cartilage thickness
 - PEMF x 75Hz x 1.5 mT x 90 days x 6 hours / day = reduced NSAID use & increased knee Fx/pain scores



Magnetic Field

- PEMF

- PARAMETERS

- BONE**

- In the Literature: (Ibiwoye... 2004; Matsumoto...2000)
 - PEMF 15Hz x 3hrs/day x 7 days a week x 10 weeks = reduced osteotomy gap size
 - PEMF 100Hz, pulse width of 25usec (x lower Teslas) = increased bone contact ratios & bone area ratios



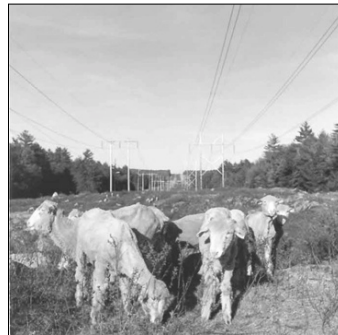
Magnetic Field

- PEMF

- PARAMETERS

- TENDONS**

- In the Literature: (Strauch...2006; Robotti...1999; Lee...1997)
 - PEMF 30 mins/day x 27.12Mhz = 69% increase in tensile strength of repaired tendons in rat Achilles)
 - 17Hz x 15-min sessions x 5.1mT = increased physiological alignment of collagen fibres in Achilles of rats
 - 15Hz, peak amplitude 12mW x 8 hours daily = decrease in tensile strength and an increase in peritendinous adhesion (chick tendons).



Magnetic Field

- PEMF

- PARAMETERS

- In the Literature: (Walker...1994; Crowe...2003)

- NERVE**

- PEMF: 2 Hz x 0.3 mT x 4 h/day during Days 1-5 post-injury = Increase in functional recover (assess day 43)

- SPINAL CORD**

- PEMF may help with motor function recovery and lesions volume size after acute SpC Injury (applied x 12 weeks mid-thoracic spine – cats)



Magnetic Field

- All the benefits of power lines with none of those nasty side-effects!

