“Do not be conformed to the pattern of this world,
but be transformed by the renewing of your mind
That you may be able to test and approve
what the will of God is,
his good, pleasing, and perfect will.”

-Romans 12:2

Non-surgical Management of Cranial Cruciate Ligament Injury

Britt Carr Benson, DVM, DACVSMR, CCRT

Diplomate of the American College of Veterinary Sports Medicine and Rehabilitation

Certified Canine Rehabilitation Therapist

CVM Veterinary Conference

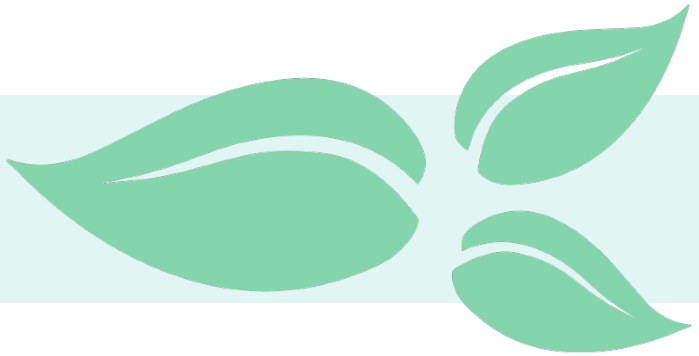
ROMANS 12:2

TRANSFORMED

Acknowledgements

- Christian Veterinary Mission

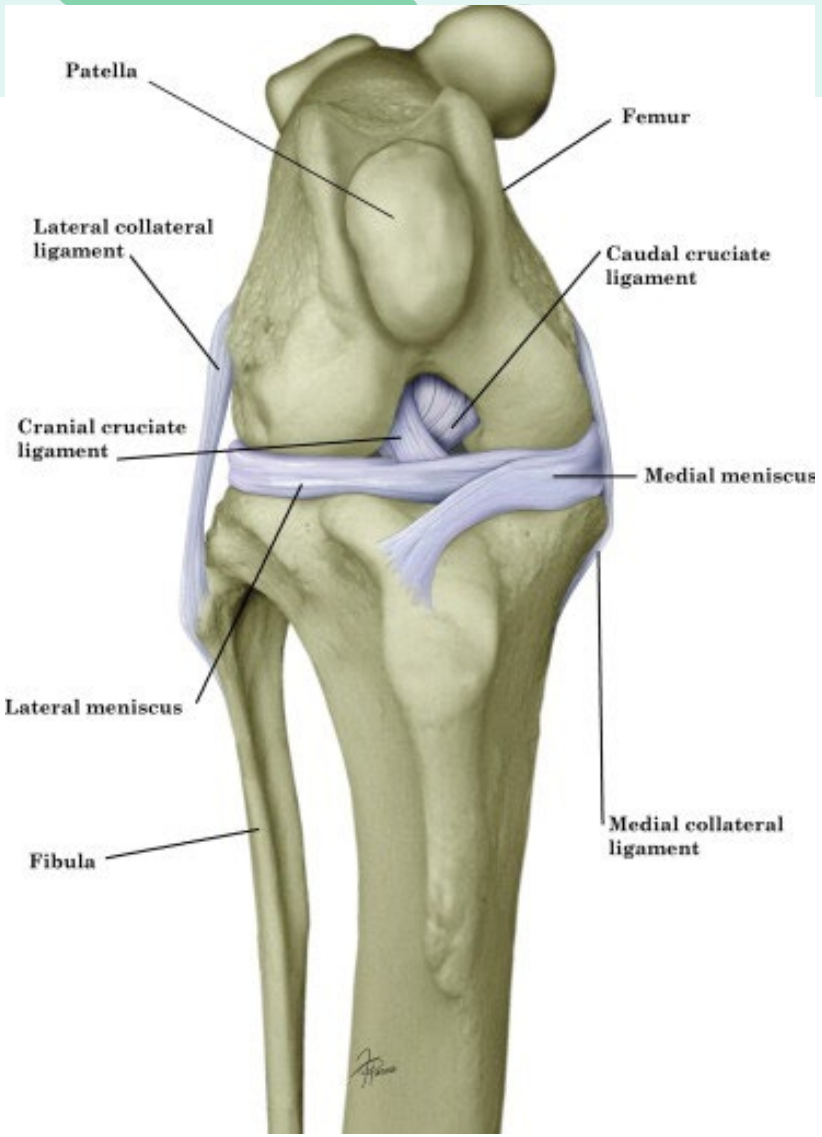
Relevant Disclosures



- I am a consultant for Companion Animal Health.

Cranial Cruciate Ligament Anatomy & Function

- Caudomedial part of lateral femoral condyle to cranial intercondyloid area of tibia
- Craniomedial band
  - Taut during all phases
- Caudolateral band
  - Taut in extension
  - Lax in flexion
- Mechanoreceptors and afferent nerve endings



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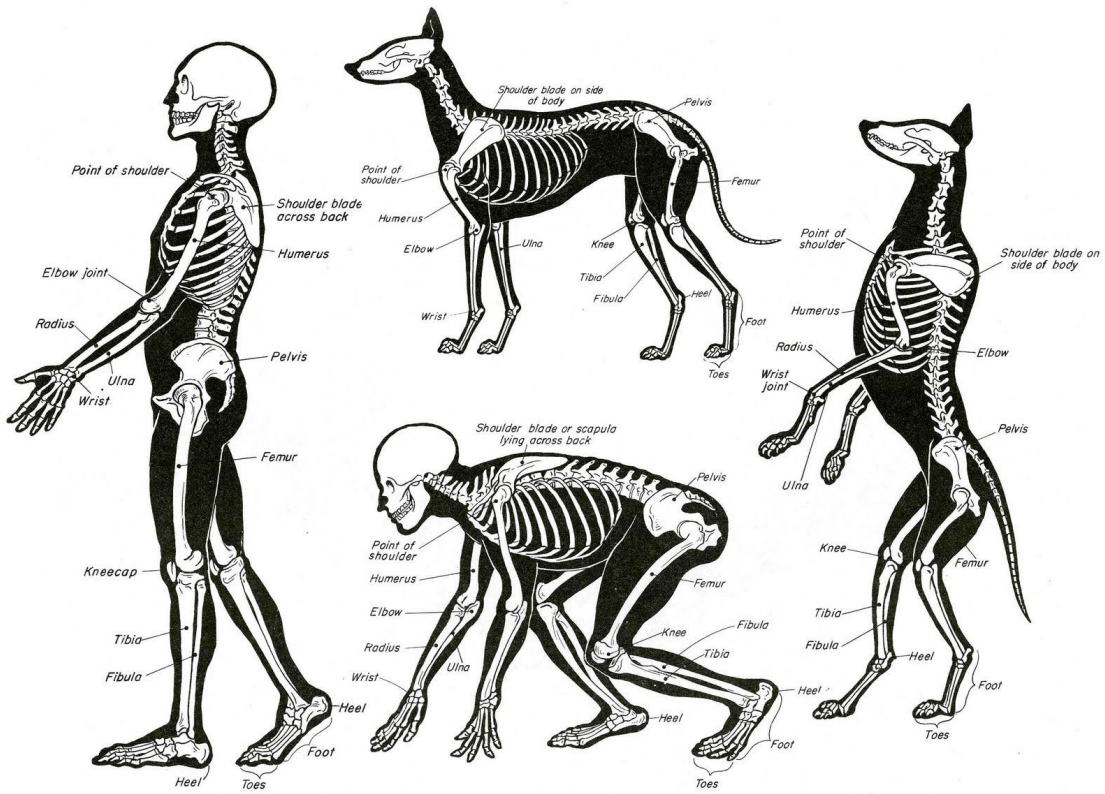
Pathophysiology of CCL Disease

"WHY IS THIS A THING IN DOGS??"



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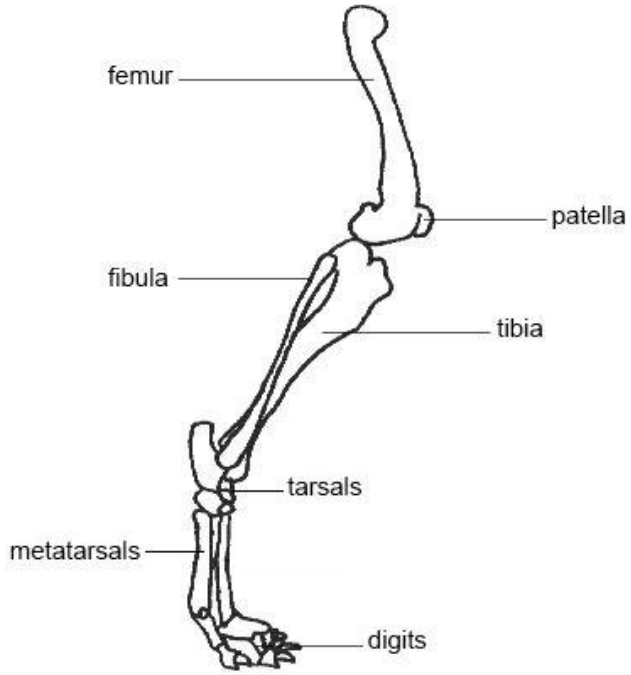
Pathophysiology of CCL Disease

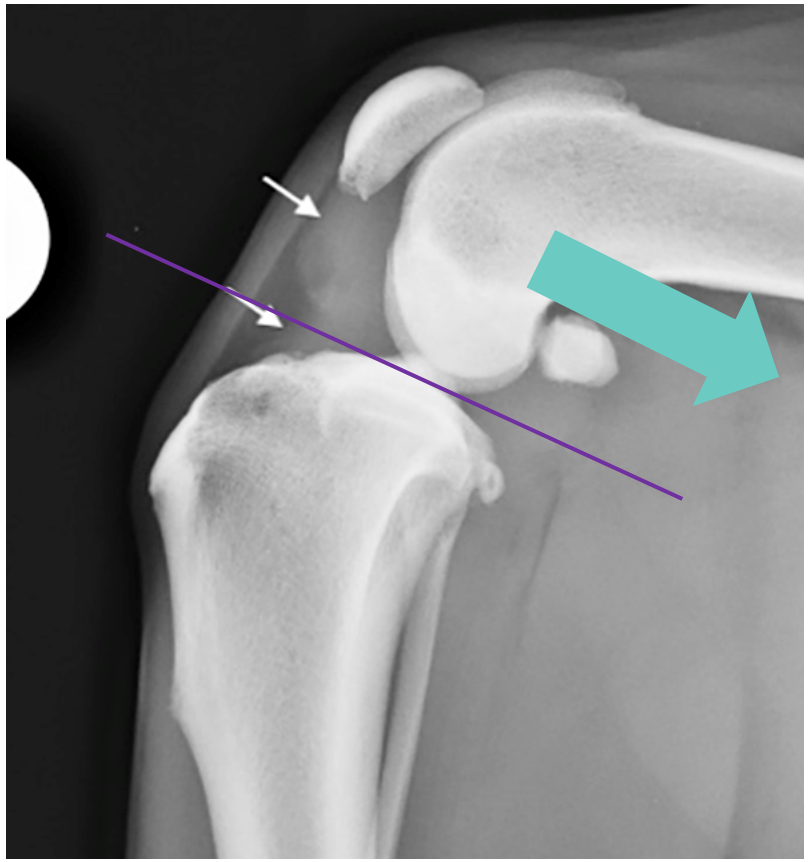
- Human hip, knee, and ankle joints are perpendicular to our weight bearing surface
- Minimal stress to the ligaments in our knee during weight bearing

Pathophysiology of CCL Disease



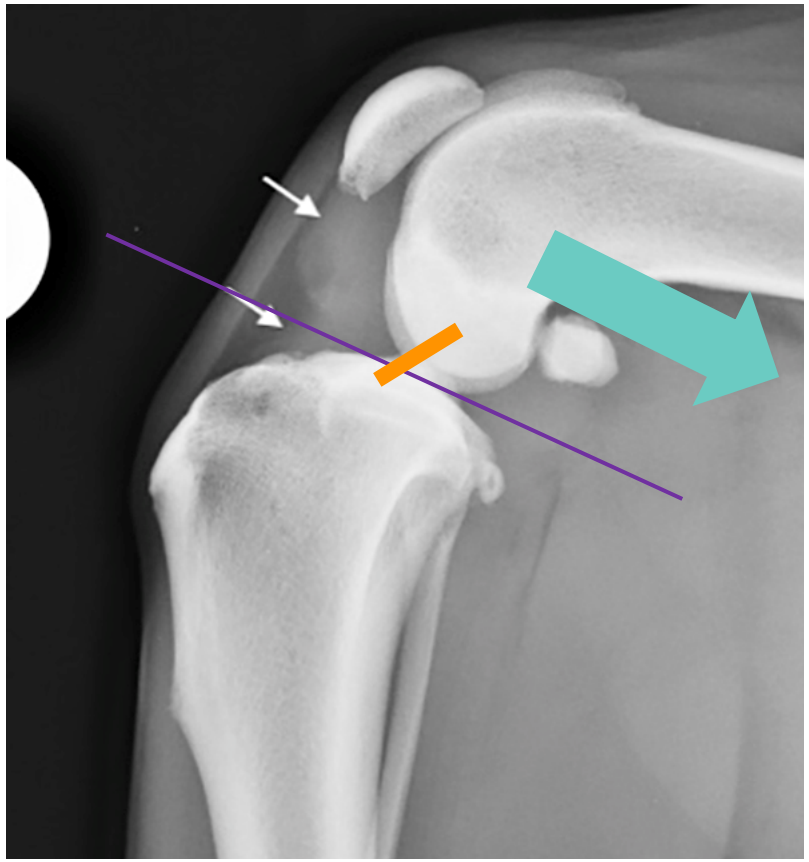
- Dogs stand on their toes with ankle elevated and knee forward.

Pathophysiology of CCL Disease



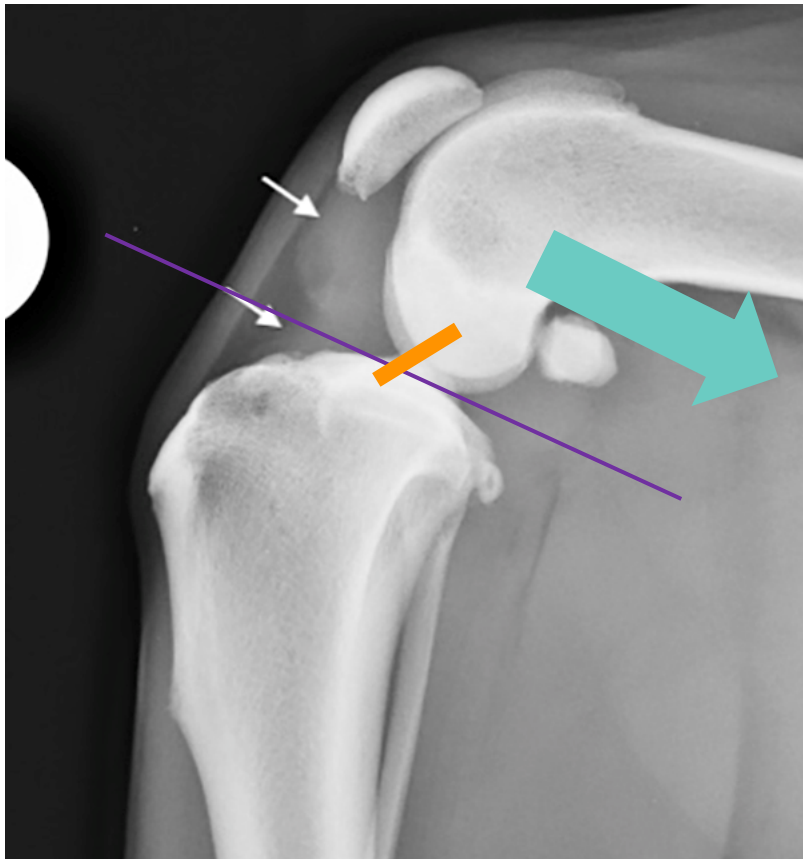
- The top of the dog's tibia is **sloped**
- Weight bearing creates a force that pushes the femur down the slope of the tibia.
- This force is called **tibial thrust**

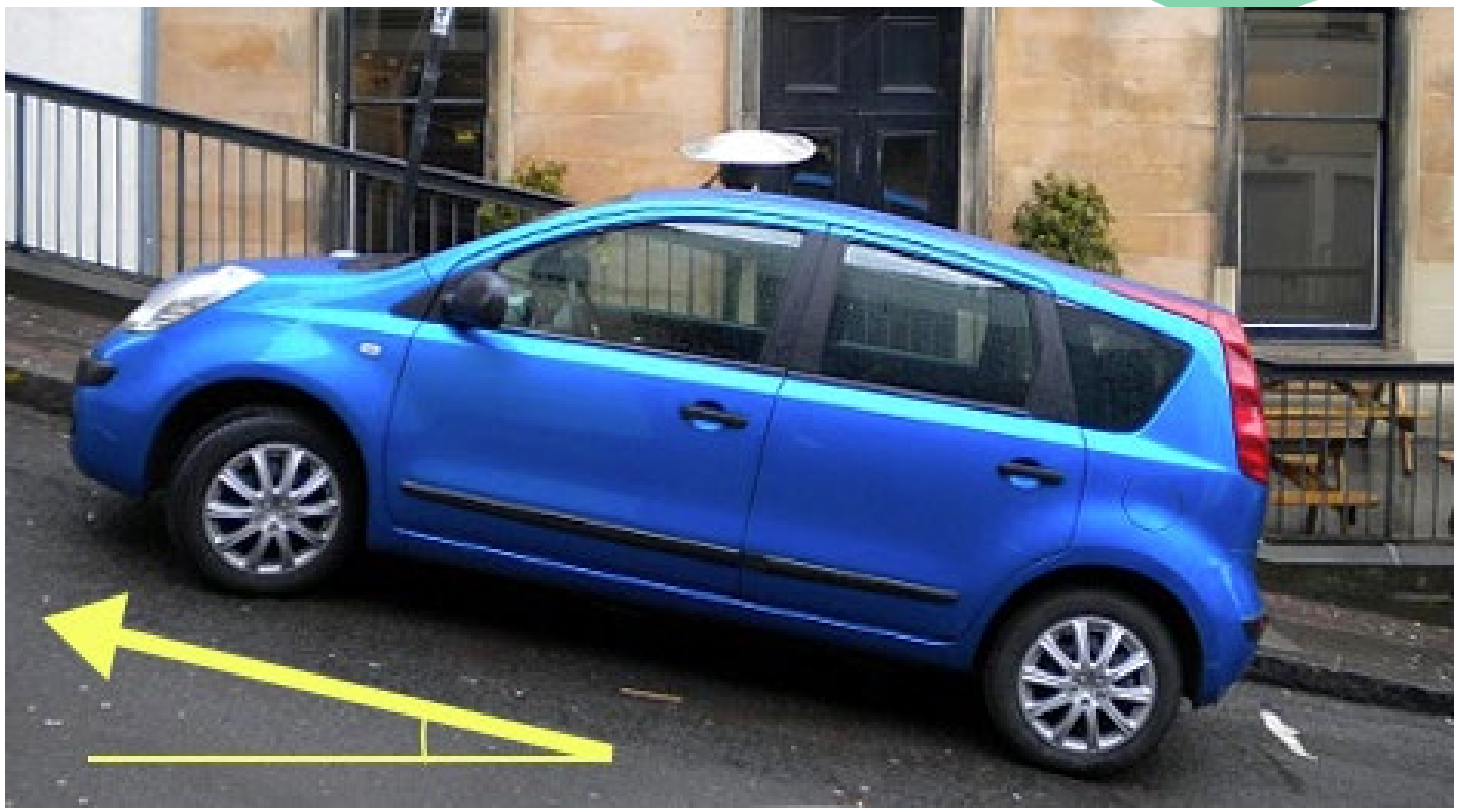
Pathophysiology of CCL Disease



- The **CCL** is prevents tibial thrust
- Each time the dog bears weight, the **CCL** is called to work.

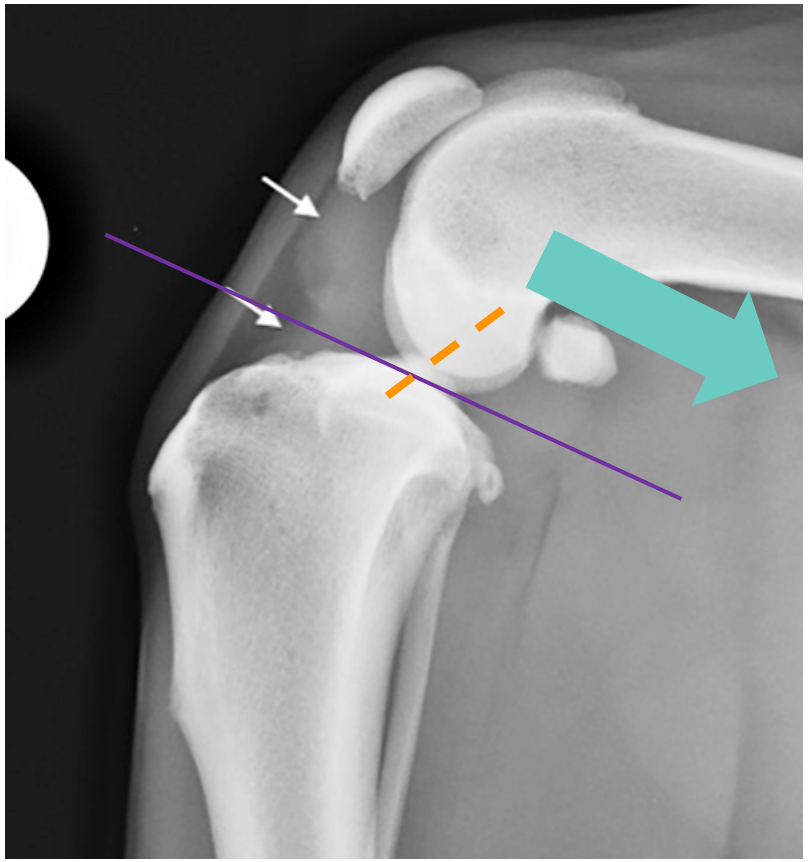
Pathophysiology of CCL Disease

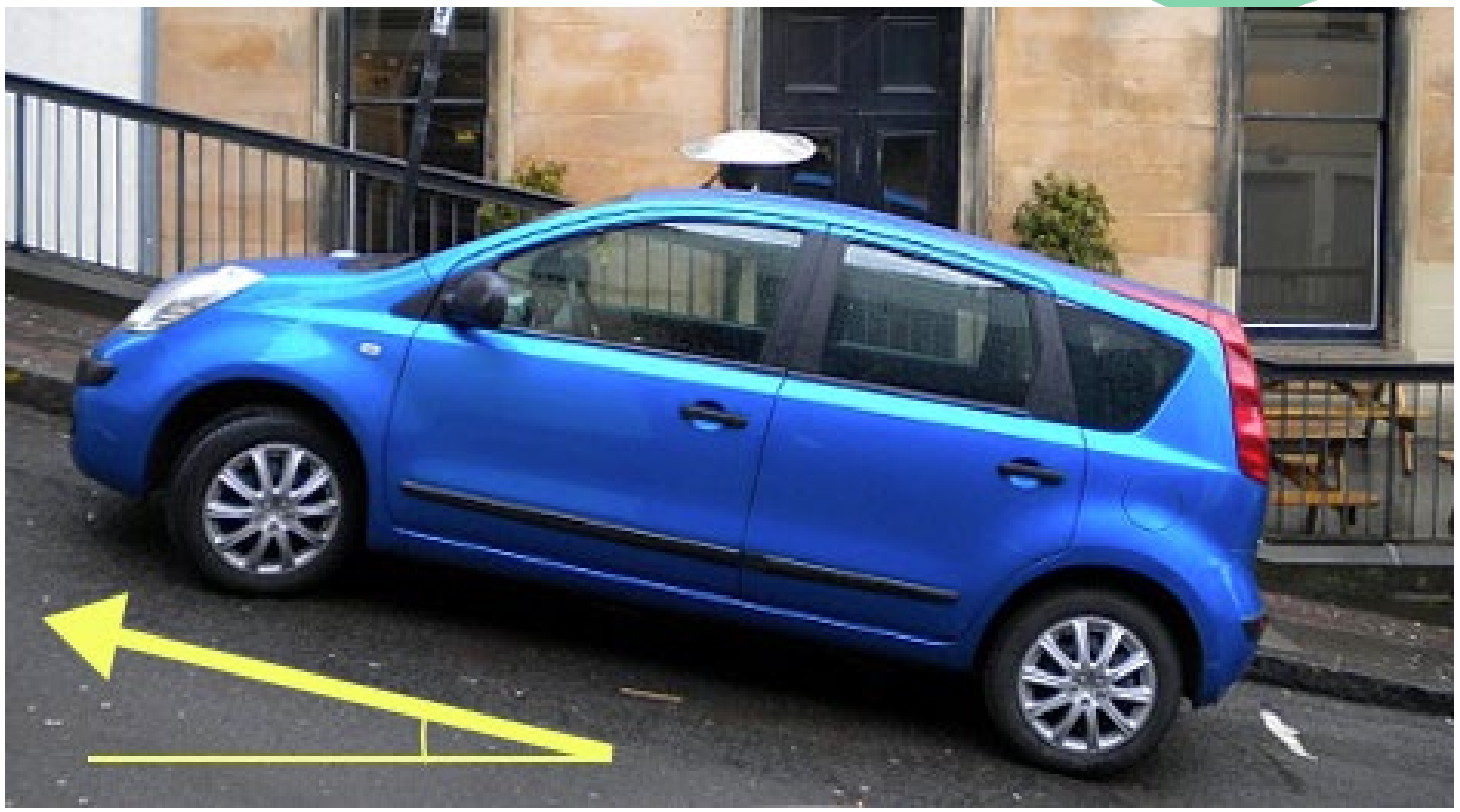




The CCL = The Parking Break

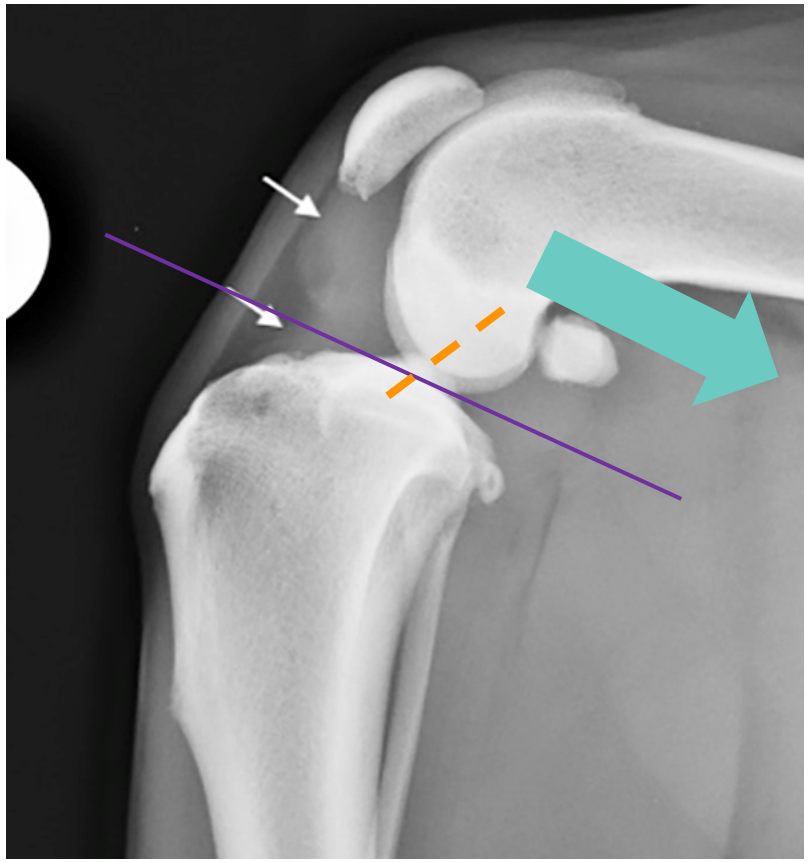
Pathophysiology of CCL Disease





Broken Break/CCL = Car/Tibia rolls down the Hill/Femur

Pathophysiology of CCL Disease

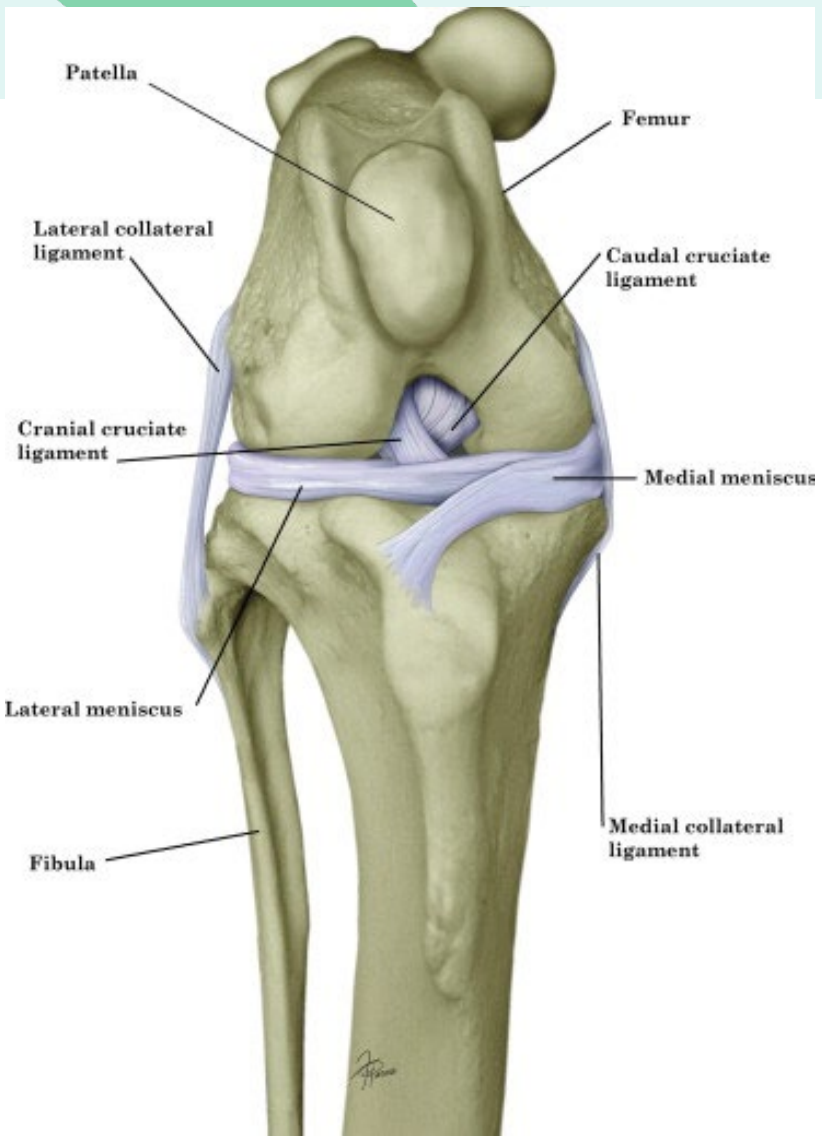


- When the CCL has ruptured, each time the dog bears weight this sliding motion occurs and causes discomfort
- Within the joint, there will be synovitis and effusion
- Medial meniscus is at risk

THIS IS WHAT WE'RE UP AGAINST

Common History

- Acute VS Chronic
  - Acute: single incident
  - Chronic: intermittent lameness that progresses
- Common causes
  - Hyperextension and internal rotation of stifle
  - Jumping if force of cranial tibial thrust exceeds breaking strength of CCL
  - Repetitive normal activities
  - Degeneration



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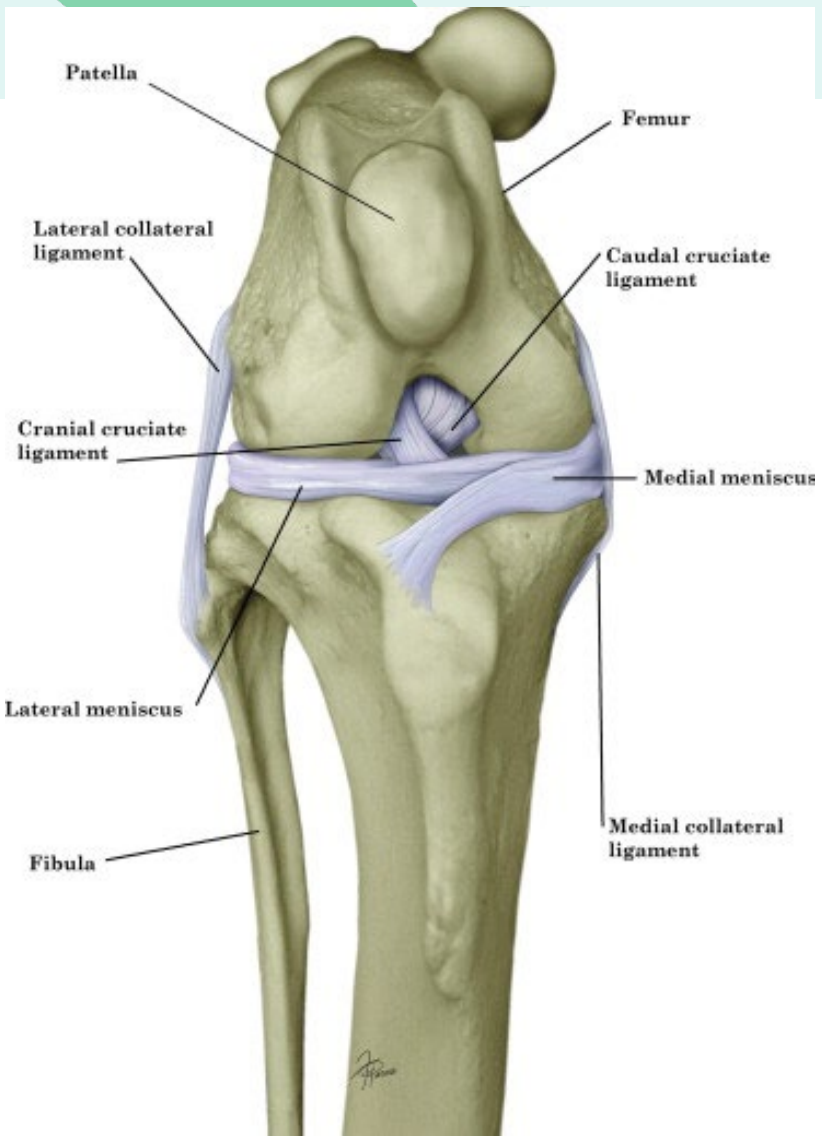
Common History

- **The majority of partial ruptures will progress to a complete rupture within weeks to months.**
- Dogs that have ruptured their CCL in one knee have a 66% chance of rupturing the CCL in their other knee within 2 years.



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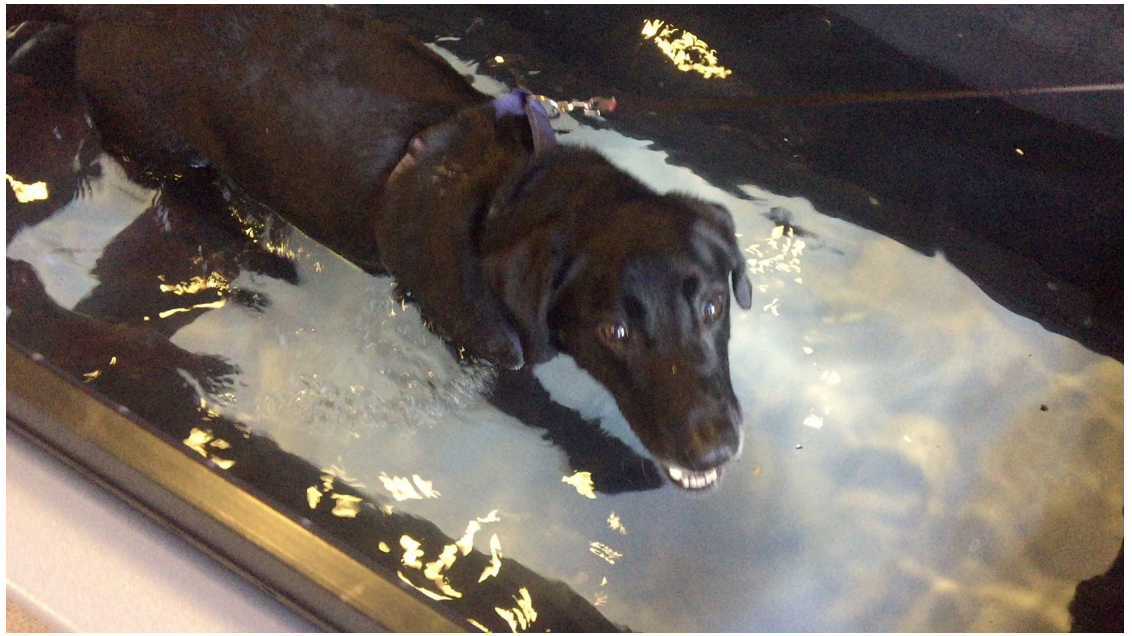
Risk Factors

- ****Obesity****
- Genetic
- Breed
  - Rottweiler
  - Newfoundland
  - Staffordshire Terrier
  - Mastiff
  - Akita
  - Saint Bernard
  - Chesapeake Bay Retriever
  - Labrador Retriever
- Neuter status?



Common Clinical Presentation

- Often non-weight bearing or toe touching hind limb lameness
  - If bilateral, patient may be severely lame in both hind limbs
- May or may not be associated with trauma
- Acute or chronic
- Sloppy sit
- Stiffness upon rising
- Stiffness in gait

Diagnosis of CCL Disease

- Loss of muscle mass
- Stifle effusion
- +/- Medial buttress
- Pain on stifle hyperextension
- Determined on palpation
  - Cranial drawer test
  - Cranial tibial thrust test
- Partial CCL ruptures can be identified by thrust or drawer while the stifle is in **flexion**

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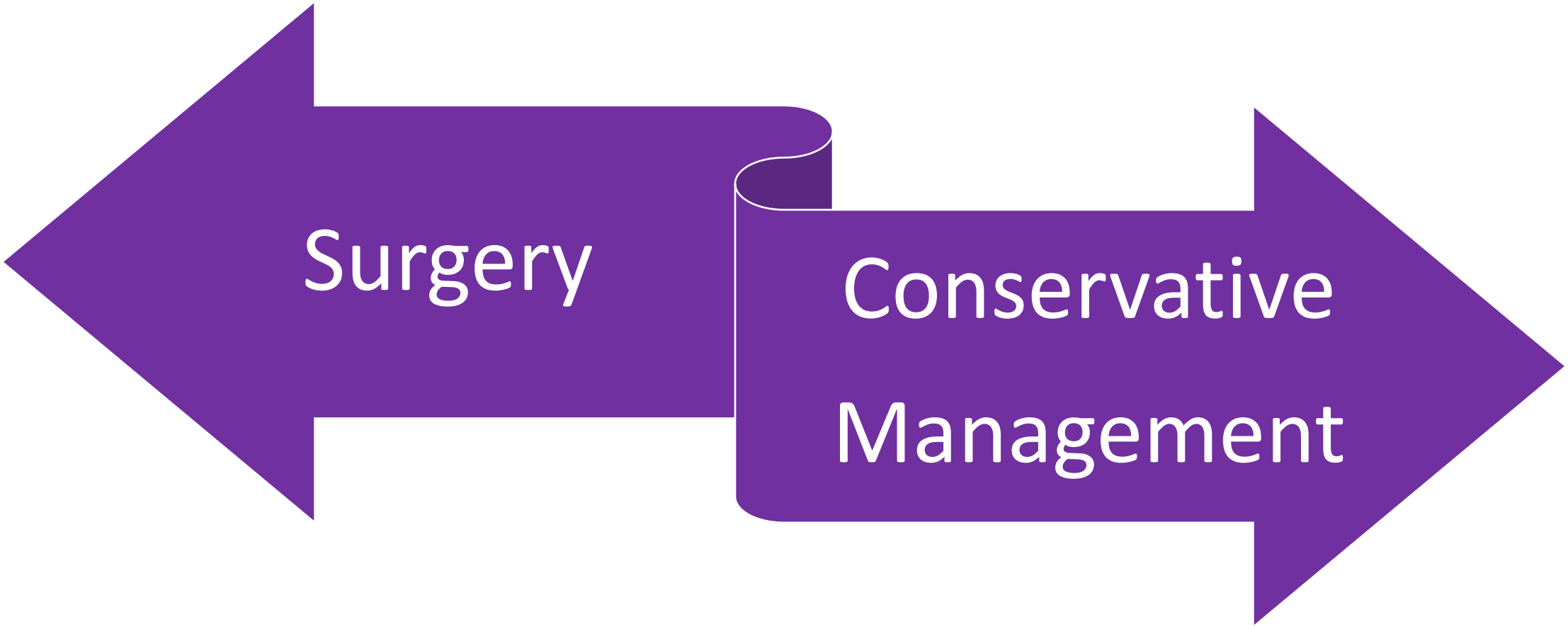
Slide Heading

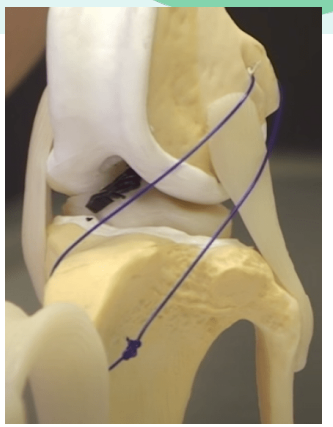
- Determined on palpation
  - Cranial drawer test
  - Cranial tibial thrust test
- Partial CCL ruptures can be identified by thrust or drawer while the stifle is in **flexion**
- Radiographs:
  - Effusion
  - +/- peri-articular osteophytosis (depending on the chronicity)
  - Radiographic drawer
- Arthroscopy/MRI to confirm

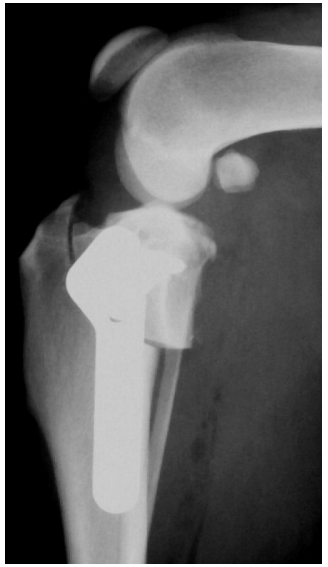
CCL Disease: Treatment Options



Surgery

- Surgery is the gold standard treatment for returning a patient to an active lifestyle
- Multiple procedures:
  - Extracapsular stabilization
  - TightRope® Stabilization System
  - Tibial Plateau Leveling Osteotomy (TPLO)
  - Tibial Tuberosity Advancement (TTA)





Surgery

- Surgery may not always be an option
  - Medical
  - Financial
  - Other client or patient factors

CCL Disease: Treatment Options

- Surgical outcomes are superior to conservative outcomes
  - However, conservative management may still be indicated in some cases

****CRITICALLY important to educate clients and establish realistic goals for their pet****

Vet Surg. 2020 Jan; 49(1): 22–32.
Published online 2019 Jul 4. doi: 10.1111/vsu.13270
PMCID: PMC6973127
PMID: 31271225

Fundamental principles of rehabilitation and musculoskeletal tissue healing

Kristin Kirkby Shaw, DVM, MS, PhD, CCRT, DACVS, DACVSMR,[1] Leilani Alvarez, DVM, CVA, CCRT, DACVSMR,[2] Sasha A. Foster, MSPT, CCRT,[3] Julia E. Tomlinson, BVSc, MS, PhD, CCRP, CVSMT, DACVS, DACVSMR,[4] Aaron J. Shaw, OTR/L, CHT, CSCS,[5] and Antonio Pozzi, DVM, MS, DACVS, DECVS, DACVSMR[6]

- The foundation of veterinary physical rehabilitation includes pain management, therapeutic exercise, manual therapy, and guided return to activity.
- Therapeutic modalities may play a beneficial yet supplementary role in therapeutic plans.
- Client education is an important role of the rehabilitation therapist

Vet Sci. 2021 Sep; 8(9): 186.
Published online 2021 Sep 6. doi: 10.3390/vetsci8090186
PMCID: PMC8472898
PMID: 34564580

Cranial Cruciate Ligament Rupture in Dogs: Review on Biomechanics, Etiopathogenetic Factors and Rehabilitation

Giuseppe Spinella,* Giulia Arcamone, and Simona Valentini

- Physiotherapy protocols play an important role in rehabilitation, with similar goals in humans and dogs: pain management, physiological articular range of motion recovery, periarticular and core muscle strengthening, and proprioceptive deficit correction.
- Physiotherapy, even if often neglected in veterinary medicine, is mandatory for the recovery of the correct functionality of the injured limb and for the return to normal daily and sporting activities.

CCL Disease: Treatment Options

J Am Vet Med Assoc. 2013 May 15;242(10):1364-72. doi: 10.2460/javma.242.10.1364.

Short-term and long-term outcomes for overweight dogs with cranial cruciate ligament rupture treated surgically or nonsurgically

Katja L Wucherer [1], Michael G Conzemius, Richard Evans, Vicki L Wilke

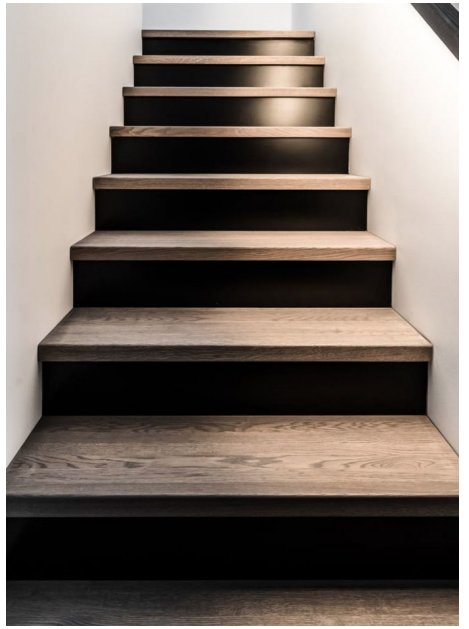
- A conservative approach including nonsteroidal anti-inflammatory drugs, weight loss, and physical rehabilitation may yield successful outcomes in approximately 2/3 of patients 1 year after CCL rupture.

CCL Disease: Conservative Management

- Activity Modification
- Medical Therapy
- Nutraceuticals
- Weight Management
- Rehabilitation Therapy
- Intra-articular Therapies
- Stifle Orthotic

Activity Modification

- Eliminate high impact activity
  - Running
  - Chasing squirrels
  - Playing fetch
- Limit Stairs
- Eliminate or limit Furniture
- Avoid slippery surfaces
- Dog bed with orthopedic foam



Medical Therapy

- NSAID
  - Acute inflammation
  - If needed regularly, I always check blood work every 6 months or sooner if concerned
- Gabapentin
  - Acute and chronic pain
- Methocarbamol
  - If there is a secondary iliopsoas strain
- Tramadol
  - I don’t reach for tramadol routinely
- Amantadine
  - In addition to NSAID and gabapentin
- T-Relief
  - If NSAID is not tolerated

Nutraceuticals

- Glucosamine/Chondroitin Sulfate Joint Supplement
- Omega-3 Fatty Acid Supplement
- MSM
- Curcumin Longa Extract

Nutraceuticals

- Adequan (Polysulfated glycosaminoglycan)
  - Inhibits catabolic enzymes which have increased activity in inflamed joints
  - Enhances activity of anabolic enzymes
  - Anabolic effects (stimulate synthesis of protein, collagen ,and proteoglycans)
  - Potentiates HA synthesis by synoviocytes
  - Helps protect cartilage from further degradation

Weight Management

- THIS IS ESSENTIAL TO THE SUCCESS OF CONSERVATIVE MANAGEMENT
- CLIENT EDUCATION**
- Diet = the MOST important part
- Appropriate caloric intake for weight loss and maintenance
- Low impact exercise is ideal when the pet is ready

Intra-articular Therapies

- Multiple options available for dogs:
  - Hyaluronic Acid (HA)
  - Platelet Rich Plasma (PRP)
  - Stem cell/PRP
  - Cortisone

Intra-articular Therapies:

J Orthop Surg Res. 2019; 14: 314.
Published online 2019 Sep 18. doi: 10.1186/s13018-019-1352-1
PMCID: PMC6749694
PMID: 31533754

A placebo-controlled study comparing the efficacy of intra-articular injections of hyaluronic acid and a novel hyaluronic acid-platelet-rich plasma conjugate in a canine model of osteoarthritis

Mun-Ik Lee,[1] Jun-Hyung Kim,[1] Ho-Hyun Kwak,[1] Heung-Myong Woo,[1] Jeong-Hee Han,[1] Avner Yayon,[2] Yun-Chan Jung,[3] Jin-Man Cho,[4] and Byung-Jae Kang[1,5]

- 12 dogs with CrCL transection
- 3 groups: 4 weekly HA IA injection vs 2 biweekly HA-PRP IA injection vs saline control
- Both treatment groups had significantly improved lameness, kinetic gait scores, and gross & histological findings
- Significantly less cartilage damage in the HA-PRP group than others

Intra-articular Therapies: HA

- If elected, typically perform 3 to 4 weekly HA injections
- Best for early injury
- I do not use if there is significant osteoarthritis as well

Intra-articular Therapies: PRP

- Series of 1-3 PRP injections every 2 weeks
- Start with one injection and recheck in 2 weeks
  - If no improvement, booster PRP at that time
- May need 2-3 injections if there is already radiographic evidence of osteoarthritis in the joint

Cook JL et al. J Orthoped Res. 2016
Vilar JM et al. PLoS One. 2018.
Venator KP et al. Vet Med (Auckl). 2020.
Carr BJ. Vet Clinics of NA. 2022.

Intra-articular Therapies: Stem Cell/PRP

- I do not use this therapy for CCL regeneration
- Recommend 1 injection
- Benefits typically last 9-12 months
- Harvesting stem cells is performed under general anesthesia
  - Often if they are not surgical candidates, this is not an option for the patient either due to need for general anesthesia
- Consider banking stem cells for future use

Canapp SO et al. Frontiers. 2016.
Linon E et al. Vet J. 2014.

Intra-articular Therapies: Cortisone

- Excellent at reducing inflammation
- If a patient has failed regenerative medicine, this is typically what I reach for
- Not safe to perform more than once every 3 months for 2 years
- Triamcinolone: dose 1-3 mg
- Side effects: increased drinking, panting, appetite

Stifle Orthotic

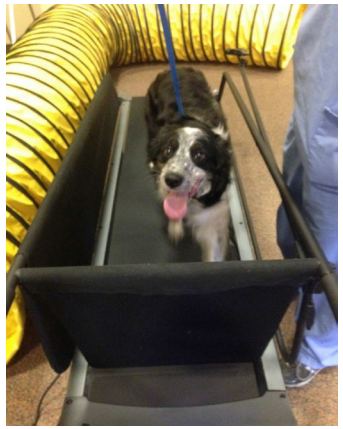
- Must be custom hinged stifle orthotic
- Patient selection
  - Conformation
  - Status of the meniscus?
- Owner selection
- Must be worn when the patient is weight bearing
- *Strongly* recommend the patient participate in rehabilitation therapy plan

Stifle Orthotic

- Cost: $1,000-1,500
- Most common complications:
  - Inappropriate fit
  - Orthotic slips
  - Rub sores

Rehabilitation Therapy: Modalities

- Manual/massage therapy
- Low Level Laser Therapy (LLLT)
- Transcutaneous Electrical Nerve Stimulation (TENS)
- Pulsed Electromagnetic Field Therapy (PEMF)
- Therapeutic Exercise (TherEx)
- Hydrotherapy
- Home Exercise Program
- Extracorporeal Shockwave Therapy (ESWT)

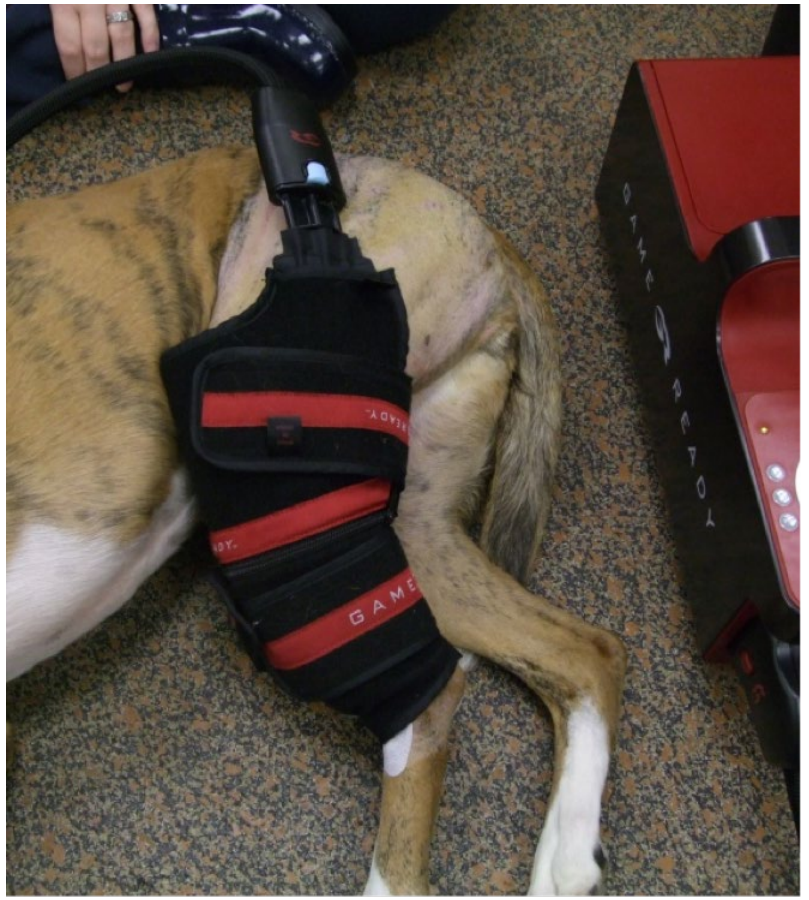


Rehabilitation Therapy: What does that actually look like?

Weeks 0-4:
Acute Phase

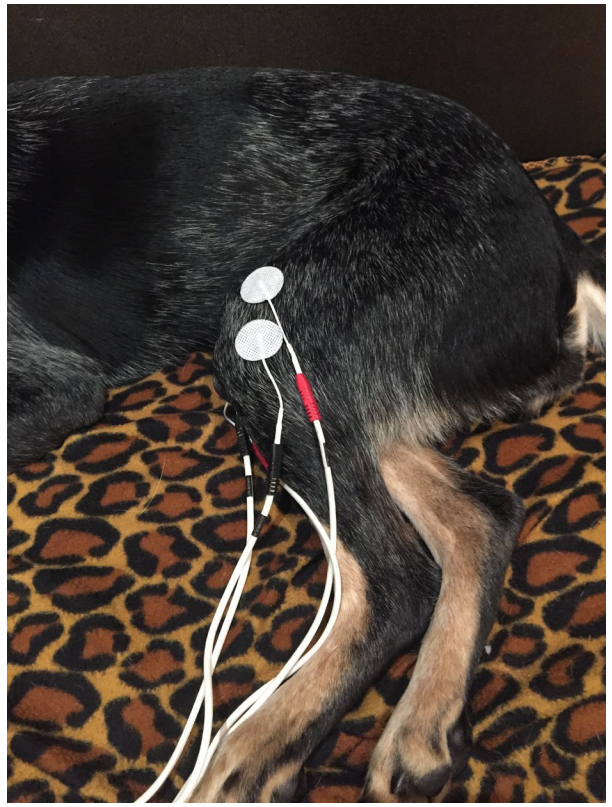
Weeks 0-4: The Acute Phase

- Goals:
  - REDUCE PAIN
  - REDUCE INFLAMMATION
- Frequency of Visits:
  - 1-3 times weekly



Weeks 0-4: The Acute Phase– In Clinic Sessions

- Manual/Massage Therapy
  - Grade 1-2/5 Joint Mobilizations to reduce inflammation and pain
- Low Level Laser Therapy
  - For the stifle and any other areas of compensatory tension
  - 2-3 times weekly if possible
- Transcutaneous Electrical Nerve Stimulation (TENS) for affected stifle
  - Reduce pain and joint effusion
- Pulsed Electromagnetic Field Therapy (PEMF)
- Therapeutic Exercise (TherEx)
  - PROM and stretching
  - Gentle, weight shifting exercises *ONCE COMFORTABLE*



Weeks 0-4: The Acute Phase

- Home Exercise Program: Weeks 0-2 (once to twice daily)
  - Potty walks to 5-10 min leash walks within comfort of patient
  - PROM
  - Hind limb extension
  - Quadriceps Stretch
  - Hamstring Stretch
  - Gentle Weight Shifting

****Not all patients will progress at the same rate, and you may have to adjust your exercise program accordingly.****

Weeks 0-4: The Acute Phase

- Home Exercise Program: Weeks 3-4 (10-15 min/day, once daily)
  - All exercises of 0-2
  - Cookie Stretches to the hip
  - Three Legged Standing with opposite hind limb up
  - Paws Up (start with a low incline)
  - Sitting squarely

Weeks 4-8:
Subacute Phase

Weeks 4-8: Subacute Phase

- Goals:
  - Improve comfort
  - Improve ROM
  - Improve function
  - Improve muscle mass
- Frequency of Visits:
  - Once weekly

Weeks 4-8: Subacute Phase– In Clinic Sessions

- Manual/Massage Therapy
  - As needed
- Low Level Laser Therapy
  - For the stifle and any other areas of compensatory tension
- Pulsed Electromagnetic Field Therapy (PEMF)
- Therapeutic Exercise (TherEx)
  - PROM and stretching
  - Isometric exercises
  - Proprioception exercises
- Weeks 6-8: May start Underwater Treadmill (UWT) **IF STIFLE AND HIP FLEXORS ARE COMFORTABLE**

Weeks 4-8: Subacute Phase

- Home Exercise Program: Weeks 4-8 (once daily)
  - Leash walks (start at 10 min and may add 5 min per week)
  - PROM
  - All passive stretches
  - Cookie stretches to the hip
  - Three Legged Standing (opposite hind limb and forelimb)
  - Two Legged or Parastanding (opposite side and diagonal)
  - Paws Up (may increase incline)
  - Sit to Stands (focus on form)

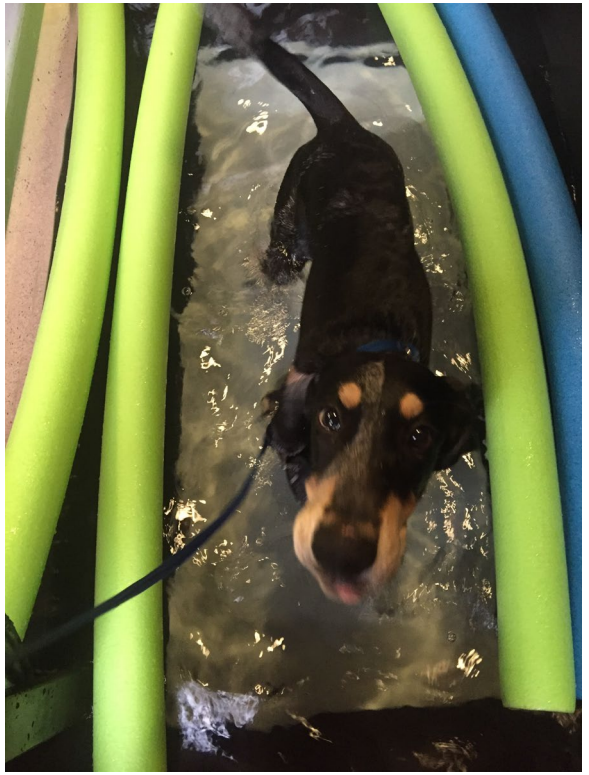
Weeks 8-12:
Strengthening Phase

Weeks 8-12: Strengthening Phase

- Goals:
  - Improve comfort
  - Improve ROM
  - Improve function
  - Improve muscle mass
- Frequency of Visits:
  - Once weekly

Weeks 8-12: Strengthening Phase

- Manual/Massage Therapy
  - As needed
- Low Level Laser Therapy
  - For the stifle and any other areas of compensatory tension as needed
- Pulsed Electromagnetic Field Therapy (PEMF)
- Therapeutic Exercise (TherEx)
  - PROM and stretching
  - Concentric/Eccentric exercises
  - Proprioception exercises
- Hydrotherapy with UWT (may increase speed and incline)



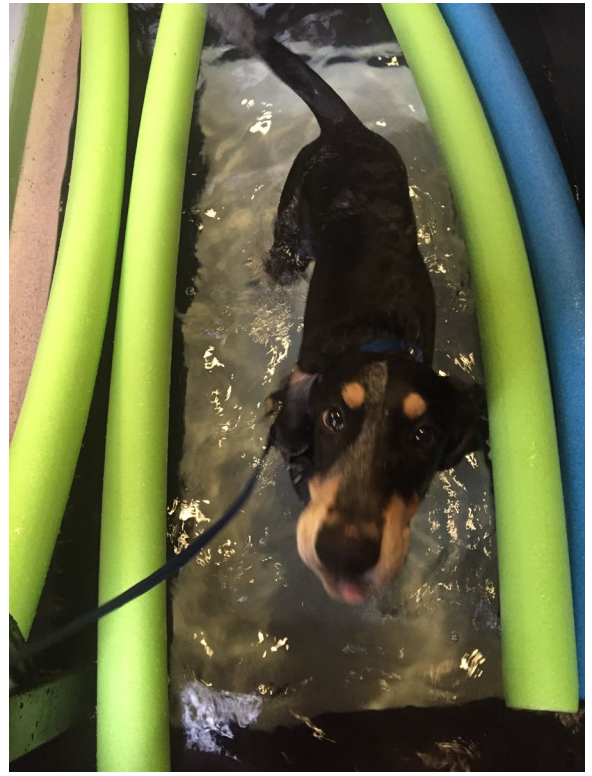
Weeks 8-12: Strengthening Phase

- Home Exercise Program: Weeks 8-12 (once daily)
  - Leash walks (add 5 min per week, add hills)
  - PROM
  - All passive stretches
  - Cookie stretches to the hip
  - Two Legged or Parastanding (opposite side and diagonal)
  - Paws Up (may increase incline)
  - Sit to Stands (focus on form)
  - Down to Stands
  - Backwards Walking
  - Cavalettis
  - May incorporate hills and unstable surfaces as a patient is ready (if available)

Weeks 12+:
Conditioning Phase

Weeks 12+: Conditioning Phase

- Manual/Massage Therapy
  - As needed
- Low Level Laser Therapy
  - As needed
- Pulsed Electromagnetic Field Therapy (PEMF)
- Therapeutic Exercise (TherEx)
  - PROM and stretching
  - Concentric/Eccentric exercises
  - Proprioception exercises
- Hydrotherapy with UWT (may increase speed and incline)



Weeks 12+: Conditioning Phase

- Home Exercise Program: Weeks 8-12 (once daily)
  - Leash walks (add in trotting, continue hills)
  - PROM
  - All passive stretches
  - Cookie stretches to the hip
  - Two Legged or Parastanding (opposite side and diagonal)
  - Paws Up (may add in unstable surface if not already)
  - Sit to Stands (focus on form)
  - Down to Stands (focus on form)
  - Backwards Walking (perform on hills)
  - Cavalettis
  - May incorporate hills and unstable surfaces as a patient is ready

Is there anything that can be done to prevent contra-lateral CCL rupture??

The Short Answer:

- Not that we've discovered
- Thought to maintain muscle mass and preserve function in affected limb to reduce load on contralateral CCL
- **Rehabilitation therapy and Home Exercise Program**

Case Study: Sadie

- 12 year old FS Golden Retriever
- Service Dog at the local Elementary School

Case Study: Sadie

- Sadie is 12 year old female spayed Golden Retriever
- Participates in reading program at local elementary school
- Previous medical history:
  - Elevated liver enzymes
- Acute right hind limb lameness following slipping down porch stair

Case Study: Sadie

Initial Presentation:

- Grade 5/5 right hind limb lameness
- Thigh Circumference:
  - Right: 43 cm
  - Left: 45 cm
- R stifle:
  - Moderate effusion
  - Cranial tibial thrust throughout range of motion
  - McMurray test for meniscal injury negative
- Radiographs of the Right stifle:
  - Moderate IA effusion
  - Evidence of mild DJD

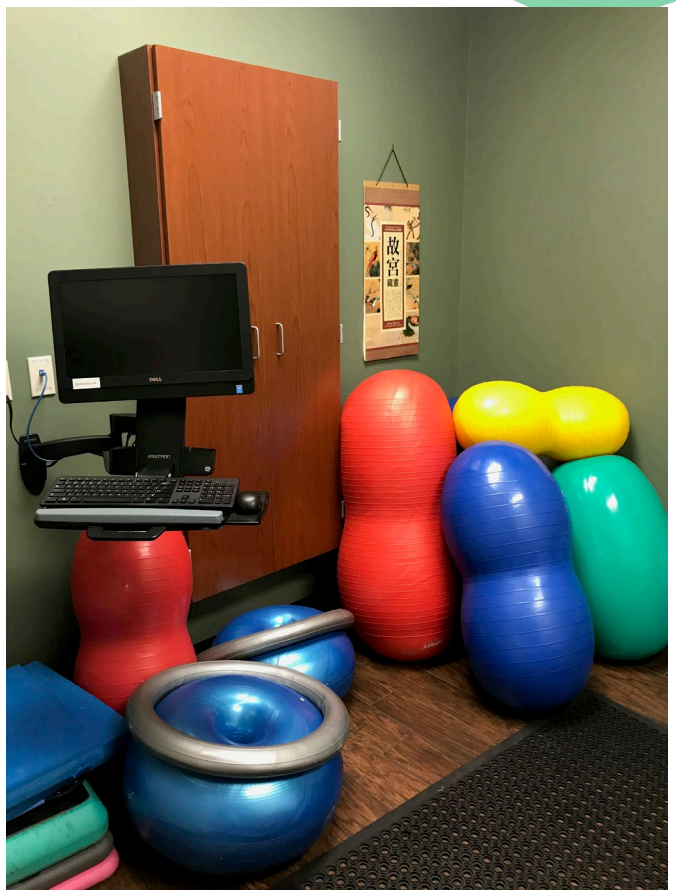
Case Study: Sadie

- Recommended a surgical consultation
- Owners declined a surgical consultation and elected to pursue conservative management options
- Owners goals were to keep her involved with the reading program at the local Elementary School and keep her comfortable during light walks

Case Study: Sadie

Recommendations:

- Medical Therapy
  - Gabapentin 5mg/kg PO TID
  - T-relief 3 tablets PO TID
- Nutraceuticals
  - Joint supplement
  - Omega 3 FA supplement
- Weight Management
  - Maintain healthy weight
- Exercise and Environmental Modifications
- Custom hinged stifle orthotic
- Intra-articular Therapies
  - Platelet Rich Plasma (PRP)
- Weekly Rehabilitation Therapy for 12 weeks



Case Study: Sadie

Custom Hinged Stifle Orthotic:

- Casted for custom stifle orthotic at the time of the initial consultation and sent the casting to the orthotist
- Custom hinged stifle orthotic fitted 4 weeks later
  - At 2 weeks post PRP recheck appointment
- Orthotic to be worn whenever patient is active (removed during times of rest and at night to sleep)

Case Study: Sadie

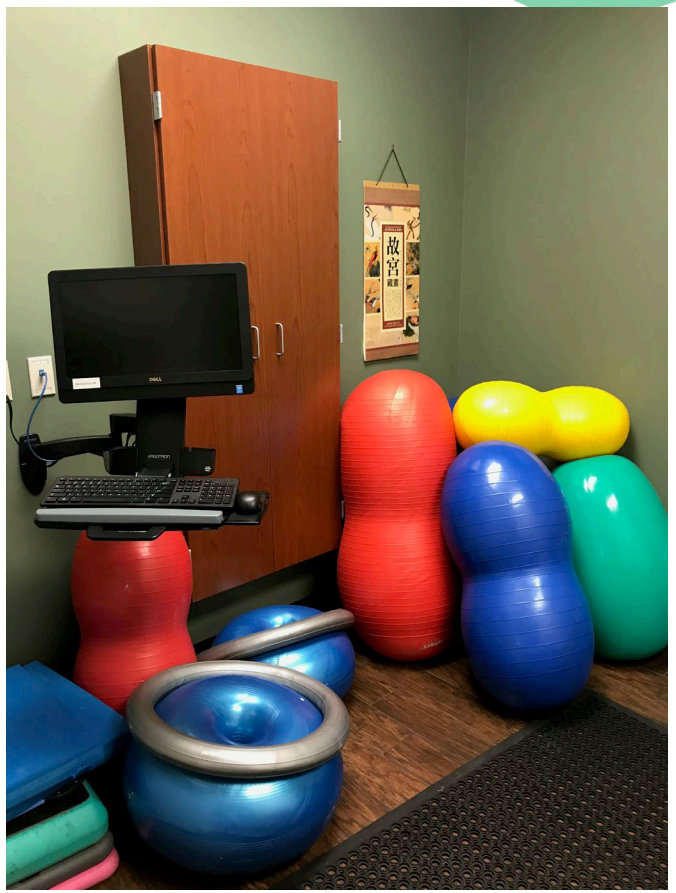
PRP Therapy:

- Sadie was sedated for the procedure
- CRT PurePRP
- Injected 2mL of CRT PurePRP into the right stifle
- Sedation was reversed and she was sent home that same afternoon

Case Study: Sadie

Rehabilitation Therapy:

- Started 2 weeks following PRP therapy
- Weeks 2-4:
  - Manual/massage therapy
  - Class IIIb LLLT (3-5 J/cm^2)
  - TherEx: Isometric Exercises
  - Home Exercise Program
- Weeks 4-8:
  - Manual/massage therapy
  - Class IIIb LLLT
  - TherEx: Concentric/Eccentric Exercises
  - Home Exercise Program
- Weeks 8-12:
  - Manual/massage therapy
  - Class IIIb LLLT
  - TherEx: Concentric/Eccentric Exercises
  - Underwater treadmill
  - Home Exercise Program



Case Study: Sadie

Follow Up:

- 2 Week:
  - Grade III/V RPL lameness
  - Mild R stifle effusion
  - No discomfort upon R stifle ROM
  - Mild R iliopsoas tension (suspect compensatory)
  - Fitted for R stifle orthotic
  - Given at home exercise plan with isometric exercises

Case Study: Sadie

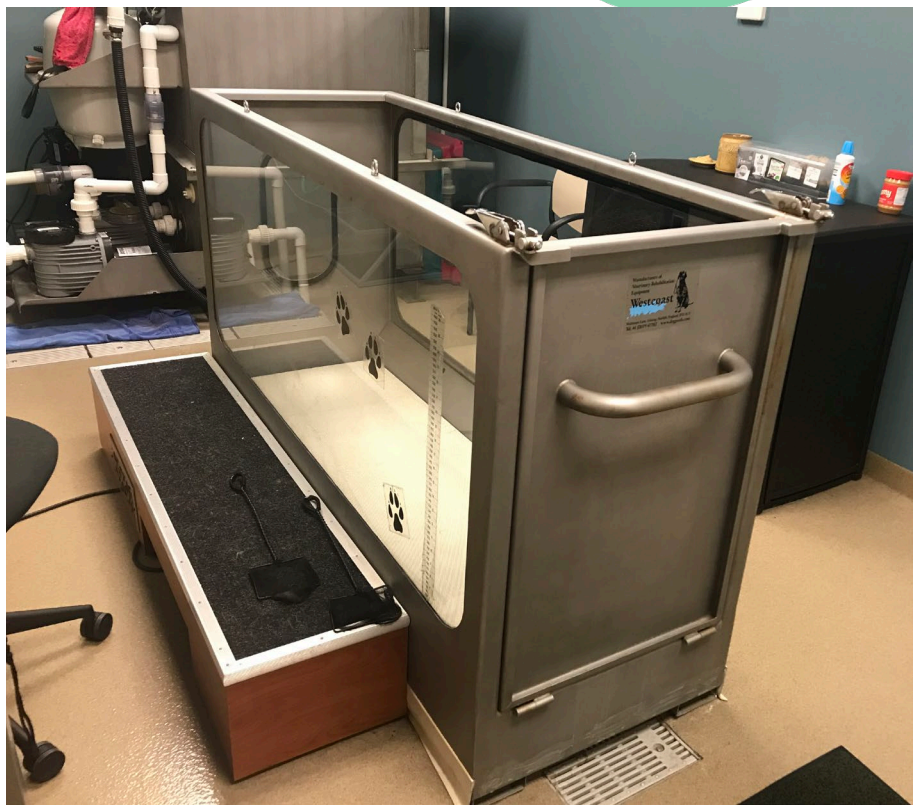
Follow Up:

- 4 Week:
  - Grade II/V RPL lameness
  - R stifle comfortable, minimal effusion
  - R iliopsoas tension has resolved
  - Using the stifle orthotic well, no issues
  - Given home exercise plan with isometric ar concentric/eccentric exercises
    - Target:
      - Core musculature
      - Hind limb musculature
        - **Especially the hamstrings**
          - Semimembranosus
          - Semitendinosus
          - Biceps femoris

Case Study: Sadie

Follow Up:

- 8 Week:
  - Grade I-II/V RPL lameness
  - R stifle comfortable, no palpable effusion
  - R iliopsoas comfortable
  - No issues with the stifle orthotic
  - Cleared to start UWT
  - Cleared to restart the reading program
  - Home exercise plan adjusted to continue challenging patient



Case Study: Sadie

Follow Up:

- 12 Week:
  - Grade I/V RPL lameness
  - R stifle comfortable, no palpable effusion
  - R iliopsoas comfortable
  - No issues with the stifle orthotic
  - Ok to continue in the reading program
  - Cleared to enter Strength and Conditioning phase
  - Home Exercise plan adjusted accordingly

Case Study: Sadie

- **Follow Up:**
- 6 months post PRP
  - I was notified that Sadie had been euthanized due to hemangiosarcoma
  - Owners reported until euthanasia she was comfortable and able to participate in the local elementary school's reading program

In Summary

- **Client Education**
  - Reasonable goals
- Activity Modification
- Medical Therapy
- Nutraceuticals
- Weight Management
- Rehabilitation Therapy
- Intra-articular Therapies
- +/-Stifle Orthotic

Questions?

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