PAIN MANAGEMENT
IN THE
CANINE PATIENT

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PART 5:
THE IMPACT OF PAIN ON THE BODY - A REHAB PERSPECTIVE

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THE IMPACT OF PAIN ON THE NEUROMUSCULOSKELETAL SYSTEM

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- **DEEP PAIN**
  - Pain in joint, muscle or viscera
  - Responses:
    - **Increase in tissue temperature**
    - **Limping**
    - **Guarding of the limb**
    - **Joint swelling**
    - **Hyperalgesia to heat and mechanical stimuli**

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- **DEEP PAIN**
  - Deep tissues inputs to a small area of dorsal horn
  - Many deep tissues project to the same receptive field in the dorsal horn
  - Deep pain stimulates more areas of the dorsal horn
    - **Thus deep pain sensations are more diffuse, poorly localized and may allow for a greater amount of referral sites**

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- IMPLICATION:
  - Deep Pain may give rise to more diffuse signs / symptoms
  - Deep Pain may affect an entire REGION or entire LIMB

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- **Nociceptors are found in <u>Skeletal Muscle</u>**
  - Dense in tendons, fascia, & aponeurosis

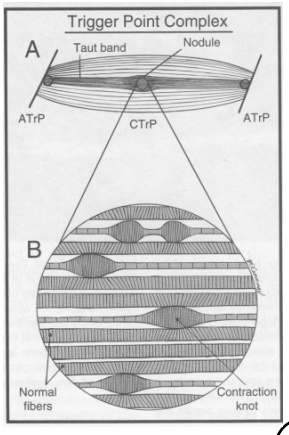
Lesion in Muscle

- Release of endogenous sensitizing and pain-producing substances ('kinins' and prostaglandins)
- Vasodilation and local edema
- = Interstitial pressure, & compression of veins, which leads to venous congestion and ischemia
- Ischemia promotes release of nociceptive substances (bradykinin or prostaglandins) which sensitize nociceptors
- Increased nociceptive activation increases excitability of dorsal horn neurons and therefore central sensitization

More pain

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- **Muscle Pain**
  - Ischemia within a muscle may lead to failure of the Ca+ pump, which can lead to a 'localized contracture'.
  - This may impair localized circulation that further enhances ischemia.
  - THIS is one proposed mechanism for the development and maintenance of trigger points



PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- IMPLICATION:
  - When confronted with Muscle Lesions we need to think about the potential for myofascial triggerpoints
    - (if not short term, then look for them in the long term)

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- **Nociceptors are found in Joints**
  - Location: joint capsule, ligaments, bone, periosteum, articular fat pads, & blood vessels (but not cartilage)

Osteoarthritis:

- Mechanical Pain:
  - Abnormal loading,
  - Stress on capsule, ligament, & periarticular tissue
- Inflammatory Pain:
  - Due to chemicals released

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

Inflammation

⇩

Increased responses in Aβ, Aδ, and type C afferents to noxious activity & innocuous joint movement

⇩

"Silent nociceptors" will respond to innocuous & noxious stimuli, and joint movement and pressure (peripheral sensitization)

⇩

Peripheral sensitization can lead to central sensitization of dorsal horn neurons

⇩

Pain & Loss of Function

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

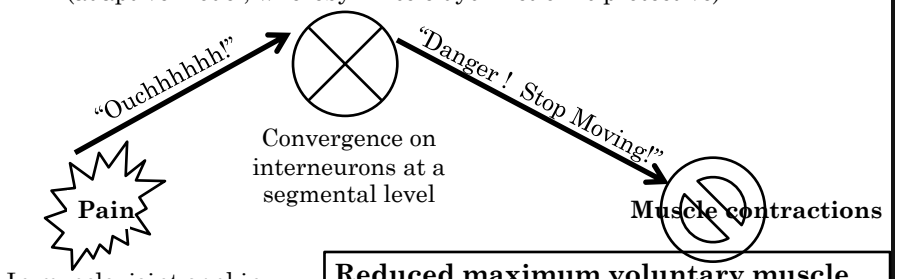
- IMPLICATION:
  - Think of Peripheral & Central Sensitization issues with O/A
  - Need to address loss of function (perhaps as much as you address the pain!)

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- **FUNCTIONAL DEFICITS - Weakness + Painful Joints**
  - Wasting of stabilization muscles in the lumbar spine (eg. multifidus) in pts with LBP (suggestive of localized reflex inhibition)
  - Reflex inhibition of Quads is associated with knee joint pathology (effusion)
  - Deficit in the timing of activation of the vastus medialis in pts with patellofemoral pain
- ***Are motor deficits compensatory, responsive, or predisposing? ??***

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- **FUNCTIONAL DEFICITS - Muscle Inhibition + Pain**
  - (adaptive model, whereby muscle dysfunction is protective)



Reduced maximum voluntary muscle contraction
- in experimentally induced muscle pain
- in LBP scenarios
- in fibromyalgia
- in temporomandibular joint dysfunction

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- **FUNCTIONAL DEFICITS - Muscle Inhibition + Pain**
  - Movement is affected:
    - Inhibition of painful muscle and facilitation of the antagonist
  - Coordination is affected:
    - Studies showed reduced stride time in induced lower leg muscle pain
    - Studies showed reduced velocity and range of voluntary trunk motion AND reduced EMG amplitude in subjects with induced paraspinal muscle pain.

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- **FUNCTIONAL DEFICITS - Muscle Inhibition + Pain**
  - Chronic pain inhibits coordination & stability:
  - Patients with chronic LBP fatigue faster, have poorer balance performance, & delayed postural response times (compared to normal subjects)
  - Patients with chronic LBP have a deficit in the recruitment of transversus abdominis during postural perturbations (thus suboptimal spinal control)
  - Patients with chronic wrist pain have a disturbance of fine motor control of the wrist on the unaffected side.

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

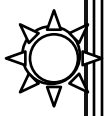
- **FUNCTIONAL DEFICITS – Proprioception + Pain**
  - Pain can impact body awareness, coordination, and proprioception
    - Falls in older adults are more frequent in those with 2 or more reported pain sites, in those with greater pain severity & pain interference.
    - Patients with L/S stenosis (even if only mild symptoms) have decreased function and balance

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- **FUNCTIONAL DEFICITS – Proprioception + Pain**
  - Neck pain and proprioception & balance
    - Chronic neck pain pts show abnormal static & dynamic balance
    - Experimental neck pain has a destabilizing effect on standing balance
    - Non-specific neck pain persons have reduced acuity of goal-directed arm movements (pointing at a visual target)
    - WAD pts have impaired shoulder proprioception (as measured by active ipsilateral arm position matching)

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- **FUNCTIONAL DEFICITS – Proprioception + Pain**
  - Osteoarthritis and proprioception & strength deficits
    - Hip & Knee OA has no impact on postural control or disability
    - Joint PAIN does have an impact on postural sway, disability, & reduced muscle strength



PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- IMPLICATION:
  - Addressing FUNCTION with your chronic pain patients
    - Balance & Coordination
    - Proprioception
    - Strength
    - Gait
    - Motor Control & Timing Issue

** Go back to your rehab notes to work out 'HOW'**

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- **Neural Mechanosensitization**
  - Peripheral neuritis occurs with minimal peripheral nerve injury, with no axonal loss or changes in nerve conduction
  - Nerve sheath inflammation can cause pain behaviours, hyperalgesia, and allodynia on sensory testing
  - The lesion site shows an increase in mechanosensitization of A-δ fibres, C-fibres, and deep nociceptor axons.

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- **Neural Mechanosensitization**
  - The inflammation and resultant mechanosensitization may cause spontaneous firing of the Aβ fibres & C-fibres
  - Subsequently, can result in spontaneous firing from the associated dorsal root ganglia
  - Spontaneous firing triggers a cascade of events in the CNS that can lead to chronic pain

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- **Neural Mechanosensitization**
  - Normally peripheral nerve root trunks and roots are painless to non-noxious mechanical stimuli and are well adapted to allow for changes in length associated with movement or postural changes
  - Sustained abnormal postures *(i.e. keyboard use in humans or prolonged kyphosis in dogs)* can alter nerve environment and cause non-specific limb pain or spine pain.

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- **Neural Mechanosensitization**
  - Inflamed neural tissue is highly sensitive to mild mechanical provocation and movement which generates a nociceptive response.
  - If disorders become severe enough, neural tissue becomes non-compliant to movement

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- **Neural Mechanosensitization**
  - Disc herniation causes nerve root sensitization d/t herniated nucleus pulposus gaining access to the nerve via the epidural space
    - Nerve conduction decreases by 20% with disc material leakage and subsequent vascular changes & NR ischemia
    - Nerve root compression ≠ pain but CHRONIC nerve root compression can = pain. INFLAMMATION is the difference!
    - Nerve root injury produces a stronger centrally mediated response than peripheral injuries

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- **Neural Mechanosensitization**
  - Spontaneous pain can = Nerve pain / Mechanosensitization

Physical Signs of Neural Tissue Mechanosensitivity (from Hall & Elvey 2004)

1. Antalgic posture
2. Active movement dysfunction
3. Passive movement dysfunction, which correlates directly with the degree of active movement dysfunction
4. Adverse responses to neural tissue provocation tests which relate specifically and anatomically to # 2 & 3
5. Mechanical allodynia in response to palpation of specific nerve trunks which relates specifically and anatomically to # 2, 3 & 4.
6. Evidence of a local cause for the neural tissue mechanosensitization disorder, which relates specifically and anatomically to # 4 & 5.

Note: There is little research to investigate the reliability, sensitivity, or diagnostic validity of such physical signs or neural tissue provocation tests, however there is no gold standard to compare them to anyways!

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- **Neural Mechanosensitization**
  - Assessment of tissue mechanosensitivity
    1. Examination of local pathology in the spine (palpation & segmental mobility tests)
    2. Assessment of neural functioning
       - Sensory loss along dermatome (lick & chew marks?)
       - Tendon reflex changes of myotomes (hyper-reflexia with CNS sensitization)
       - Muscle weakness (d/t pain inhibition)
    3. Diagnostic validity has been shown when social history & physical exam of neural functioning are taken into consideration.

PAIN & THE NEUROMUSCULOSKELETAL SYSTEM

- IMPLICATION:
  - Contemplate the role that NERVES play in the chronic pain scenario
    - What MEDS address nerve-related pain?
    - What REHAB therapies address nerve-related pain?

The Impact of Pain on the Autonomic Nervous System, The Endocrine System & The Immune System

Pain & Overall Health

- Stress is concomitant with pain & impacts various systems & strategies within the body

PAIN & OVERALL HEALTH

Adrenaline, the Sympathetic & Parasympathetic Nervous System

- The sympathetic nervous system (fight or flight) activates quickly with painful or stressful situations and normally shuts down within an hour.
- If the sympathetic nervous system doesn't shut off, it contributes to persistent levels of chronic pain and stress

PAIN & OVERALL HEALTH

Adrenaline, the Sympathetic & Parasympathetic Nervous System

- Adrenaline is released when the SNS is activated and can heighten the body's alarm system
  - (and lead to sensitization if not shut off as well)
- The parasympathetic system (rest and digest) should switch ON when a 'threat' has passed.
- In chronic pain states, and especially if the patient is unable to get restful sleep, the parasympathetic system does not get a chance to assist in tissue replenishment and growth.

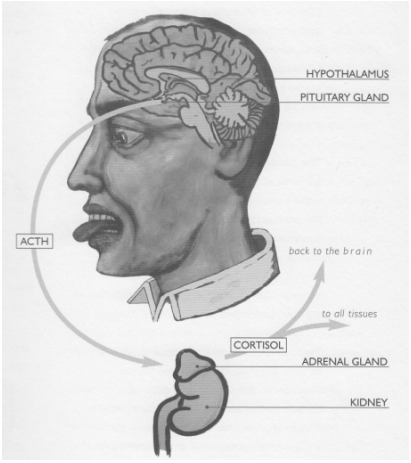
PAIN & OVERALL HEALTH

- IMPLICATION:
  - NORMALIZATION of the Autonomic Nervous System may be required
    - RESTFUL sleep
      - i.e. Meds for sleeping
      - i.e. Daily exercise to aid with sleep quality
    - Relaxation techniques
      - i.e. Massage
      - i.e. Pleasant daily activities

More information to come!

PAIN & OVERALL HEALTH

The Endocrine Response:



PAIN & OVERALL HEALTH

Endocrine Response

- The endocrine system is involved in the stress response.
  - Effects can last weeks or months rather than minutes or hours.
- With threatening inputs, memories, and circumstances,
  - the hypothalamus releases hormones...
  - which makes the pituitary gland release hormones (adrenocorticotropic hormone – ACTH) into the blood...
  - Within a couple of minutes ACTH is picked up by chemical sensors in the adrenal gland which then produces a number of hormones, including cortisol.

PAIN & OVERALL HEALTH

Endocrine Response

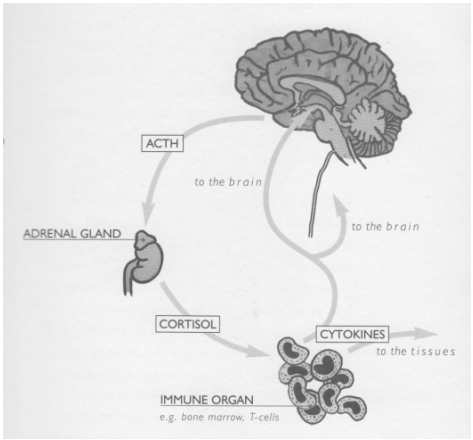
- Cortisol protects you when you are challenged:
  - Supports and enhances muscles, the brain, and stimulates some endorphin support; while repressing things such as reproduction and digestion.
- Cortisol increases in production with both physical *and mental* threats.
- However:
  - Persistent elevated levels of cortisol are linked to slow healing, loss of memory, depression, despair and a decline in physical performance.

PAIN & OVERALL HEALTH

- IMPLICATION:
  - You must also REDUCE STRESS in chronic pain patients.

PAIN & OVERALL HEALTH

The Immune System:



PAIN & OVERALL HEALTH

The Immune System:

- Cytokines are the warriors of the immune system.
  - Some cytokines promote inflammation, and some try to stop it.
- Cortisol activates the immune system,
  - The immune system can be stimulated by the sympathetic system,

the immune system can signal the brain,
the brain activates the cortisol system… and so on.

PAIN & OVERALL HEALTH

The Immune System:

- The immune system is more involved when pain becomes serious or chronic, and can become a 'learnt responses'.
- Long term stress and pain (or repetitive, ongoing minor events) can lead to increases in circulating pro-inflammatory cytokines.
- The immune system can also (like the other systems) be activated by the brain's interpretation of events.

PAIN & OVERALL HEALTH

The Immune System:

- Known behaviours to buffer the immune system:
  - **To have an influence on the quality of one's life**
  - **To be in control of your life and your treatment options**
  - **To have family and medical support**
  - **To have strong belief systems**
  - **To have and use a sense of humour**
  - **To exercise appropriately**

How might we apply this to the animal patient?

THE IMPACT OF PAIN ON THE BODY

- **Summary**
  - Pain can cause the following changes:
    - **Diffuse, poorly localized pain**
    - **Myofascial pain syndrome / Myofascial trigger points**
    - **Adaptive posturing**
    - **Muscle weakness / reflex inhibition**
    - **Altered coordination / body awareness / proprioception**
    - **Neural tissue mechanosensitization**
    - **Abnormalities of the Autonomic Nervous System**
    - **Abnormalities of the Endocrine System**
    - **Abnormalities of the Immune System**