Value And Impact of Hyperbaric Medicine In The Treatment of Brain and Spinal Cord Injuries in Veterinary Patients

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Veterinary Hyperbaric Chambers

Class C – Animal Chamber

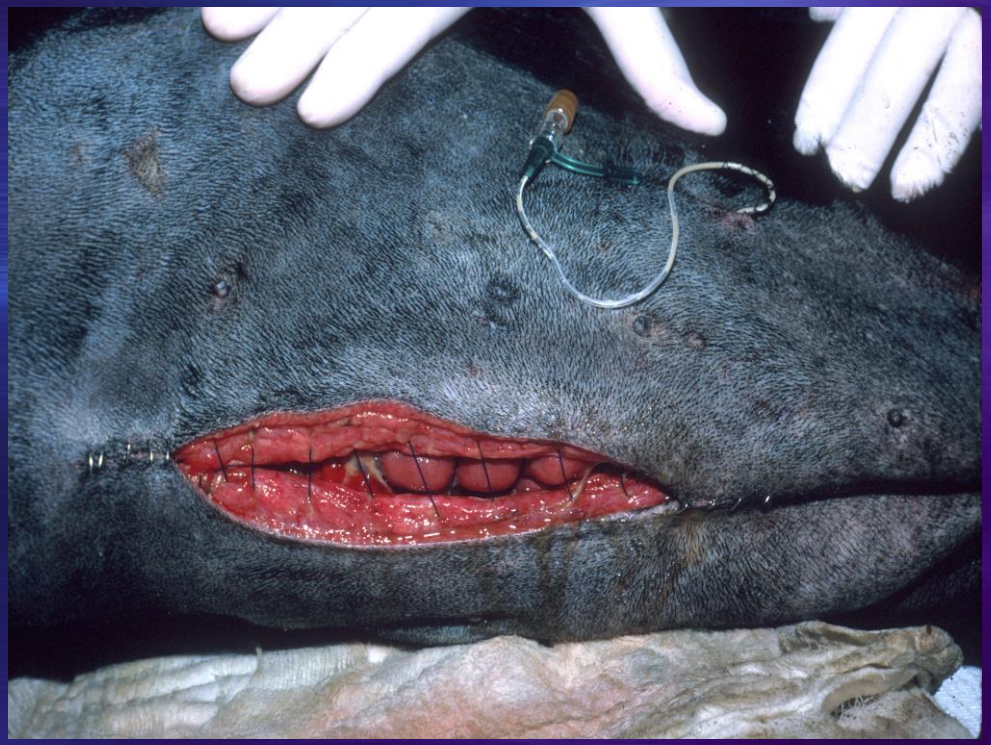
Approved Uses In Humans

14 Approved Indications by Undersea Hyperbaric medicine Society (UHMS)

1. Air or Gas Embolism
2. Carbon Monoxide Poisoning • Carbon Monoxide Poisoning Complicated By Cyanide Poisoning
3. Clostridial Myositis and Myonecrosis (Gas Gangrene)
4. Crush Injury, Compartment Syndrome and Other Acute Traumatic Ischemias
5. Decompression Sickness
6. Arterial Insufficiencies: Central Retinal Artery Occlusion, • Enhancement of Healing In Selected Problem Wounds
7. Severe Anemia
8. Intracranial Abscess
9. Necrotizing Soft Tissue Infections
10. Osteomyelitis (Refractory)
11. Delayed Radiation Injury (Soft Tissue and Bony Necrosis)
12. Compromised Grafts and Flaps
13. Acute Thermal Burn Injury
14. Idiopathic Sudden Sensorineural Hearing Loss

Approved Uses

- Russia, China, South Korea, Japan, Europe
  - Much Wider Accepted Application
  - Over 175 Uses!
  - Limitations In US
    - #1 Insurance
    - #2 FDA Studies
    - Can't Patent Oxygen
      - $$$$$$$$
- Less Limitations On Vet Medicine



Veterinary Use

HBOT

Best Termed "Complimentary"

- Surgery
- Regenerative Medicine
- Physical Rehabilitation

- Oxygen Used As A Drug
- Over 60 Years of Research and Science Support It's Use
  - US Navy
  - Animal Models

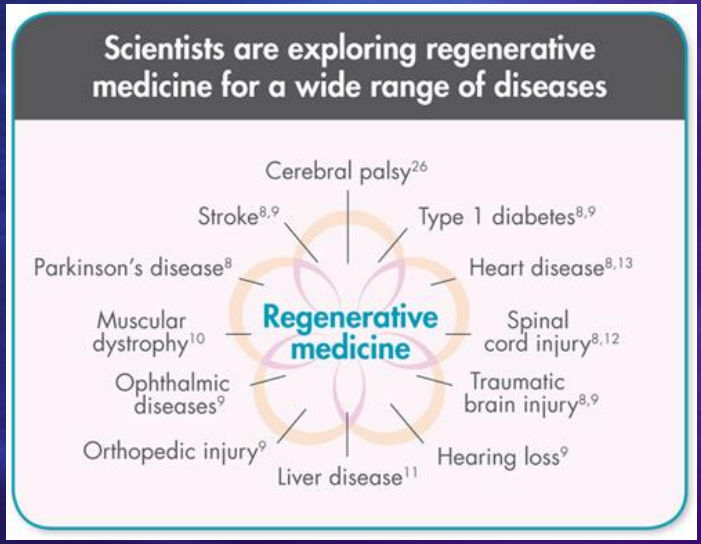
- Google Scholar Search :

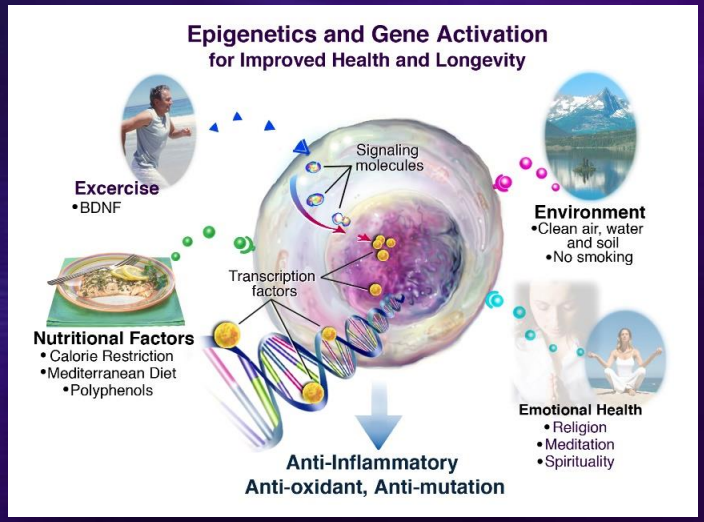
  >136,000 HBOT Papers!
  - >29000 HBOT/Head Trauma
  - >17,000 HBOT/Spinal Cord
  - >14,000/HBOT/Stems Cells

Complimentary Treatments…. Rehab

Major Effects On Neurological Tissues

- Vasoconstriction
  - Swelling
  - Edema
  - Inflammation
- Stem Cell Recruitment
- Neuronal Cells - O_2 Dependent
- *EpiGenetics : Gene Therapy
  - Humans: 8001 Genes
  - ↑ Growth Hormone and Factors
  - ↓ Inflammation
  - ↓ Cell Death
  - ↓ Reperfusion Injury

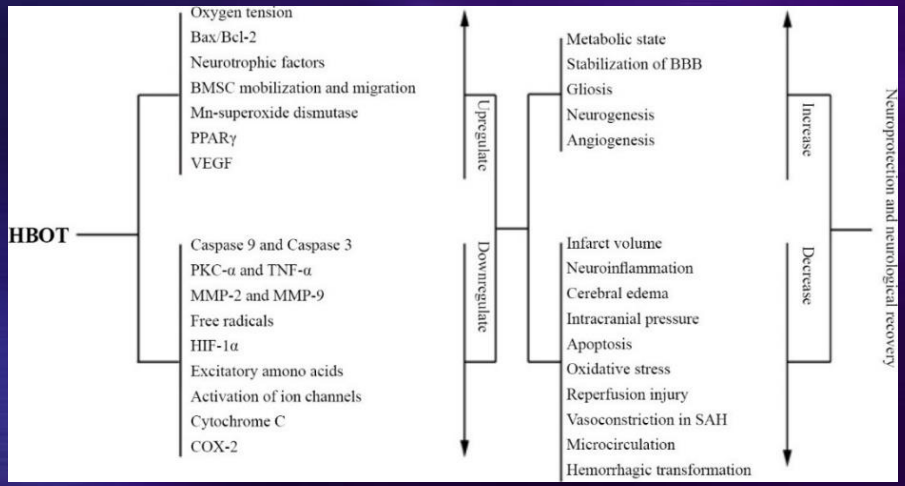




Reperfusion Injury – Neuronal Tissue

- HBOT ↓ Reperfusion Injury
  - Restoration of Blood Supply
  - Inflammation And Oxidative Damage
    - Induces Oxidative Stress
    - ROS And Interleukins
    - Cell Wall Damage
  - Neutrophil Flags → Stick→ Leave Vessel
  - Reactive Proteins and Free Radicals →Tissue Damage
  - Supplemental O2 Exacerbates

- **HBOT - Oxygen Paradox**
  - Nitric Oxide ↓ ROS Formation
  - ↓Cox-2
  - ↓MMP 2-9



Common Neurological Issues

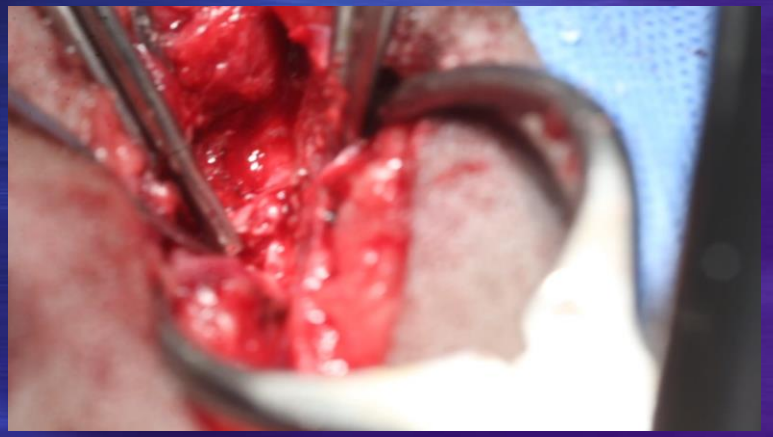
1. Intervertebral Disc Disease
   - *Hansen Type I - 90%
   - *Hansen Type II – 10%
2. Fibrocartilagenous Emboli (FCE)
3. Neoplastic Disease
4. Spinal Cord / Head Trauma
   - *Fractures
   - *Concussion
5. Meningitis
   - *GME, Steroid Responsive Meningitis
   - *Primary Secretory Otitis/OEMI

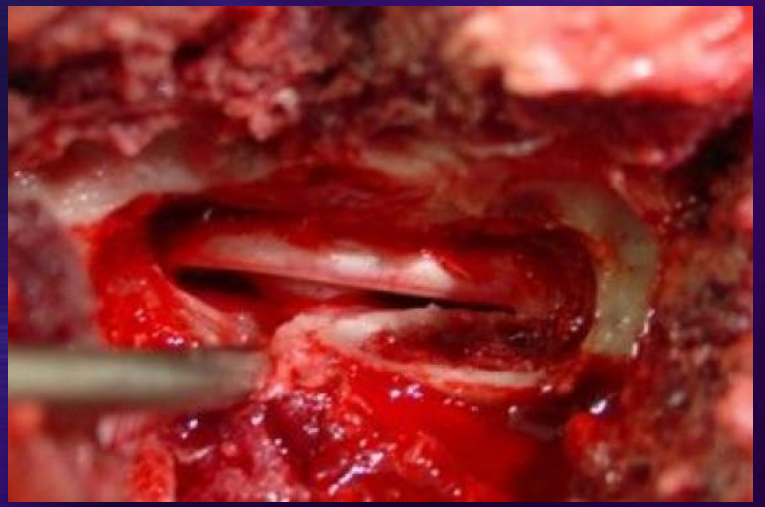
Intervertebral Disc Disease

- Hansen Type I
  - Dorsal Annulus Failure
    - Thin
    - Easily Stressed
  - Disc Extrusion
    - Degenerated Nucleus Pulposus
  - Two Effects:
    - Compression
    - Initial Impact and Velocity
    - Combination of Both

Acute Spinal Cord Injury

- IVDD
  - Compressive Vs' Concussive
  - Can Address Compression
    - Hemilaminectomy /V-Slot Decompression
  - Concussive – Largest Contributor To Neuronal Death
    - Swelling, Edema, Inflammation
    - Decreased Blood Flow
    - ↓ Oxygen Tension
    - Contusion/Bruising



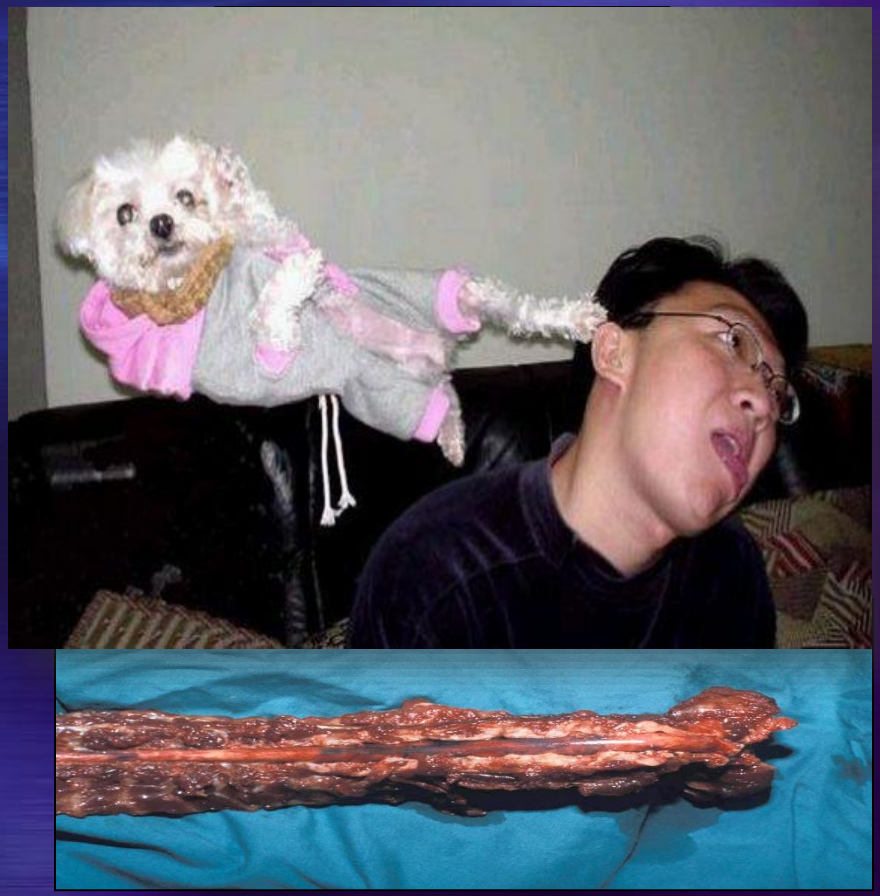


Pre and Post Hyperbaric Treatment

- 1.5 - ATA
  - 1 Treatment Prior to Surgery
  - 3-9 Additional Postop
  - Treat Until Plateau
  - Low Pressure 1.5-ATA
    - Oxygen Paradox
    - ↓Free Oxygen Radicals and Reperfusion Injury
    - ↓Risk of Central Cord Malacia (High Pressures)

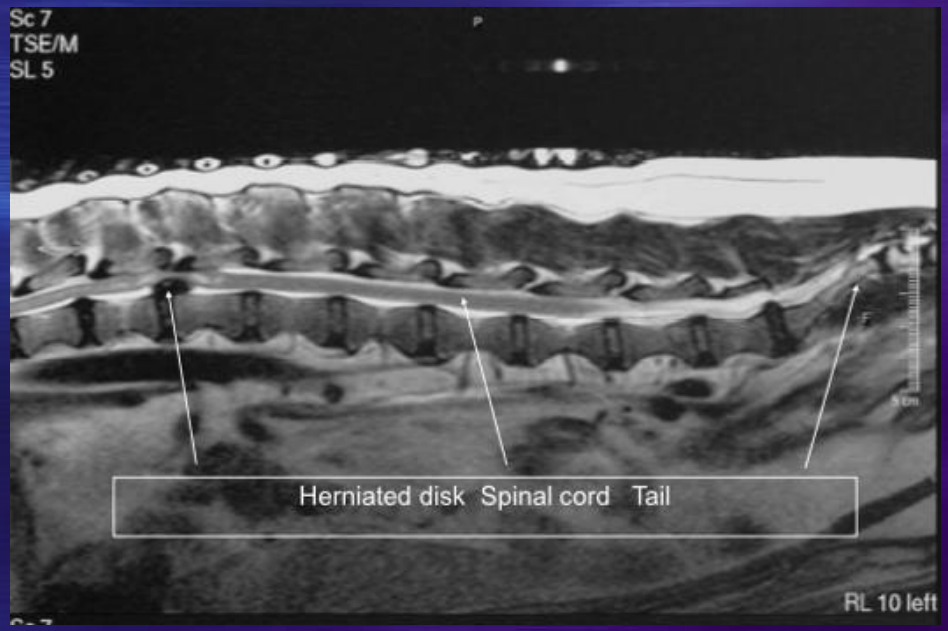
What Have We Found?

- Avg. Return To Ambulation 6.2 Days Faster Vs Non-HBOT
- Avg. Return to Voluntary Urination 4.2 Days Faster Vs Non-HBOT
- Decreased Need For Opiods
- Deep Pain (Sensory) Negative Patients
  - With Deep Pain 85-90%
  - Typical Prognosis 10-50% (Time Dependent) Return To Ambulation
  - 14/18 – 77% Return To Ambulation
    - IVDD Cases Only



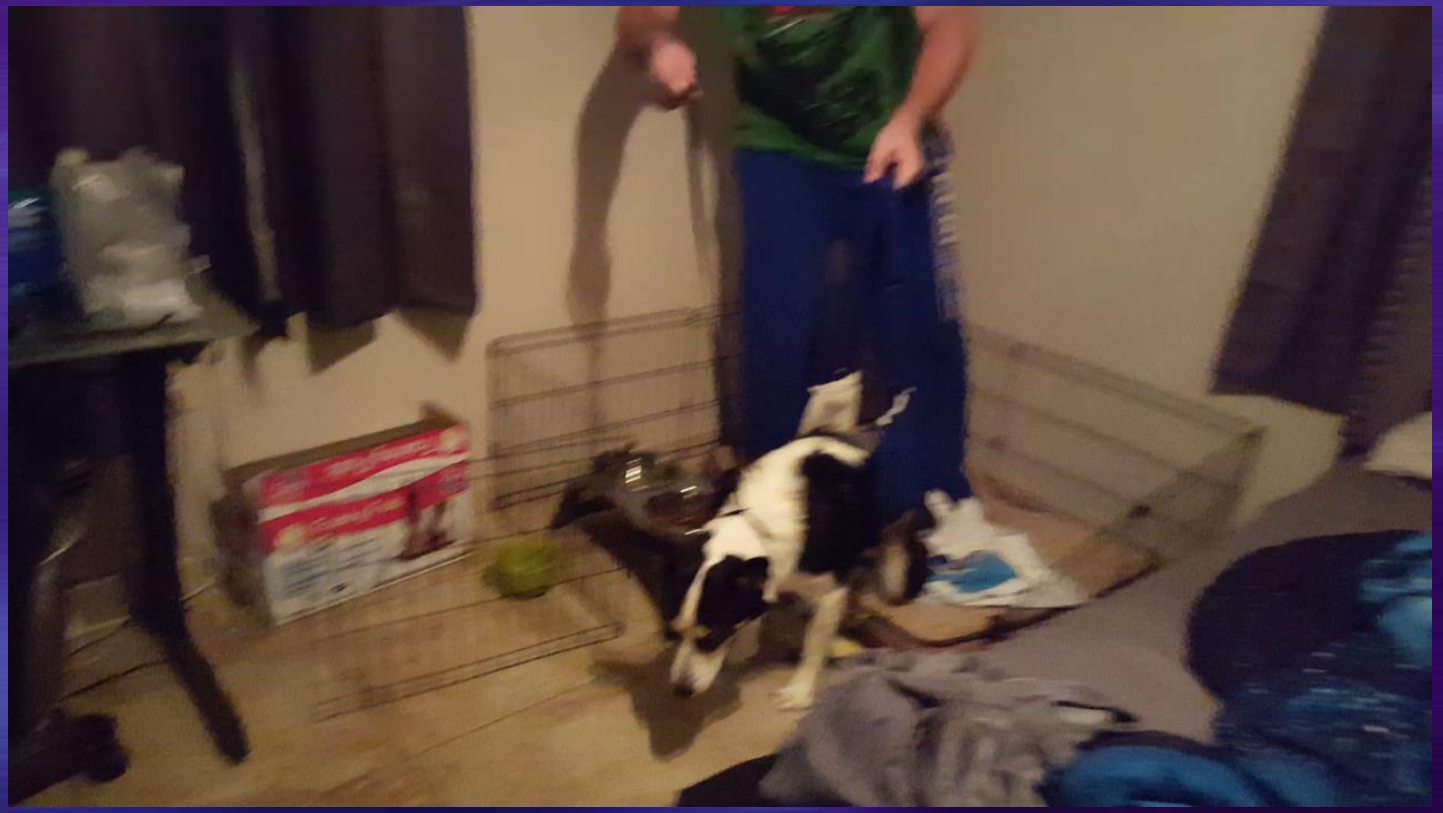
IVDD Case Example : Kai

- Kai, 3yo, Male Mix
  - Presentation: UMN, Non-Ambulatory Paraplegia
  - Analgesic in Both Pelvic Limbs
    - 6 Hours Duration
  - Hemilaminectomy
  - 10 HBOT Treatments



IVDD Case Example : Kai

Day 2 Postop Discharge : Deep Pain Returned, No Voluntary Motor (3 HBOTs)



IVDD Case Example : Kai

1 Week Post Op: Weakly Ambulatory, Moderate to Severe Ataxia, Voluntary Urination (5 HBOTs)

IVDD Case Example : Kai

2 Weeks Post Op: Ambulatory, Mild Proprioceptive Deficits, Voluntary Urination (8 HBOTs)

IVDD Case Example : Kai

8 Weeks Post Op: 10 HBOTs Total

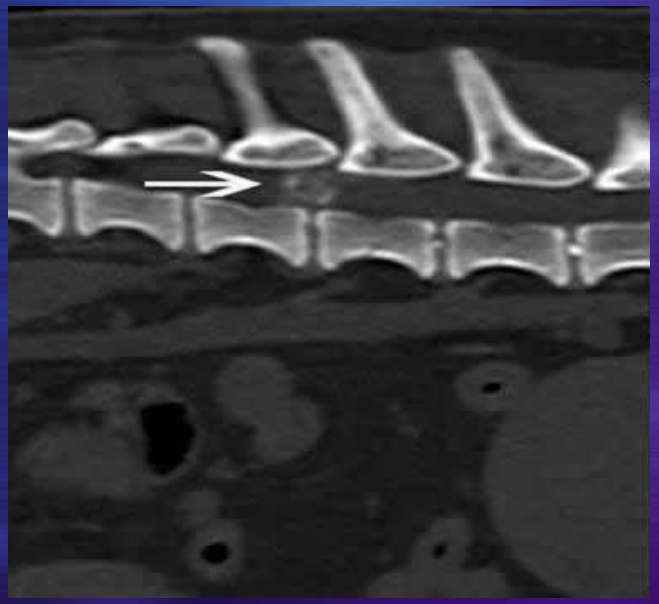
95% Neurologically Normal

T-L IVDD Example : Maya

- Maya, 7yo, female Pekinese.
  - UMN Non-Ambulatory Paraplegia
  - No Voluntary Motor in Pelvic Limbs
  - Sensory Negative
  - Panniculus Lost L2
  - Withdrawl Reflex Intact
  - Lesion Localized T3-L3

T-L IVDD Example : Ollie

- Ollie, 5yo, Dachshund
  - UMN, Non-Ambulatory Paraparesis
  - No Voluntary Motor Function
  - Severe T-L Hyperpathia
  - Pain Sensation Intact
  - Imaging: T13-L1 IVDD
  - Treatment:
    - Hemilaminectomy T13-L1
    - 1 Preop HBOT/3 Postop HBOT
    - Class IV Laser
    - Rehabilitation.



T-L IVDD Example : Sam

- Sam is 7yo, Male Shibu Inu.
  - UMN, Non-Ambulatory Paraparetic
  - Minimal Voluntary Motor
  - *Superficial Pain Absent
    - Dermatomes and Tail
  - Withdrawl Reflex Intact
  - Panniculus Absent L2
  - Severe T-L Hyperpathia.
  - Hemilaminectomy T12-13
  - HBOT
    - 1 Preop and 3 Postop

Cervical IVDD

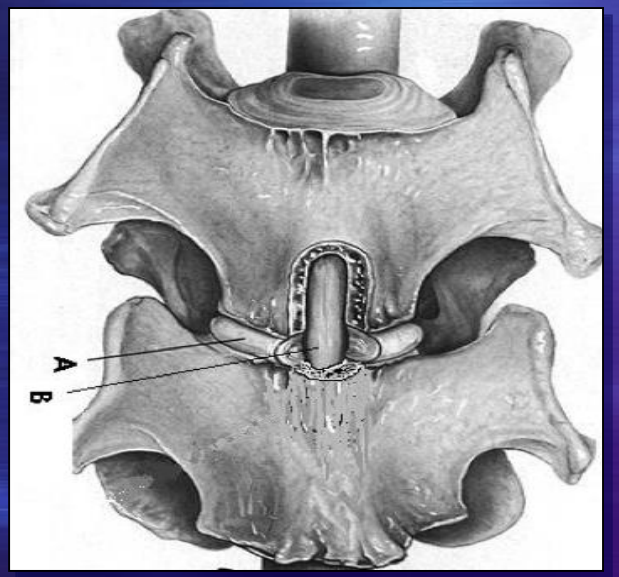
- ~15% of IVDD Cases
- Dachshunds, Toy Poodles, Beagles
  - More Common Than T-L IVDD in Beagles
- 4-8 Years of Age
- C2-3 Most Common
  - Decreases Caudally

Cervical IVDD

- Neck Pain
  - Stiff Gait
  - Lowered Head
  - “Neck guarding”
  - Shoulder/Neck Muscle Spasms
- Nerve Root Signature
  - Up to 50%
  - Confused as Lameness
- Paralysis, Paresis
  - Lateralization
  - Pelvic Limbs > Thoracic Limbs

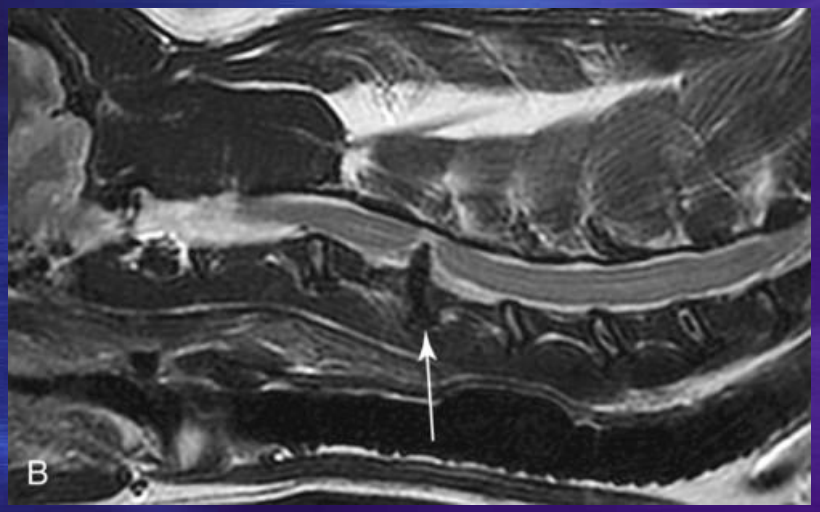
Cervical IVDD Treatment

- Preoperative HBOT
- Ventral Slot - Cord Decompression
- 2-3 Postoperative HBOT
- 95% Success Rates
  - Alleviation of Pain
  - No Neurological Deficits



Cervical IVDD Example : Sammy

- Sammy, 9yo, male Dachshund
  - UMN Non-Ambulatory Tetraparesis
  - Voluntary Motor
  - Superficial and Deep Intact
  - Severe Cervical Hyperpathia.
  - Treatment:
    - Ventral Slot
    - 10 HBO Treatments
    - Aggressive Rehabilitation



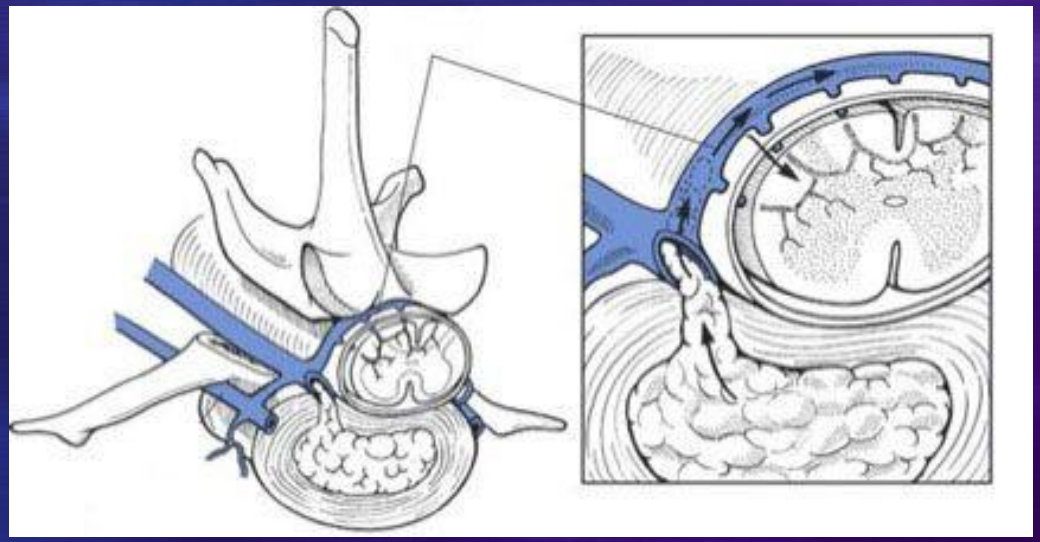
Sammy At 5 Months!

Cervical IVDD Example : Fiona

- Fiona, 3yo, Female Dachshund. Presented With:
  - UMN, Weakly-Ambulatory Tetraparesis
  - Left Radiculopathy
  - Severe Cervical Hyperpathia
  - Treatment:
    - Ventral Slot
    - 9 HBOT Treatments Over 2 Weeks

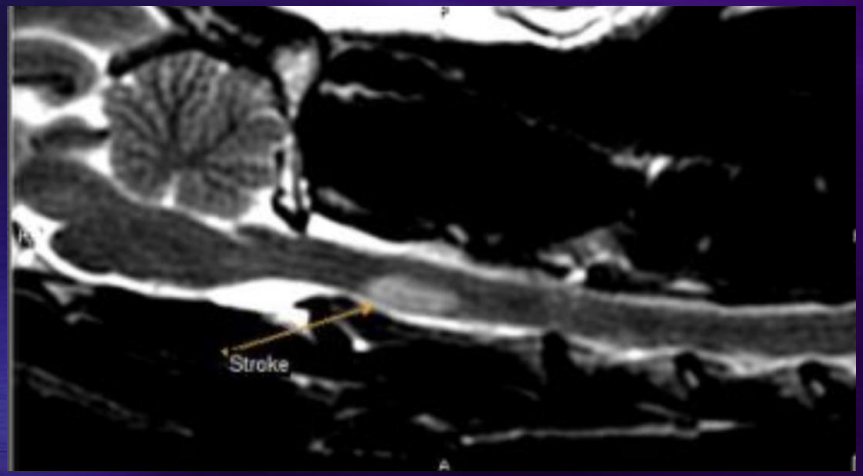
Fibrocartilagenous Embolic Myelopathy(FCE)

- Embolization of the Arterial or Venous Supply Of Spinal Cord
  - Emboli – Fibrocartilage From Nucleus Pulposus
  - Large Breeds More Commonly Affected
  - Age - <3 years
  - Typically Asymmetric



FCE Example: Axel

- Axel is a 2yo/Male, Boykin Spaniel
  - Acute, UMN Tetraparesis
  - Minimal Motor Function
  - No Spinal Hyperpathia
  - Normal Cervical ROM
  - Withdrawl Reflex Intact
  - No Cranial Nerve Signs
  - C1-C5 Localization



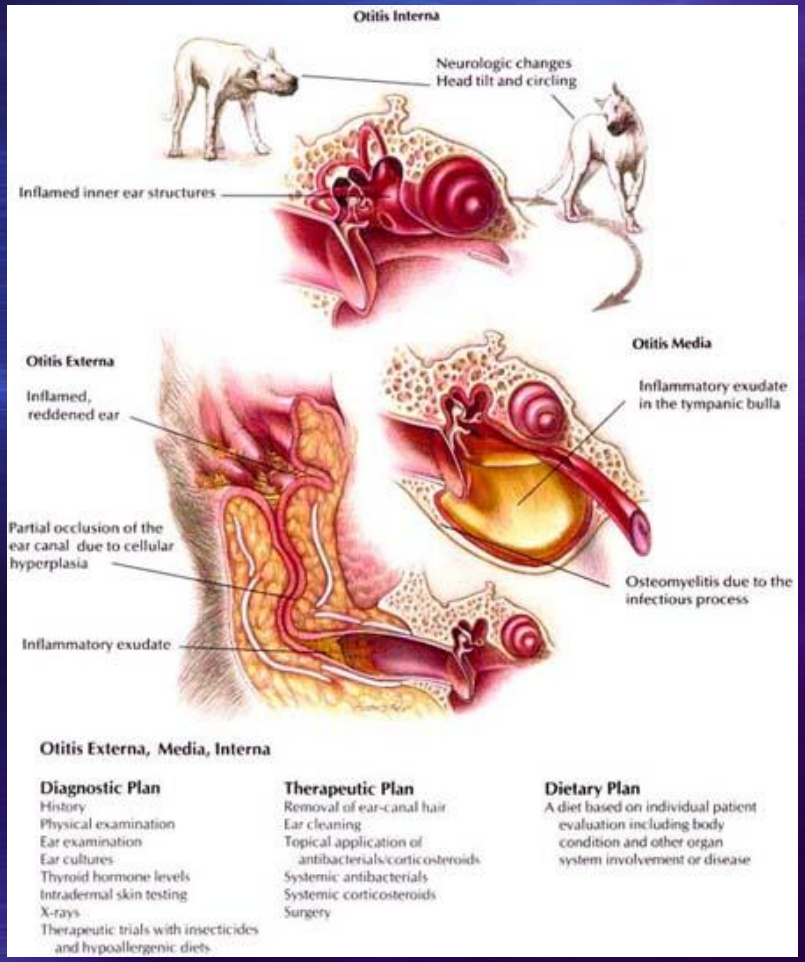
FCE Example: Axel

Treatment:

- 10 HBO Treatments
- Class IV Laser
- Physical Therapy

Severe Otitis Externa/Media

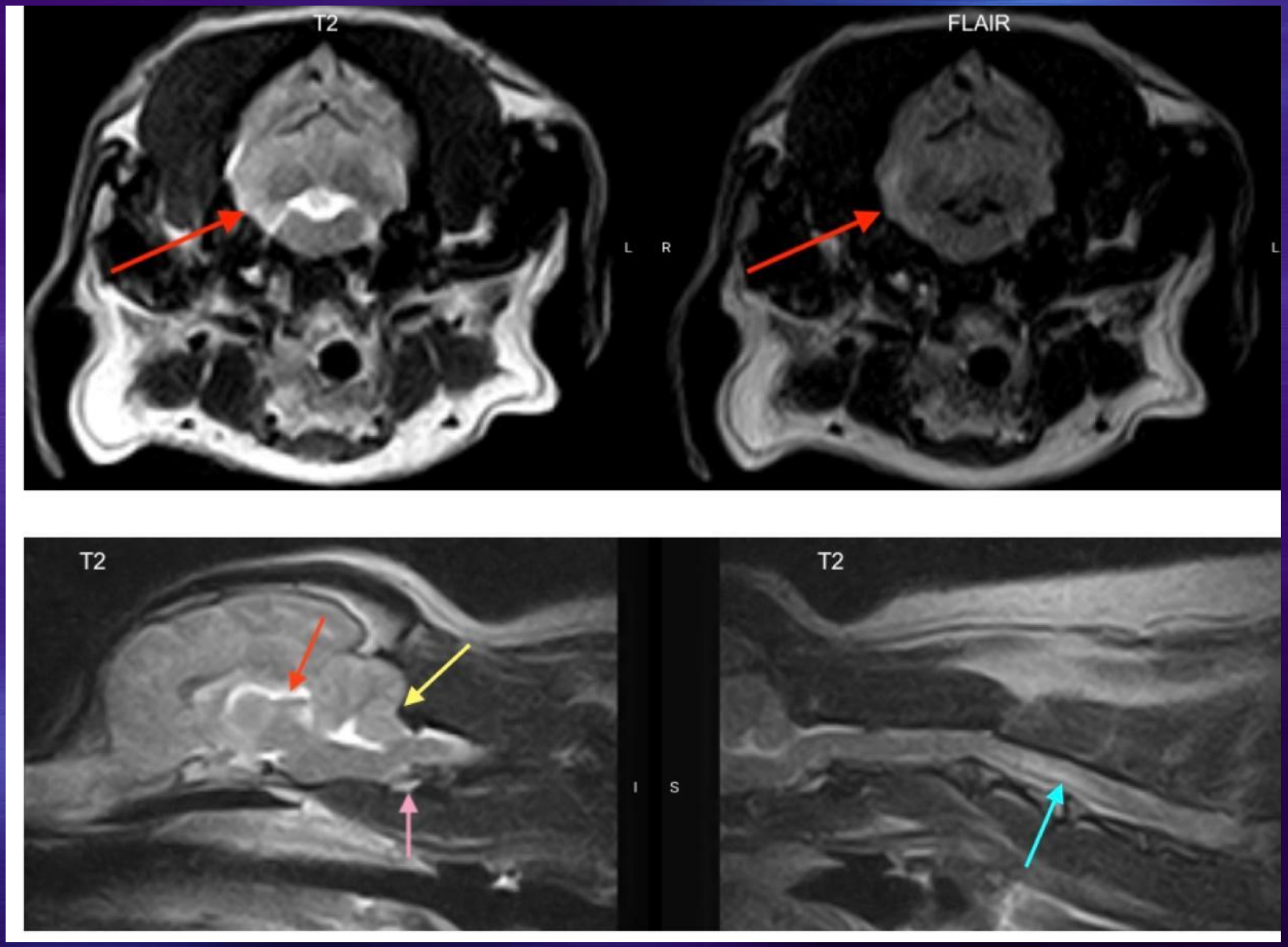
- Otitis Externa-Media-Interna (OEMI)
  - Accumulation of:
    - Sebaceous Debris/Mucous
    - Occluded Canal (scar tissue)
    - Infected Bulla Epithelial Lining
    - Diseased Temporal Bone
    - Neck Pain/Head Tilt
    - Jaw Pain
    - Ruptured Tympanic Membrane



Case Example: Queen Elizabeth – OEMI

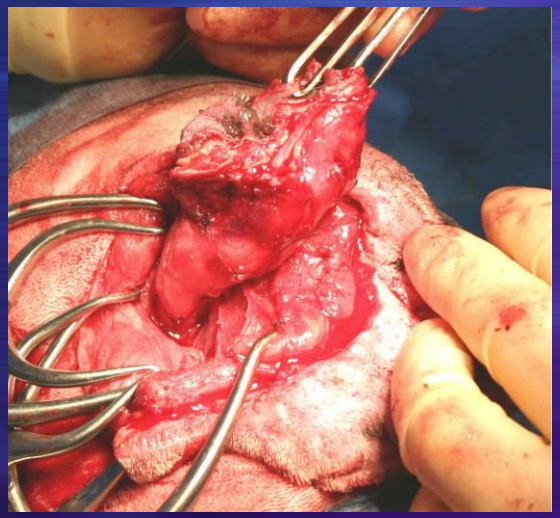
- Queen Elizabeth is 5yo, F/S, CKC- Presented With:
  - Severe Otitis Externa Media
  - Right Sided Head Tilt
  - Cervical Hyperpathia
  - Mild Ataxia
  - Circling To Right
  - Depressed Mentation
  - Hyperesthesia

Case Example: Queen Elizabeth – OEMI



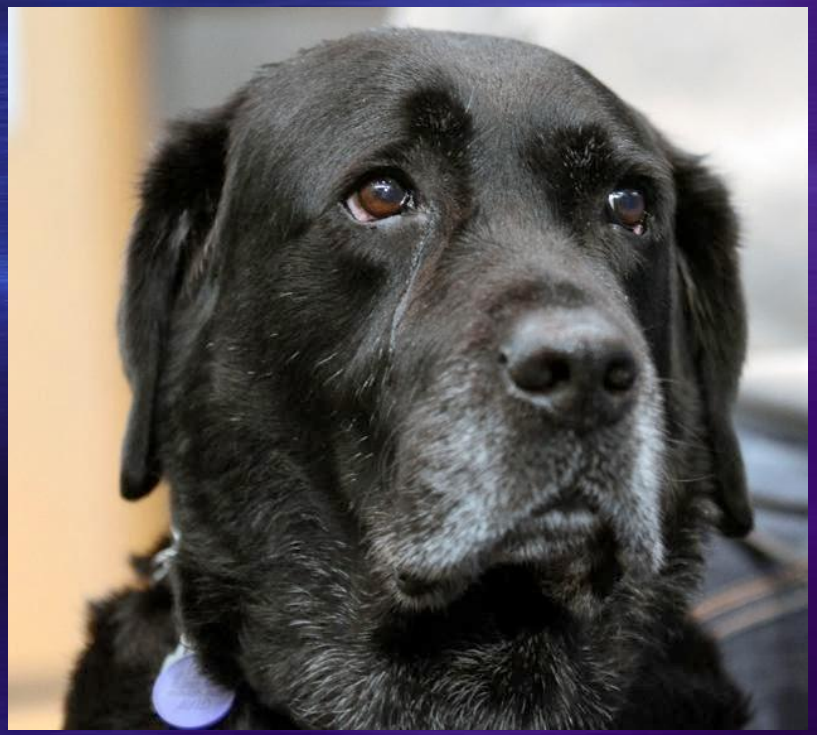
Case Example: Queen Elizabeth – OEMI

- Treatment:
  - Total Ear Canal Ablation and Bulla Osteotomy
  - Rocephin Initially
  - Culture Ear and CSF
    - + MRSP
  - Amikacin IV SID X 14 Days
  - 12 HBO Treatments SID
    - 1.5 ATA
  - Class IV Laser of Surgical Site



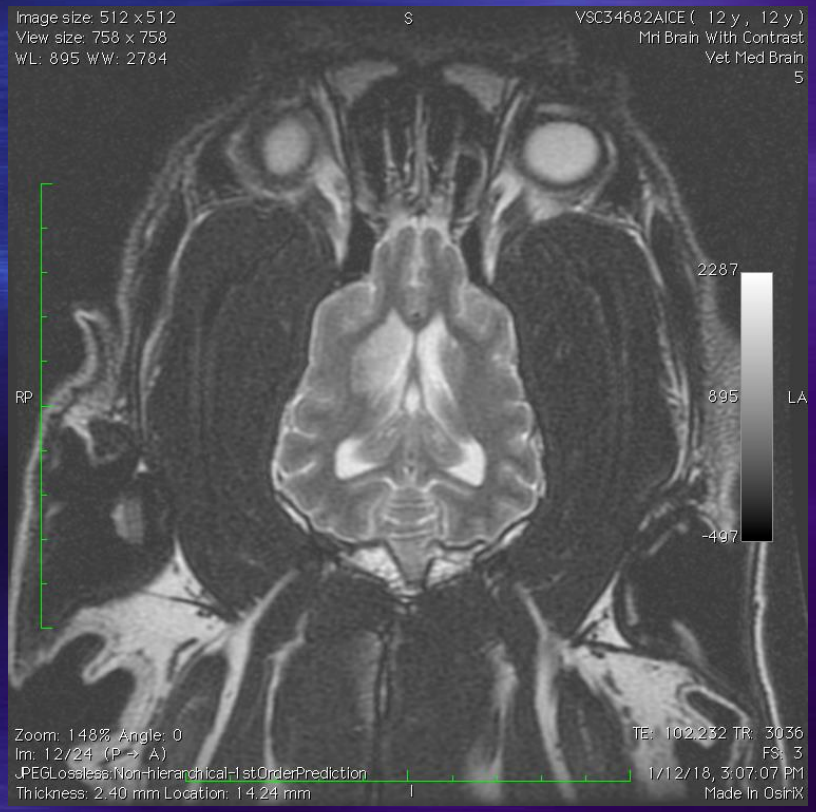
Case Example: Brain Stroke - Max

- Max is a 12-yo Labrador Retriever
  - Acutely, Lateral Recumbent, UMN, Non-Ambulatory Tetraparetic
  - Mentally Depressed
  - Circling, Loss of Balance
- CT – Chronic C6-C7 Disc Moderate Compression
- Referred To MS State Neurology
  - Worsening Mental Deficits
  - High Field MRI



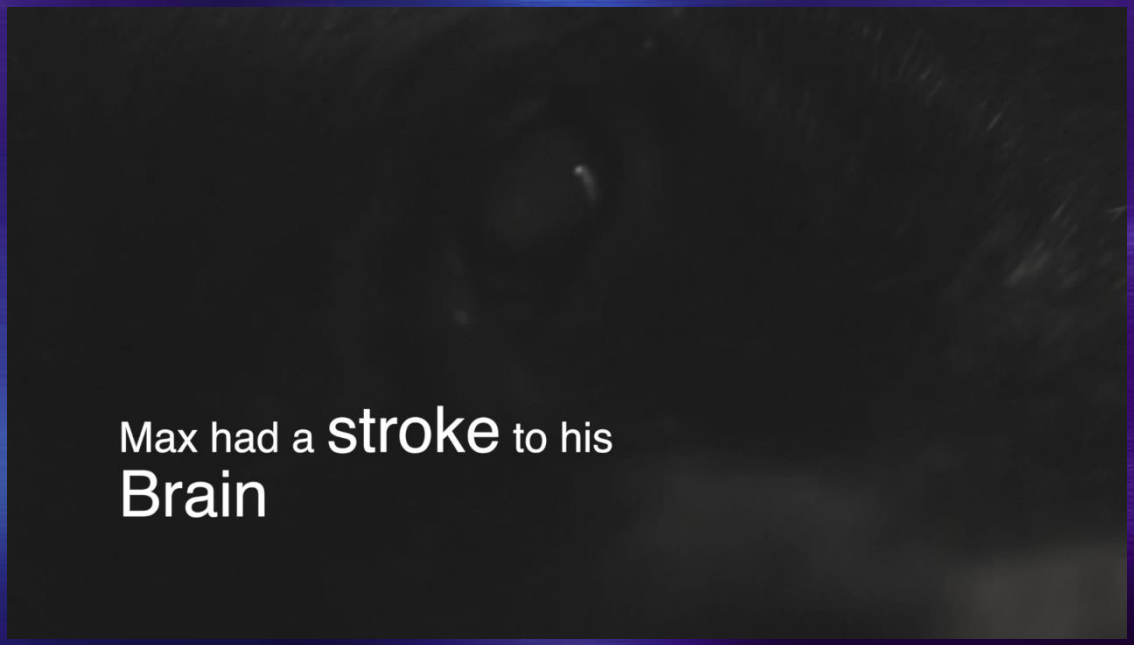
Case Example: Brain Stroke - Max

- MS State
  - Diagnosed Hypothyroid
  - Myxedema and Cerebrovascular Infarct



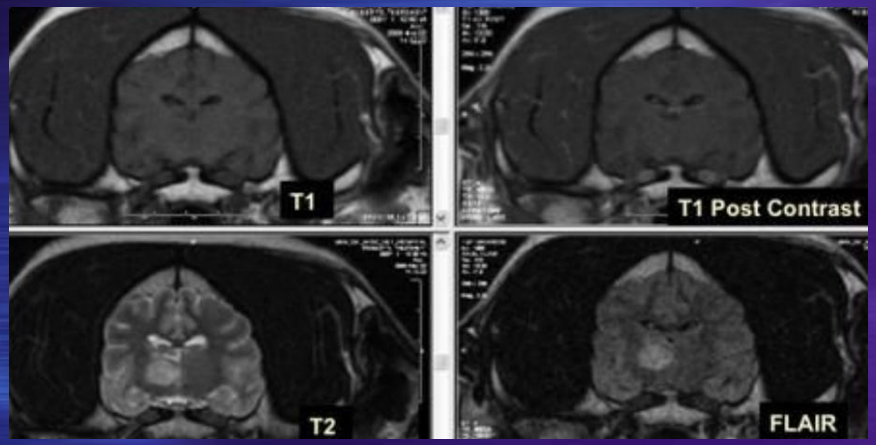
Case Example: Brain Stroke - Max

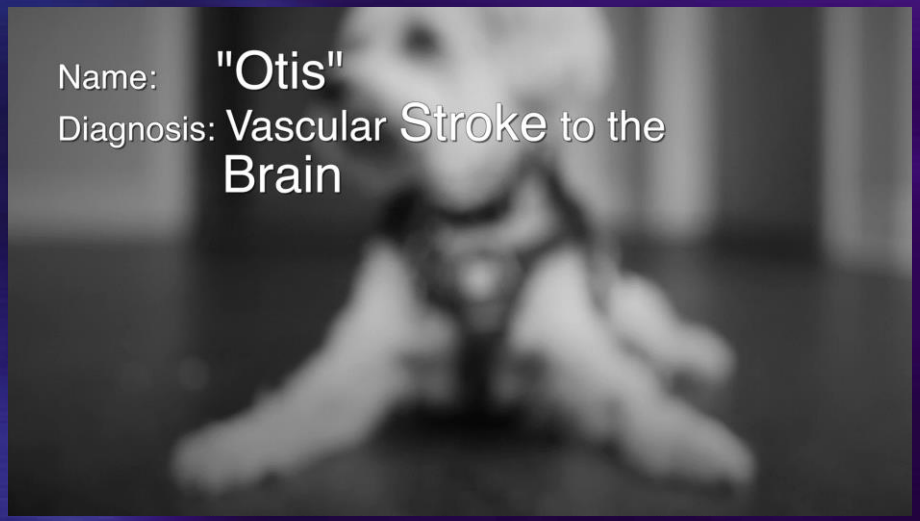
- Treatment
  - Levothyroxine
  - HBO Treatments X 20
  - Physical Rehabilitation



Case Example : Brain Stroke - Otis

- Referral From Local Neurology Service
  - Acutely Tetraparetic
  - Vision Loss
  - Incoordination
  - MRI
    - Vascular Infarct
- Treatment
  - 10 HBO Treatments
  - Aggressive Rehabilitation

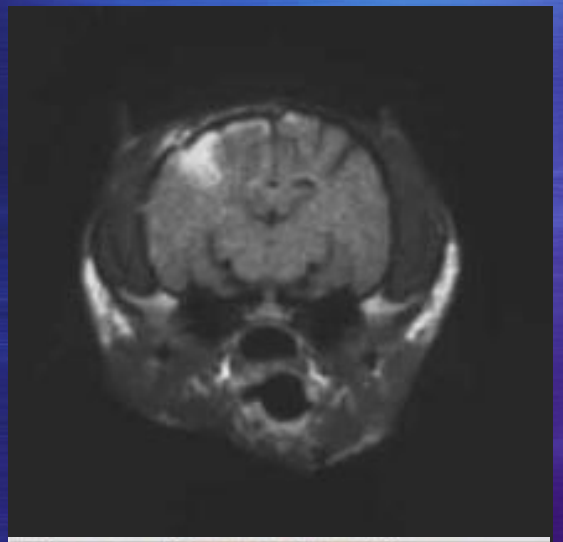




Traumatic Brain Injury

Head Trauma

- Cerebral Contusion
  - Swelling / Edema
- HBOT ↓ Intracranial Pressure
  - Vasoconstriction of Vessels
  - ↑ O_2 In Plasma Diffuses to Neuronal Cells
    - Very Oxygen Sensitive Tissues
  - ↓ Lactate
  - ↑Aerobic Metabolism
- Decreases Small Vessel Injury
  - Reperfusion Injury



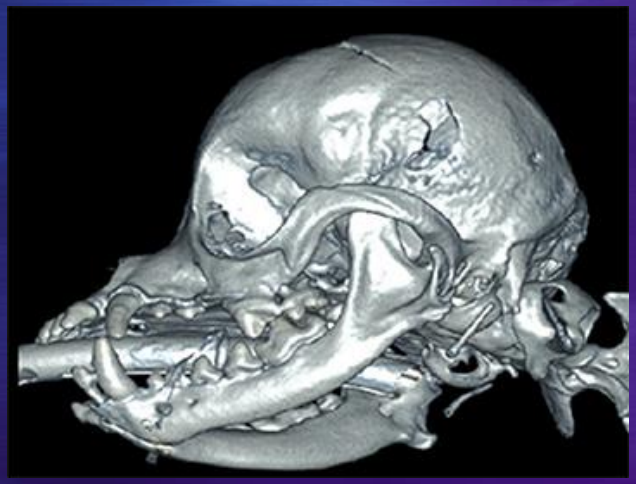
1.5-ATA : 5-10 Treatments

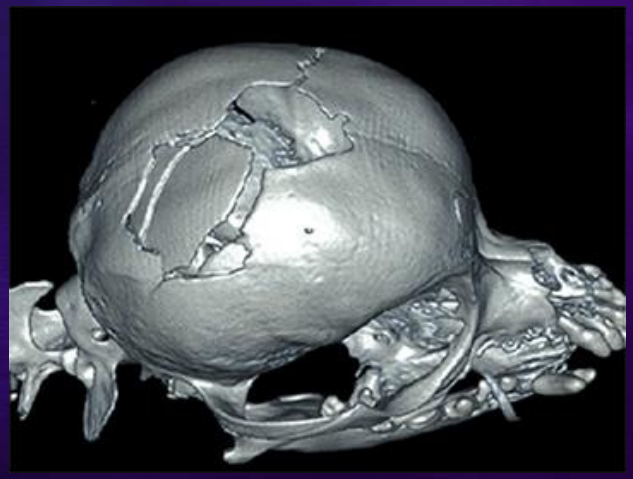
Case Example – Head Trauma - Louie

- Louie, 8-yo Male mix
  - Coyote Attack
    - Left Eye Proptosis
    - Nasal Bleeding
    - Depressed Mentation
    - Multiple Bite Wounds Head and Neck
    - Non-Ambulatory
    - Torticollis, Tetraparetic
    - Unable To Stand or (Hip Flip)

Case Example – Head Trauma - Louie

- Diagnostics
  - CT Head
    - Left Depression Fracture
    - Displaced Skull Fracture - Fontanelle
- Treatment
  - Mannitol and Hetastarch (Colloid)
  - BP Maintained 80-100mmHg
  - IV fluids
  - 12 HBOT – 1.5 ATA, 45-minutes
    - 2 Treatments/Day – 48 Hours
      - Significant Improvement 48 Hours
    - Eye Enucleation Day 3
    - 1 Treatment/Day 8 Days





Traumatic Brain Injury

Lagniappe Case – "Hollywood"

- Hollywood, 4yo, Shiloh Shepherd
  - Severe Frostbite To Carpal Joint
  - Treatment
    - Wound Debridement
    - 31 HBO Treatments
    - Surgery 1 : Digital Amputation
    - Surgery 2 : Carpal Pad Transposition
    - Surgery 3 : SIS/BMAC StemCell/PRP Graft

“Hollywood”

Questions……..