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Inside This Issue

Canine Idiopathic Pulmonary Fibrosis

Joshua W. Tumulty, DVM, DACVIM (SAIM)

1

A Note From the Editor

3 Leonard J. Marino, MD, FAAP, LVT

Acupuncture and Electroacupuncture for Pain Management: Mechanisms of Action from a Conventional Medical Perspective

C.W. Dewey, DVM, MS, CVA, CVCH, DACVIM (Neurology), DACVS

7



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Canine Idiopathic Pulmonary Fibrosis

Joshua W. Tumulty, DVM, DACVIM (SAIM)

Idiopathic pulmonary fibrosis (IPF) is a chronic, progressive interstitial lung disease (ILD) of unknown cause. The disease is recognized in humans, cats, and dogs. The prevalence and incidence of canine IPF (IPF) are currently unknown and can be difficult to estimate. Recognizing a dog with early IPF is challenging because the slowly progressive clinical signs can be confused with aging. Additionally, confirming IPF requires very thorough examinations.

It seems that, at least in West Highland White Terriers (WHWT), IPF is a manifestation of aberrant collagen regulation. This may be a result of increased synthesis of collagen matrix, or decreased lysis / degradation (remembering that synthesis and degradation of collagen normally occurs throughout life, and is tightly controlled). In dogs, a genetic component is strongly suspected since the disease affects the WHWT disproportionately, however preliminary genetic studies have not yet helped to identify causative mutations in this breed. The Cairn Terrier, Scottish Terrier, Jack Russell Terrier, Bull Terrier, American Staffordshire Terrier, Yorkshire Terrier, Bichon and Shi-tzu are possibly affected as well, but are less predisposed. In human medicine, the disease affects approximately 20 people per 100,000. People over 60 years are most fre-



quently affected and mean survival time after diagnosis is between 3 and 5 years.

IPF is considered an inevitably progressive disease. At the early phase of the disease affected dogs are often quite normal. The mean duration of clinical signs when presented to

the veterinarian has been estimated to be 8 to 13 months, with great individual variation. The most typical clinical signs are exercise intolerance and chronic cough in otherwise bright and alert dogs. Syncope, gagging, panting,

and tachypnea are also reported. Not all affected dogs cough. Eventually, IPF can cause respiratory difficulty, cyanosis, and respiratory failure. In dogs with IPF, mean survival time has been reported as 18 months from

Recognizing a dog with early IPF is challenging because the slowly progressive clinical signs can be confused with aging.

Continued on Page 4 ►

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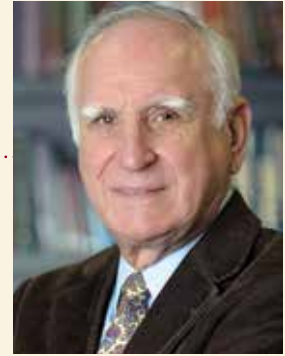
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A Note from the Editor



Cherry blossom petals seem to line the streets as Mother's Day celebrations, pool openings, graduations and the events of spring seemed to come upon us. The rain has encouraged the arrival of pollens, weeds, dust and other allergens to make breathing a difficult exercise for many. Itchiness however is now being effectively treated by a new drug, Cytopoint, an injectable, which can be used in tiny dogs and together with Apoquel, which is orally administered, offer quite promising results.

The Dermatology department has maintained extended hours to offer the services of LIVS to clients and referring veterinarians and is available to consult in cases that need direction and appropriate allergic management.

Graduation celebrations with lots of outdoor grilling mean we and our pets will be consuming the usual tasty bits of BBQ'd foods, leaving both owners and pets subject to GI upsets. Summer also brings on more accidents, rashes, ingestions, etc., with subsequent dehydration and injuries of many kinds. LIVS is always open for any emergencies that may arise and our extended hours remain as before with each service ready to serve the needs of our clients and those patients which you refer to LIVS.

A few years ago, there was a Salmonella outbreak in foods containing peanuts; this year E. Coli outbreaks have occurred in contaminated Romaine lettuce. We should remain vigilant that foods insufficiently cooked or dairy left out may harbor the bacteria that can affect us and our pets. While still at SCCC, I learned that strangely named obligate aerobic bacterium "Bdellovibrio" was able to parasitize other gram negative bacteria like E. coli, inserts itself into the periplasmic space, feed on the proteins and nucleic acids of its host, multiply, devour and lyse the bacterium releasing other progeny to follow suit. No news on its use in treating E. Coli so far.

Dr. John Sapienza, director of Ophthalmology is again participating this May in an event endorsed by the ACVO in which service dogs are evaluated at LIVS, at no charge to the owners.

The Internal Medicine department has expanded appointment availability for elective consultations and ultrasound evaluations Monday through Saturdays as does Ophthalmology. The Surgery department has appointment hours available seven days a week. Feel free to contact any of the aforementioned staff members about how they may be of service.

LIVS continues to offer patients, clients, veterinarians and the community, an "always open" policy of state of the art care. Feel free to contact any of the specialty departments' staff members about how they may be of service.

As before we welcome all comments, please submit them to lmario@livs.org.

Leonard J. Marino, MD, FAAP, LVT

Canine Idiopathic Pulmonary Fibrosis

► Continued from Front Cover

the beginning of clinical signs and less than 1 year from the time of diagnosis. Nevertheless, survival time seems to vary greatly between individuals from some months to some years. Most human patients with IPF die within 5 years of diagnosis.

The diagnosis of IPF is based on presenting history, physical exam findings and diagnostic imaging, with exclusion of other respiratory diseases. Only histopathologic examination of lung tissue provides a definite diagnosis, but lung biopsies are seldom taken due to expense and the need for invasive surgery. Dogs with IPF are usually bright and alert due to adaptation to slowly developing respiratory impairment, but some severely affected dogs can be dyspneic and cyanotic. Bilateral, inspiratory crackles are a characteristic finding on lung auscultation, but they might not be audible if the dog is breathing shallowly. In some dogs, crackles can even be heard without a stethoscope when the dog is breathing with an open mouth. An abdominal breathing pattern is commonly present. A murmur, usually low-grade, right-sided, and systolic, can be heard in those dogs with tricuspid regurgitation due to pulmonary hypertension (PHT). Blood hematological and biochemical analyses do not show specific changes for IPF but are commonly taken to rule out other reasons for exercise intolerance.

Older dogs, particularly Terriers, with signs of exercise intolerance or rapid breathing should be considered candidates for further evaluation of IPF. Fibrosis is commonly mistaken for chronic bronchitis or congestive heart failure. The diagnostic approach may involve thoracic imaging (XR or CT), echocardiography, pulmonary function testing, bronchoscopy, BAL and lung biopsy.

Thoracic radiographs may reveal a generalized, bilateral, 'heavy' interstitial pattern (without consolidation or mass), however near normal radiographs do not rule out IPF. Right sided cardiomegaly (secondary to pulmonary hypertension) is occasionally present (**figure 1**).

Echocardiography is useful to document PHT that may represent an additional therapeutic target. The existing studies document PHT in at least 40% of dogs with IPF. PHT can be assessed both qualitatively and quantitatively using echo. Qualitative echocardiographic

abnormalities consistent with PHT, evident on B and M mode echo, include right ventricular (and atrial) dilatation, thickening of the right ventricular free wall, paradoxical motion of the interventricular septum, and decreased size of the left ventricular lumen. Additionally, PHT can be quantified using Doppler echocardiography. Assuming the presence of a



Figure 1: Idiopathic pulmonary fibrosis with a diffuse bronchointerstitial lung pattern. Idiopathic pulmonary fibrosis was confirmed upon lung biopsy.



Figure 2: Thoracic CT scan images obtained from an healthy dog (A) and from a dog affected by pulmonary fibrosis (B).

tricuspid regurgitant (TR) jet (and the absence of pulmonic stenosis); the pulmonary artery systolic pressure correlates with velocity of the TR. Using this velocity value in the Bernoulli equation allows estimation of the pulmonary artery pressure during systole. A tricuspid pressure gradient of $>30\text{mmHg}$ ($V_{\text{max}} > 2.8\text{m/sec}$) is suggestive of systolic PHT.

High-resolution computed tomography (HRCT) is the standard of care for evaluation of humans with suspected IPF, and would

likely be performed in a referral hospital setting. Classic HRCT abnormalities associated with IPF (in order of decreasing frequency in WHWT) include ground glass opacities (GGOs), traction bronchiectasis and honeycombing. GGOs are multifocal increases in lung opacity that do not obscure the underlying pulmonary vasculature. GGOs have been present in all dogs with IPF in all veterinary studies that report CT findings. Bronchiectasis refers to irreversible bronchial dilation. Traction bronchiectasis refers to dilated bronchi with irregular margins. Bronchiectasis can be diffuse, but is usually localized or multifocal in dogs with IPF. Honeycombing refers to the presence of air-filled cystic structures within the lungs that are often peripherally located and variable in diameter (mm to cm) (**figure 2**).

CT has much better correlation with physiologic dysfunction than thoracic radiography. Pulmonary function testing is also used to support a diagnosis of pulmonary impairment, however collection of arterial blood gases is challenging, especially in small, dyspneic dogs. Dogs with IPF have profound hypoxemia and increased A-a gradients.

Bronchoscopy and BAL are unlikely to be helpful but are usually performed for the sake of completeness and to exclude other diseases. Bronchoscopic abnormalities are non-specific and may reflect concurrent disease. Abnormalities can include mucosal irregularity (may be seen in normal dogs), tracheal collapse, bronchial mucus accumulation, bronchiectasis and bronchomalacia. The lower airway cytology in dogs with IPF usually reveals an increased total cell count (the inflammation occurs secondary to fibrosis, not vice-versa).

Lung biopsy is required for definitive diagnosis, however rarely performed in veterinary medicine due

to associated costs, inherent risks and the inability of histopathologic (HP) findings to facilitate more effective therapy at this time. Samples for HP can be obtained via an open approach (thoracotomy), with a key-hole thoracotomy or thoroscopically. Histopathology of WHWT with IPF is characterized by expansion of the pulmonary interstitium with an eosinophilic, trichrome staining, extracellular matrix

Continued on Page 6 ►



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Michel Selmer, DVM, CTCVMP (Integrative Medicine)

Dr. Michel Selmer is an Integrative Veterinarian and one of only a handful of Traditional Chinese Veterinary Medicine Practitioners in the United States.

Dr. Michel Selmer attended Long Island University and graduated Cum Laude with a Bachelor of Arts Degree in Psychology. Following his undergraduate studies, he was admitted to Michigan State University School of Veterinary Medicine and earned his Doctorate of Veterinary Medicine in 1995. Following his Traditional Veterinary studies, he was admitted to the Chi Institute where he graduated with the top honor of being a Certified Traditional Chinese Veterinary Medicine Practitioner (CTCVMP).

Dr. Selmer is a published author and consults with other veterinarians as well as pet parents around the globe. In 2018, he made the exciting decision to join the Long Island Veterinary Specialists team as the Lead Veterinarian in their Integrative Medicine Department.

The passion Dr. Selmer has for his profession - and his love for all animals - has contributed to the high quality medicine that he practices.

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Canine Idiopathic Pulmonary Fibrosis

► Continued from Page 4

(ECM), that can either be diffuse or regional. IHC confirms the ECM is both type I and predominantly III collagen. The collagen expands the interstitium down at the level of the alveolar septa, and is reported to have concentric distribution around alveolar capillaries. The presence of the matrix increases the distance between alveolar epithelial cells and pulmonary capillary endothelial cells at the blood-air interface. A mixed inflammatory infiltrate (lymphocytes, macrophages and plasma cells) is also usually present, but of variable severity (scant to marked). Other reported abnormalities include type II pneumocyte hyperplasia, prominent intra-alveolar macrophages and emphysema. Interestingly the HP of WHWT with IPF is not identical to IPF in people, nor does it fit nicely into any of the human categories of IPF (**figure 3**).

At the moment, there is no effective treatment of IPF. Treatment is mainly used to reduce clinical signs on an individual basis and, secondly, to alleviate possible complications that can develop during the course of the disease. No clinical treatment trials have been performed on dogs with IPF and only anecdotal evidence exists for an effect of any drug.

Oxygen supplementation is really the mainstay for the acute treatment of dogs with IPF. Not only does oxygen supplementation improve the hypoxemia, it also results in pulmo-

nary vasodilation and ameliorates pulmonary hypertension. Interestingly chronic oxygen therapy can even reverse some of the structural changes that occur in the lungs in animals with chronic PHT. Late stage IPF is an oxygen dependent state; and thus disease may prog-

are phosphodiesterase inhibitors (PDEI), which increase cAMP and promote smooth muscle relaxation and vasodilation.

Antitussives can be used in dogs with a history of cough, for symptomatic relief. Hydrocodone and butorphanol are used most commonly. Sedation is a common side effect, however this may be beneficial if coughing is triggered by excitement.

Sildenafil (1-3mg/kg PO q 8-12 hours) is indicated for dogs with significant pulmonary hypertension. Sildenafil increases cGMP and promotes NO mediated vasodilation.

Treatment with proton pump inhibitors or histamine-2 receptor blockers could be considered if corticosteroid therapy is started because hypoxemia can make the dog more prone to adverse gastrointestinal effects. In human patients with IPF, gastroesophageal reflux, either symptomatic or occult, is very common, and microaspiration is speculated to have a role in the pathogenesis of IPF.

The prognosis associated with IPF is guarded; many dogs die or are euthanized due to progressive pulmonary failure and associated respiratory distress within 12-18 months. Prognosis is grave for dogs that are oxygen dependent at first diagnosis, but lesser affected dogs may have a markedly prolonged survival. □

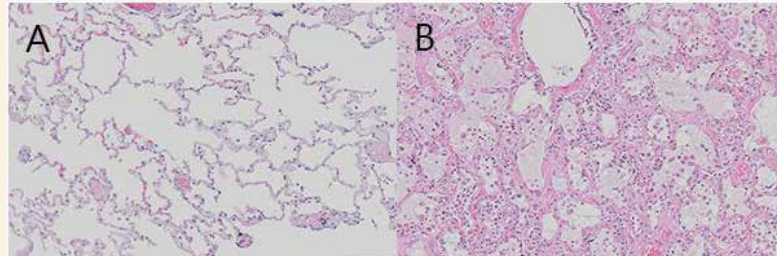


Figure 3: The histopathology of IPF in WHWTs is characterized by mild diffuse interstitial fibrosis (left) with multifocal areas of more severe interstitial fibrosis, alveolar epithelial atypia and hyperplasia, along with alveolar proteinosis and minimal interstitial inflammation (right).

ress to the point that we would recommend an oxygen cage at home for dog owners wishing to pursue treatment.

Given the limited treatment options available for IPF, corticosteroid therapy is usually tried. However, any inflammation that occurs is only secondary to the fibrosis, and while steroids may reduce the inflammation, they are unable to reverse the fibrosis. The use of traditional anti-inflammatory doses of prednisone (0.5-1mg/kg/day PO) are commonly utilized.

While bronchodilators are not specifically indicated for dogs with IPF, theophylline may have some benefit in the treatment of dogs with PHT secondary to IPF. Methylxanthines



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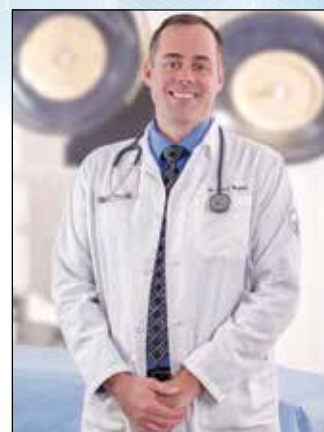
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Acupuncture and Electroacupuncture for Pain Management: Mechanisms of Action from a Conventional Medical Perspective

C.W. Dewey, DVM, MS, CVA, CVCH, DACVIM (Neurology), DACVS

The appeal of acupuncture as a pain-relieving therapy is growing in veterinary practice; however, there remains some reticence among veterinarians to accept acupuncture as a viable treatment modality; this reticence persists despite numerous experimental and clinical studies demonstrating both specific biological effects of acupuncture and measurable clinical benefit. Most of these studies have been performed in laboratory animals and humans with painful conditions, but much of the knowledge from this literature can be applied to veterinary practice. One of the barriers to integrating acupuncture into modern veterinary practice is a commonly held perception that it is based on archaic principles, rather than contemporary medical science. Although the traditional Chinese veterinary medical (TCVM) terminology and mechanistic explanations are indeed based upon an antiquated system of understanding, the physiologic prin-

Most of these studies have been performed in laboratory animals and humans with painful conditions, but much of the knowledge from this literature can be applied to veterinary practice.

ciples and rationale for clinical application of acupuncture as a pain-relieving modality can be couched in contemporary medical terms. One of the frustrating aspects of learning how to use acupuncture in modern veterinary practice relates to the nomenclature used to describe the acupuncture points; the acupuncture points are found along specific conceptual pathways-meridians or channels-that traverse the patient's body. Because these pathways and respective points are named according to an ancient medical system, they may not make inherent sense to veterinarians unfamiliar with TCVM concepts. For instance, there are several Gall Bladder (GB) points around the hip joint.

Before delving further into the scientific basis of acupuncture, it is important to point out that acupuncture includes manual acupuncture or "dry needling" (DN), aquapuncture (injecting a sterile liquid into an acupuncture point) and electroacupuncture (EA). Aqua-



puncture may have a greater therapeutic effect than DN; presumptive mechanisms include enhanced stimulation of the injected acupuncture point via spatial distortion of the injected substance and pharmacologic effects of the injected substance. It is generally believed that the clinical effects of EA are more potent and longer-lasting than DN or aquapuncture. The vast majority of experimental and human clinical literature supports the use of EA as the most likely permutation of this treatment method to exert a measurable and lasting physiologic and clinically appreciable effect on pain alleviation. In short, the author's recommendation is to employ EA routinely during acupuncture sessions, rather than DN alone.

As mentioned, acupuncture is a treatment modality that has been around for thousands of years, but many of the mechanisms by which acupuncture is thought to exert beneficial physiologic effects have only recently been elucidated. The recent expansion of knowledge pertaining to the scientific basis of acupuncture is due mainly to advances in neuroimaging and molecular biology techniques. Although the actual names of the acupuncture points along their respective meridians may cause some confusion, the majority of these points and their respective meridians line up with the peripheral nervous system (PNS). Others correspond to known fascial planes of the body. Some believe that acupuncture signals may also follow vascular routes. It is possible that signals are transmitted through a variety of anatomic scaffolds, but it is likely that the nerves play a prominent role in all the scenarios described. In general, the entire body-including the CNS and the viscera-is accessible via the PNS. Classification of acupuncture points is also based upon the location of nerves associated with those points

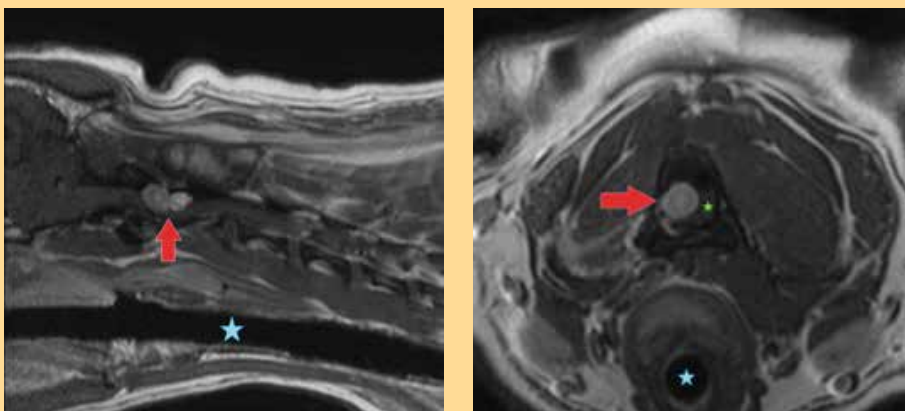


Figure 1: Sagittal (a.) and Transverse (b.) T1W post-contrast images of an English Bulldog with a Peripheral Nerve Sheath Tumor (PNST) at C1-C2. After contrast product injection, the neoplasia is visible as a hyperintense (bright) lobulated mass (red arrow) invading the meninges and severely compressing the spinal cord. "squeezed" into a crescent shape on the transverse images (green star). The nearby trachea is identified (blue star). The tumor was surgically removed after dorsal laminectomy at C1-C2 and durotomy, and the patient recovered ambulatory status post-surgically.

Continued on Page 10 ►

Acupuncture and Electroacupuncture for Pain Management: Mechanisms of Action from a Conventional Medical Perspective

► Continued from Page 9



Figure 2: English Bulldog post-surgery (same patient as in Figure 1): Acupuncture (dry needle as illustrated here, or electro-acupuncture) is an invaluable method to help relieving neck pain, post-surgically (as illustrated here) or in cases where conservative/medical management is preferred.



Figure 3: Long-haired Dachshund receiving electro-acupuncture treatment post-operatively, following thoracolumbar hemilaminectomy for IVDD.

as follows:

- Type I (motor points)-these are located where major nerves penetrate muscles. These are most common and comprise nearly 70% of all acupuncture points.
- Type II-located where nerves intersect on the dorsal and ventral midlines.
- Type III-located where superficial nerves branch.
- Type IV-located where nerves penetrate tendons (e.g., Golgi tendon organs).

An acupuncture point can be thought of as an anatomic unit consisting of free nerve endings, small arterioles, venules, lymphatics and mast cells. There is some evidence that acupuncture points may be thought of as larger than “points” and more like receptive regions or fields in the vicinity of the “point”. Acupuncture points are usually physically in areas of surface depressions and physiologically in cutaneous regions typified by low electrical resistance and high electrical conductivity.

The effects of acupuncture on pain relief include local, segmental (spinal cord level) and suprasegmental mechanisms. Electroacupuncture is more likely to most effectively recruit all three of these mechanisms, in comparison with DN alone. Acupuncture can be thought of as a method of counter-irritation. After providing a stimulus to the tissue with either DN or EA, a local reaction ensues that elicits a number of inflammatory and immune responses. Acupuncture-in particular EA-has a number of physiological effects peripherally (locally) which contribute to alleviating pain. As we

will see, many of these processes involve endogenous opioids. These effects include:

- Induction of release of endogenous opioids from lymphocytes, macrophages and granulocytes into tissue. These opioids then suppress the propagation of nociceptive signals by acting at receptors of the peripheral nerves in the tissue.
- Activation of sympathetic nerve fibers, which leads to increased levels of endogenous opioids in the region. Some of this effect is via adrenergic receptor activation of inflammatory cells, which causes them to release endorphin into the tissue.
- Sympathetic nerve fiber activation also leads to increased expression of specific intracellular adhesion molecules in blood vessels of inflamed tissue. These adhesion molecules promote migration of neutrophils and mononuclear cells that contain endorphin and met-enkephalin.
- Increased levels of cannabinoid CB2 receptors in tissue, which leads to upregulation of endogenous local opioids.
- Decreasing levels of local inflammatory cytokines, including tumor necrosis factor- (TNF α), interleukin 1 β (IL-1 β), and interleukin 6 (IL-6). This is also believed to involve endogenous opioids.
- Inhibition of cyclooxygenase-2 (COX-2) and prostaglandin E2 (PGE2) production.

The segmental (spinal) and suprasegmental (brain) effects of acupuncture cannot be completely separated out, as they are anatomically

and physiologically connected. However, there are a number of anti-nociceptive effects induced by acupuncture (again, particularly EA) at the spinal level that include the following:

- Dampening of glutamate receptor activity in spinal cord dorsal horn neurons, via increasing endogenous opioids, nor-adrenaline and serotonin levels.
- Increased serotonin levels in the spinal cord accentuate the ability of GABA to inhibit pain signal transmission.
- Inhibition of spinal glial cell activation, thereby decreasing astrocyte and microglial-derived pain-promoting cytokines (IL-1 β , IL-6, TNF α , COX-2 and PGE2).
- Blocking of substance P release in spinal cord gray matter (substance P promotes nociceptive signals and activates glial cells).
- Upregulation of Nociception/Orphanin FQ (N/OFFQ) receptors in the spinal cord gray matter. N/OFFQ is a powerful opioid-related peptide that has potent analgesic properties and is widely distributed throughout the spinal cord. It inhibits C fiber evoked responses and wind-up.
- Increasing spinal cord dorsal horn levels of acetylcholine and dopamine, both of which are believed to inhibit nociceptive signaling.
- Activation of spinal cord δ opioid receptors, leading to reduced cellular GABA reuptake. Increased levels of GABA in

Continued on Page 11 ►

Acupuncture and Electroacupuncture for Pain Management: Mechanisms of Action from a Conventional Medical Perspective

► Continued from Page 10

the extracellular space enhance its anti-nociceptive effects.

Although the mechanisms for suprasegmental effects of acupuncture are not as well understood as segmental effects, they are based on the descending anti-nociceptive pathway. There is considerable evidence from functional MRI and PET (positron-emission tomography) studies in people, as well as experimental animal models, that specific acupuncture points—when stimulated—activate specific regions of the brain. This point specificity for stimulation of anti-nociceptive regions of the brain-stem descending pain modulating pathway is most convincing for limb (vs. trunk) acupuncture points. In addition, activation of such points with a sufficient stimulus will activate the intended brain-stem center, without necessarily producing an appreciable segmental effect. By contrast, stimulating an acupuncture point in the dermatomal segment of interest (e.g., a back Shu point for thoracolumbar pain) may produce a mainly segmental analgesic response, or a segmental and descending brain-stem response, depending on the stimulus intensity (if intense enough, the ascending pathways

to brain-stem nociceptive centers may also be recruited). These physiological phenomena are consistent with the typical TCVM recommendations to treat at both local and distal sites. In this way, local, segmental and suprasegmental effects can be combined for maximum results. Some specific examples of suprasegmental effects of acupuncture (primarily EA) include:

- Activation of serotonergic NRM neurons in the medulla.
- Activation of noradrenergic neurons in the locus ceruleus of the pons.
- Stimulation of the hypothalamus to release β -endorphin.
- Activation of descending neurons of the periaqueductal gray (PAG) matter of the mesencephalon.

It has also been demonstrated that low frequency EA (2-10 Hz) is more effective for pain control than high frequency EA (100 Hz). However, there is some rationale to combining modes of acupuncture (DN and EA) and different frequencies of EA to produce a greater analgesic effect than would be possible with only one modality or one frequency. There is some evidence that DN may be more effective

at mediating analgesic effects through C fibers than EA, with EA mediating analgesic effects mainly through A β and A δ fibers. Electroacupuncture has been shown to cause the release of different mediators of analgesia, dependent upon the frequency applied. At low frequencies (2-10 Hz), endorphins and enkephalins are mainly released. At higher frequencies (50-100 Hz), the primary opioid released is dynorphin. At even higher frequencies (>200 Hz), the most prominent neurochemical mediator released is serotonin. In addition, there are other anti-nociceptive agents released, according to certain applied frequencies. For example, at low frequencies, there are also noradrenergic and muscarinic cholinergic mechanisms that are recruited. At high frequencies, there are muscarinic cholinergic and GABA-ergic mechanisms that are brought into play to help decrease nociceptive signaling. It would appear that endorphins and enkephalins may be the most effective EA-induced mediators of pain (at low frequency stimulation); however, it is likely that providing other pain-mitigating agents at higher frequencies may have an additive effect. □

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- Destructive behavior when left unattended (such as at home during the day)
- Excessive barking (or excessive vocalization)
- Compulsive disorders and/or Self Destructive Behavior
- Inappropriate elimination
- Fears and phobias



Long Island Veterinary Specialists

Where You Refer Your Patient First Makes All The Difference

163 South Service Road, Plainview, New York 11803



LIVS Radiation Therapy



To refer your clients for radiation therapy, call
516-501-1700 or visit www.livs.org

Maria Camps, DVM, DACVIM (SAIM, Onc.) • Nicole Leibman, DVM, DACVIM
Dominic J. Marino, DVM, DACVS, DACCT, CCRP



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LIVS has pioneered the application of a specific type of radiation therapy called electronic brachytherapy (EB) to dogs and cats. EB allows the radioactivity to be administered to the surrounding cancer cells from a miniaturized radiation source, rather than a radioactive material as with conventional radiation therapy.

- Effective for a variety of tumor types
- Early radiation "drop off" and direct treatment of tumor bed results in less damage to surrounding tissues
- **Treatment ranges from 3-8 days**
- Can be used in combination with surgery and/or chemotherapy to provide permanent control or death of a tumor
- Up to 30% lower cost than traditional radiation therapy