

Growing old is not easy, but it sure beats the alternative



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Thank you to our sponsor:



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Conflict of Interest Disclosure:

I have no active financial interest, arrangement or affiliation with any company or organization. However, I have previously accepted free products from Spectravet Lasers, and was a paid lecturer for both Antech Imaging and Companion Animal Health.

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What are we going to talk about today?

Lecture #1

- ▶ Concepts in canine gerontology
 - ▶ The importance of frailty
 - ▶ Muscle mass matters
 - ▶ Why we need to keep 'em moving
- ▶ Multimodal treatment of osteoarthritis


Lecture #2

- ▶ Diagnosing and treating back pain in dogs
- ▶ Diagnosing and treating spinal dysfunction

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Age

"the progressive accumulation of changes with time, associated with or responsible for, the ever-increasing susceptibility to disease and death"





Ever vigilant: Portrait of a geriatric squirrel hunter

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Biologic Age vs Chronologic age

Chronologic Age:
The period of time the individual has been alive

Biologic Age:
The extent to which aging has impacted an individual's robustness, resilience, and state of health and function

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Healthspan vs Lifespan: Quality vs Quantity


Lifespan
the period of time alive

Healthspan
The period of time free from significant age-related disease or disability

Medical care	Social/family support	Healthy lifestyle	Environmental conditions
Financial resources Geographical access to veterinarians or specialists Pet insurance	Value placed on pet Motivation to provide rehabilitative or nursing care	Appropriate nutrition Appropriate and regular exercise or risks	Climate/Season Home layout and potential obstacles or risks
Temporal access (time of work, children, etc.) to seek veterinarian	Physical ability to provide rehabilitative or nursing care Perspectives on seeking a pet's quality of life	Mental stimulation and engagement Duties or hobbies: sporting, working, therapy, etc.	Human and animal interactions (positive or negative) Other physical environment (food puzzles, territorial exploration, access to outdoors, access to stimuli, etc.)
Awareness of a problem and where to seek help	Access to resources for or having education in pet care	Preventative care (vaccinations, parasite prevention, dental hygiene, etc.)	Exposure to environmental risks (smoking, pollutants, toxins, infectious or parasitic agents etc.)
Annual or biannual wellness exams			

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Ruby



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Canine Geriatric Syndrome

- CGS consists of the multiple, interrelated physical, functional, behavioral, and metabolic changes that characterize canine aging as well as the resulting clinical manifestations, including frailty, diminished quality of life, and age-associated disease.

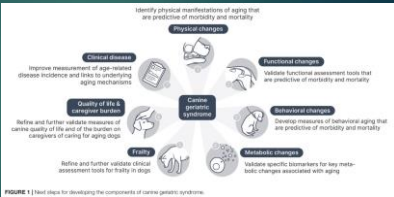


FIGURE 1 | Best steps for breaking the components of canine geriatric syndrome.

Canine Geriatric Syndrome: A Framework for Advancing Research in Veterinary Geroscience. BA, McEwen et al. Frontiers in Veterinary Science, April 2022 | Volume 9 | Article 853743

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Physical Changes

- Greying facial hair, lens opacity and extent of dental disease
- Only correlates with chronologic age



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Clinical Disease



That's all I've got to say about that.

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Metabolic Changes

Adipose:

- Increases with age, regardless of diet
- Also changes in distribution, cellular composition, and endocrine signaling
- Is a pro-inflammatory endocrine organ

Adipokine	Major Actions	Association with OA
Vitellogenin	B cell insulin secretion (IAD pathway), leukocyte adhesion, NF- κ B upregulation	Negative
Chemerin	Functions vary depending on cell type, insulin resistance in muscle, insulin sensitization in adipocytes, chemotactant for immune cells	Negative
Adiponectin	Insulin sensitization (via AMPK), anti-inflammatory (decreased NF- κ B), reduced gluconeogenesis, increase PPAR γ activation	Positive
Leptin	Appetite regulation, increase energy expenditure, lipid oxidation, chronic inflammation	Negative
Resistin	Insulin resistance (decreased AMPK), increase I- κ B, and TNF- α secretion, increased gluconeogenesis	Negative
IL-6	C-reactive protein production, increased secretion of VLDL	Negative
TNF- α	Increase adhesion molecules, macrophage and inflammatory cell migration, insulin resistance, NF- κ B induction	Negative

From: Obesity, Exercise and Orthopedic Disease. Frye, CW et al. Vet Clin Small Anim. 46 (2014) 1031-1041

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Metabolic Changes

Adiponectin:

- ▶ an anti-inflammatory adipokine associated with improved metabolic health and longevity
- ▶ serum adiponectin is lower in dogs with poor metabolic health
- ▶ promising biomarker for metabolic health



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Quality of life/Caregiver burden

Quality of Life

- ▶ QoL is reflection of physical, cognitive, and mood related health
- ▶ Owners notice loss of appetite, mobility, perceived pain, and incontinence, but might underestimate anhedonia
- ▶ No consensus on how to measure QoL

Caregiver Burden

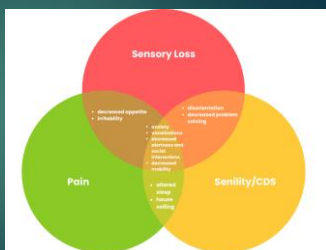
- ▶ Welfare is a family collective
- ▶ Dog size vs owner strength/health
- ▶ The guilt of "giving up"

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Behavioural changes

Pain and behaviour are intertwined

- ▶ Pain has 2 components:
 - ▶ Afferent Signal
 - ▶ Processing
- ▶ Limbic System
 - ▶ Anxiety
 - ▶ Aggression
 - ▶ Depression



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Canine cognitive dysfunction (CCD) Cognitive decline syndrome (CDS)

Multifactorial pathophysiology

- ▶ Deposition of toxic β -amyloid protein (A β) around neurons and blood vessels
- ▶ Brain vascular compromise
- ▶ Neuronal mitochondrial dysfunction
- ▶ Oxidative brain damage
- ▶ Inflammation

4 key clinical signs

1. Sleeping during the day and restless at night
2. Decreased interaction
3. Disorientation at home
4. Anxiety

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Exercise and brain health

- ▶ Acute exercise:
 - ▶ Transiently improve cognitive function
- ▶ Long-term exercise:
 - ▶ Stimulates brain plasticity, improves brain function, and helps to stave off neurological disease



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Brain Derived Neurotrophic Factors (BDNF) and exercise

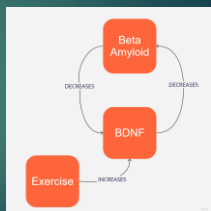
- ▶ BDNF levels in humans are significantly elevated in response to exercise, and the magnitude of increase is exercise intensity dependent
- ▶ BDNF play an important role in maintaining synaptic plasticity in learning and memory.
- ▶ BDNF appear to be a beneficial marker for cognitive health



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BDNF and Aβ

"Aβ plaques in the cranial part of the parietal lobe correlated with behavioral changes in aged companion animals related to appetite, drinking, incontinence, day and night rhythm, social behavior, orientation, perception, and memory."



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Bottom line:

"Growing evidence supports the value of regular physical exercise to prevent Alzheimer's disease as well as cognitive decline in affected patients."



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Functional Changes - ADLs

- ADL = activities of daily living
- In humans, there is strong established connection between functional capacity and mortality

TABLE 2 | Canine task dependent movement.

Basic activity for daily independent mobility (BADIM)	Instrumental activity for daily quality of life (IADQOL)
Rising from a down position	Ascending/descending a full flight of stairs
Ambulating in and out of the home	Moving in and out of a vehicle
Posturing to eliminate	Walking short distances outside
Posturing to eat and drink	Exploring the home environment
	Interacting in play (fetch, chase, tug of war, etc.)
	Ability to navigate place of rest (couch, bed, crate, etc.)
	Maintain control of urination and defecation for 6-8 h

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Frailty

- Multidimensional syndrome characterized by a loss of resilience to stressors associated with aging



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Frailty is the reduction of:

Robustness

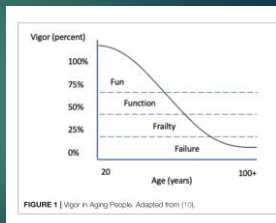
- The ability of an organism to maintain a state of baseline or optimal physiologic function in the face of external stressors

Resilience

- The ability of an organism to return to a state of baseline or optimal physiologic function following perturbations caused by external stressors

Vigor

- The retention of positive attributes such as strength, speed, and energy



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The Importance of measuring Frailty

- Superior way to assess the manifestations of aging and associated risks of disease and death
- Can direct medical or surgical protocols to improve outcomes and survival rates
- Early identification and targeted intervention can delay, prevent or reverse the progression of frailty



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How to measure frailty

Frailty Phenotypic (FP)

- FP model is based on the presence or absence of components that can be physically evaluated (5 part test)


Frailty Index (FI)

- FI model includes medical and laboratory findings and assigns numeric scores to those components

Category	Frailty Phenotypic Score	Median Survival Time (months)
Non-frail	0 /5	42.5
Pre-frail	1-2 /5	35.4
Frail	3+ /5	10.5


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How to prevent frailty and biologic aging




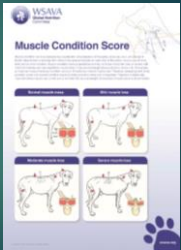
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Keep 'em lean: Adipose alters perception of pain



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Muscle Mass Matters: Keep 'em beefy

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Muscle changes with age: Sarcopenia

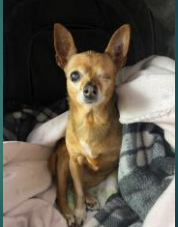
- ▶ marker for increased risk for disease and death
- ▶ effects on strength, immune function, and quality of life
- ▶ increase morbidity and mortality



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Muscle changes with age: Cachexia

- ▶ Common condition
- ▶ Linked to a variety of chronic and acute diseases such as:
 - ▶ Congestive heart failure
 - ▶ Neoplasia
 - ▶ Chronic kidney disease
 - ▶ Respiratory disease
 - ▶ Acute illness or injury



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Cardiac Cachexia

- ▶ 10-15% of all dogs and cats affected by some form of heart disease
- ▶ 48-54% of dogs with CHF have some degree of cachexia
- ▶ Cardiac cachexia typically is recognized only after CHF has developed
- ▶ 34-84% of dogs and cats with heart disease have reduced food intake, which becomes more common with increasing severity of disease
- ▶ Dogs with CHF that lost weight had significantly shorter survival times compared to those of stable or normal weight



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Renal cachexia and the Obesity Paradox

Obesity Paradox

- ▶ Obesity is a risk factor for the development of heart disease in humans, but has a protective effect once heart failure is present
- ▶ Obese or overweight patients had a lower mortality compared to underweight patients
- ▶ Also appears to exist in dogs and cats with renal cachexia
- ▶ Thin dogs having significantly shorter survival times compared to normal weight or even overweight dogs
- ▶ Lowest survival is for cats with a low body weight, followed by very overweight, with cats in the middle having the longest survival times.
- ▶ Decreased appetite is an important contributing factor

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Cancer Cachexia

- ▶ Thin animals had a significantly shorter survival time compared to those that were normal or overweight



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How to increase muscle mass: Adequate dietary protein

- ▶ 25% animal based protein on a dry matter basis
- ▶ 3mg/kg lean body weight



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How to increase muscle mass: Supplements

Myostatin inhibitor

- ▶ Fortetropin (Myos)
- ▶ Mechanism:
 - ▶ Promotes muscle growth by upregulating mTOR pathway and lowering myostatin levels
 - ▶ Slows slowing muscle degradation by downregulating ubiquitin pathway

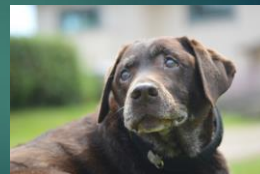


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How to increase muscle mass: Omega 3 Fatty Acid (EFA) Supplementation

EFA and CHF

- ▶ Dogs with CHF have significantly lower omega-3 fatty acid concentrations compared to healthy controls
- ▶ Decreases the muscle loss in dogs with CHF
- ▶ May improve appetite in some cases
- ▶ Antiarrhythmic effects and also may enhance myocardial energy metabolism
- ▶ Supplementation is linked to longer survival time
- ▶ Dosage: 40 mg/kg EPA and 25 mg/kg DHA



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How to increase muscle mass: Omega 3 Fatty Acid (EFA) Supplementation

EFA and OA

- ▶ Reflex inhibition and disuse atrophy
- ▶ Dosages: 100mg/kg combined DHA & EPA



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How to increase muscle mass: Appetite Stimulants

- ▶ Address underlying issue whenever possible
- ▶ Mirtazapine
- ▶ Entyce?
- ▶ Prednisone???



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How to increase muscle mass: Strength training and exercise

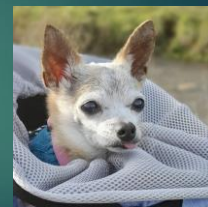
- ▶ ADL activity
- ▶ Therapeutic exercise (Therex)



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Keep 'em Moving Exercise reduces pain

- ▶ Exercise induces changes in the brain, spinal cord, immune system, and at the site of injury to prevent and reduce pain
- ▶ Works via central mechanisms
 - ▶ Endogenous opioids
 - ▶ Serotonergic system
 - ▶ Endocannabinoid system



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Keep 'em Moving Exercise reduces pain

- ▶ Inactivity increases the risk of developing chronic pain
- ▶ Sedentary people have a higher incidence of musculoskeletal pain
- ▶ Exercise works both as a prevention and a treatment of chronic pain or hyperalgesia



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Keep 'em Moving Exercise reduces pain

- ▶ There is a minimal threshold of activity necessary to protect against development of hyperalgesia.
- ▶ Exercise to exhaustion resulted in hyperalgesia that was more severe than a sedentary lifestyle



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Keep 'em Moving Exercise reduces pain

- ▶ An acute bout of exercise can increase pain in individuals with chronic pain, but regular exercise both prevents and alleviates chronic pain
- ▶ Treadmill training 2 weeks before injury combined with 2 weeks after injury produced the greatest analgesic effects compared with solely training either before or after injury.
- ▶ Greater intensity exercise produced greater analgesia, but increasing the frequency of less intense exercise did not




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Bottom Line:

To reduce and prevent pain:

- ▶ Regular exercise
- ▶ Intermittent sessions of more intense exercise
- ▶ Do not exercise to the point of exhaustion



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Treating Osteoarthritis



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Keep 'em Moving Feed the cartilage with movement



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Healthy and Unhealthy Joints

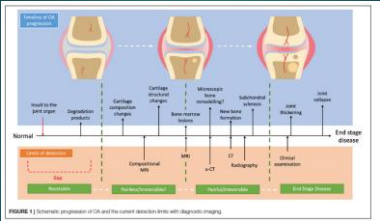
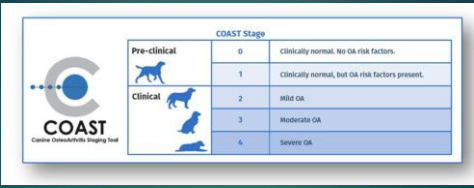


FIGURE 1 Schematic progression of OA and the current detection limits with diagnostic imaging.

▶ Jones et al., Moving Beyond the Limits of Detection: The Past, the Present, and the Future of Diagnostic Imaging in Canine Osteoarthritis, *Front. Vet. Sci.*, 15 March 2022. See, *Veterinary Surgery and Anesthesiology*, Volume 9 | 2022 | <https://doi.org/10.3389/fvets.2022.789888>

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Treating Osteoarthritis




COAST Stage		
Pre-clinical	0	Clinically normal, no OA risk factors.
Pre-clinical	1	Clinically normal, but OA risk factors present.
Clinical	2	Mild OA
Clinical	3	Moderate OA
Clinical	4	Severe OA

Mosley, C. et al., Proposed Canadian Consensus Guidelines on Osteoarthritis Treatment Based on OA-COAST Stages 1-4, *Front. Vet. Sci.*, April 2022 | Volume 9, doi: 10.3389/fvets.2022.830098

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Treatment for all cases: Optimal body condition



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Optimize body condition:

Lose excess body fat:

- Adipose is a pro-inflammatory endocrine organ
- Biomechanical stress
- Altered movement patterns

Adipokine	Major Actions	Association with OA
Viscerin	↑ all insulin secretion (IAD pathway), leukocyte adhesion, NF- κ B upregulation	Negative
Chemerin	Functions vary depending on cell type, insulin resistance in muscle, insulin sensitization in adipocytes, chemoattractant for immune cells	Negative
Adiponectin	Insulin sensitization (via AMPK), anti-inflammatory (decreased NF- κ B), reduced glucocorticoids, increase FFA oxidation	Positive
Leptin	Appetite regulation, increase energy expenditure, lipid oxidation, chronic inflammation	Negative
Resistin	Insulin resistance (decreased AMPK), increase IL-6, and TNF- α secretion, increased glucocorticoids	Negative
IL-6	C-reactive protein production, increased secretion of IL-6, inflammation, reduces adiponectin, increases leptin and chemerin	Negative
TNF- α	Increase adhesion molecules, macrophage and inflammatory cell migration, insulin resistance, NF- κ B induction	Negative


From: Obesity, Exercise and Orthopedic Disease, Frye, CW et al. Vet Clin Small Anim 44 (2014) 831-841

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Optimize body condition:

Maintain/build muscle mass:

- Minimum 25% animal protein in diet (3g/kg lean body mass)
- Fortetropin
- Appropriate exercise
 - Exercise modification
 - Therapeutic exercise



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Treatment for all cases: Nutriceuticals:

<p>1st Tier</p> <ul style="list-style-type: none"> ▶ Omega-3 Essential Fatty Acids ▶ Green Lipped Muscle/Antinol ▶ Cartrophen ▶ Undenatured Type II Collagen (UCII) 	<p>2nd Tier</p> <ul style="list-style-type: none"> ▶ Boswellia ▶ Avocado and soybean unsaponifiables (ASU) ▶ Myos ▶ Glucosamine and Chondroitin ▶ Astaxanthin ▶ Egg shell membrane ▶ Turmeric/Curcumin ▶ Hyaluronic acid (oral)
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Treatment for all cases: Exercise Modification

- ▶ Goldilocks Zone
- ▶ Target motor and proprioceptive nerves
- ▶ Challenge without failure
- ▶ Terrain considerations



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Treatment for all cases: Therapeutic Exercise

- ▶ Flexibility
- ▶ Proprioception
- ▶ Strength



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Treatment for all cases: Resolve Comorbidities (nothing works in isolation)

Shelbow



Shneck



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Treatment for all cases: Resolve Comorbidities

Hip or Stifle OA Sequelae

- ▶ Hip flexors
 - Sartorius
 - Iliopsoas
 - Rectus femoris
- ▶ SI joint
- ▶ Lumbar paraspinals
- ▶ Anticlinal region
- ▶ Iliocostalis
- ▶ Shoulder flexors
 - Traps
 - Lat dorsi
- ▶ Pectineus muscle



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Treatment for all cases: Situational NSAIDs



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Treatment for select cases:



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Pharmaceutics

- ▶ NSAIDs
- ▶ Librela
- ▶ Amantadine
- ▶ Gabapentin/Pregabalin
- ▶ CBD
- ▶ Acetaminophen
- ▶ Opioids
- ▶ Ketamine
- ▶ Tramadol



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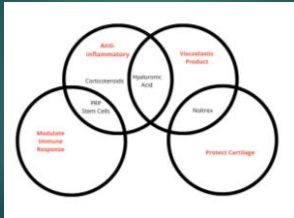
Treatment for select cases: Extracorporeal Shockwave Therapy (ESWT)

- ▶ Stimulates production of growth factors
- ▶ q7d x3 then pm q3m pm
- ▶ 80% response rate



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Treatment for select cases: Palliative Joint injections



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Treatment for select cases: Palliative Joint injections

Anti-inflammatory products:

Corticosteroids

- ▶ Triamcinolone
 - ▶ Shorter acting
 - ▶ Not chondrototoxic?
- ▶ Methylprednisolone
 - ▶ Longer acting
 - ▶ chondrototoxic



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Treatment for select cases: Palliative Joint injections

Anti-inflammatory products:

- ▶ Regenerative Medicine
 - ▶ PRP, ACP, ACS
 - ▶ Stem cells (ADSC, SVF, BMAC, etc.)



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Treatment for select cases: Palliative Joint injections

Viscoelastic products

- ▶ Hyaluronic acid (HA)
- ▶ Polyacryamide aqueous hydrogels (PAAAG)
 - ▶ Noltrex



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Treatment for select cases: Acupuncture

Local response:

- ▶ Decrease pro-inflammatory cytokines

Central response:

- ▶ Release of pain inhibiting neurotransmitters into spinal cord



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Treatment for select cases: Laser

Effects:


- ▶ Transduction of photons into metabolic changes via chromophores
- ▶ Increased ATP production
- ▶ Nitrous Oxide modulation
- ▶ Reduces inflammation



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Treatment for select cases: Pulsed Electromagnetic Field Therapy (PEMF)

- ▶ Adjunct treatment
- ▶ Mediates nitric oxide effects on local perfusion
- ▶ Increases cartilage matrix synthesis in vitro and in vivo
- ▶ Benefits are of short duration for OA
- ▶ RCT on 40 dogs found improved force plate values, CBPI scores, joint extension, and thigh circumference



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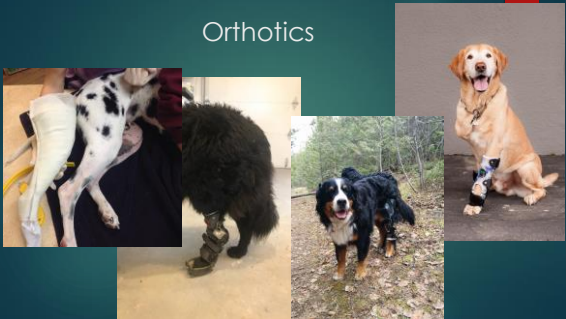
Treatment for select cases: Transcutaneous Electrical Nerve Stimulation (TENS)

- ▶ Pain control via gate control of pain
- ▶ Works best for localized pain of moderate intensity in superficial location



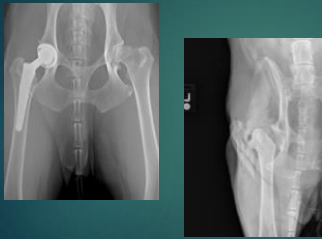
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Orthotics



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Surgery

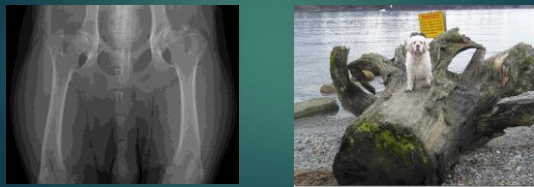


- ▶ THR/FHO
- ▶ Arthrodesis
- ▶ CUE
- ▶ TKR
- ▶ Joint resurfacing

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Diagnose the patient, not the radiograph

"HD dogs show no direct correlation between the degree of pain and the severity of radiographic changes within the joints"



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