

DIAGNOSTIC IMAGING OF CANINE SPORTS MEDICINE AND REHABILITATION PATIENTS

Dr. Kelly Mann
Diplomate, American College of
Veterinary Radiology

Agenda

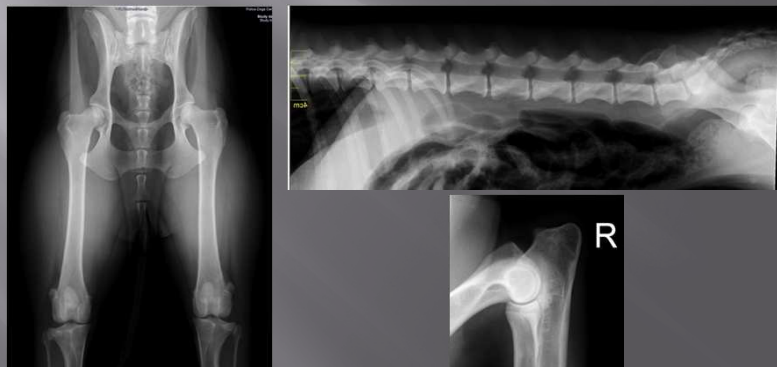
- ▣ Common injuries
 - Focus on soft tissue
- ▣ Importance of screening exams
- ▣ Numerous imaging modalities
 - Often multiple pathways to diagnosis
- ▣ Case Examples
 - Forelimb lameness
 - Whole body advanced imaging

Common Injuries

- ▣ Scientific and non-scientific reviews
 - Large numbers but possible over-representation of some breeds and activities (e.g., border collies, agility)
- ▣ Trends
 - Assuming normal conformation
 - Shoulder and back > neck > stifle > elbows
 - Strains/sprains often dominant complaint
 - ▣ Tendon/muscle and ligament injuries

Screening Exams

- ▣ Hips, elbows, lumbosacral region
 - Other areas based on breed predilection, trainer observation, physical and lameness examinations



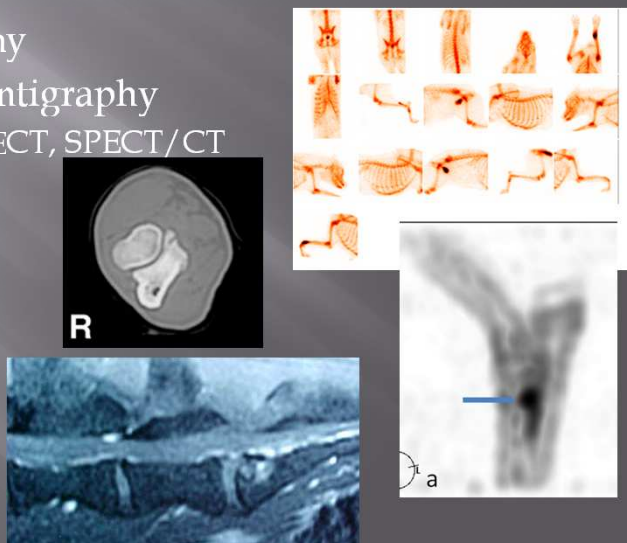
Screening Exams

- ▣ Avoid common problems
 - Predisposition for lameness
 - Decreased effective working life



Imaging Modalities

- ▣ Radiography
- ▣ Nuclear scintigraphy
 - Planar, SPECT, SPECT/CT
- ▣ US
- ▣ CT
 - PET/CT
- ▣ MRI
 - PET/MR



Imaging Options

- ▣ Step-wise imaging plan based on:
 - Availability (radiography and ultrasound)
 - Expense & cost:benefit ratio (failure of other modalities or benefit for surgical planning)
- ▣ Tendon/muscle and ligament injuries
 - Radiography – laxity, mineralization, lysis, avulsion
 - US – fiber alignment, effusion, swelling, mineralization
 - MRI – free fluid, effusion, hemorrhage
 - PET – increased cellular respiration/metabolism

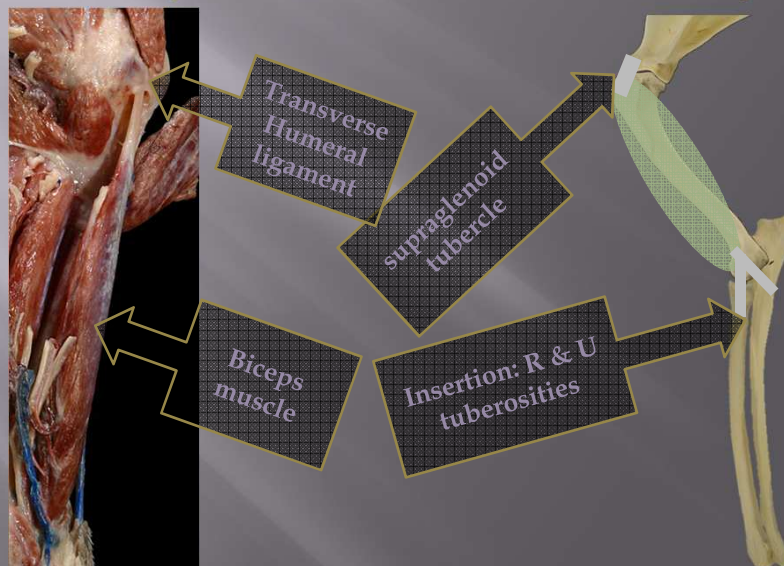
Case example – forelimb

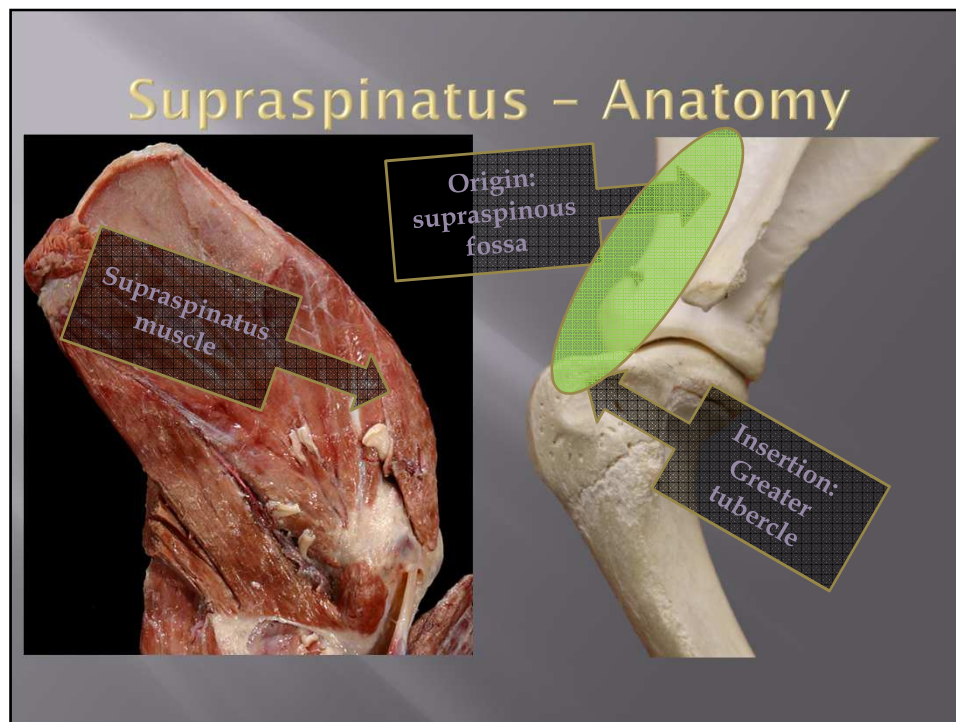
- ▣ Phalanges
- ▣ Carpus
- ▣ Elbow
- ▣ Shoulder / Scapulohumeral joint
 - Medial shoulder instability (MSI)
 - Osteochondritis dissecans (OCD)
 - Biceps tendinopathy
 - Fibrotic myopathy of the infra- or supraspinatus m.
 - Fractures of humerus or scapula

Case example – forelimb

- ▣ 5 year old, MN, Golden Retriever
- ▣ History of forelimb lameness
- ▣ Recent worsening of lameness despite:
 - Glucosamine CS, Omega 3-fas, Tramadol, Rimadyl, Gabapentin, Adequan
- ▣ Physical Exam
 - Pain both elbows (mild pre-existing elbow dysplasia)
 - + biceps test (L>R)

Biceps brachii – Anatomy





Biceps / Supraspinatus

- ▣ Tendinopathy
 - Biceps tendonitis, tenosynovitis
 - Supraspinatus calcification (dystrophic)
- ▣ Etiology
 - Degeneration +/- inflammation
 - Hypovascular areas at origin/insertion
 - Hypoxia → fibrocartilaginous transformation of tendon
 - Primary - repetitive microtrauma (often large breed, active dogs), trauma, overuse
 - Secondary (biceps) – irritation/inflammation due to other joint disease (OCD, supraspinatus, MSI)

Biceps / Supraspinatus

- ▣ Typical presentation
 - Signalment: Middle-aged, medium/large breed athletic dogs
 - History: progressive lameness (NWB with partial acute avulsion), exacerbated with exercise
 - Frequently bilateral but unilateral lameness (especially supraspinatus)
- ▣ Differential diagnoses
 - ED/DJD – rads +/- CT for adult-onset (also NM)
 - OA, proximal humerus OSA – rads
 - Neuro (including brachial plexus tumor)
 - Check reflexes, proprioception, axillary pain

Biceps / Supraspinatus

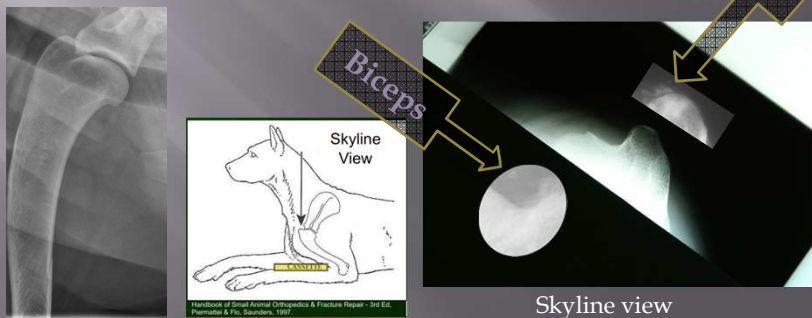
- ▣ Diagnosis – Radiographs:
 - Calcifying tendinopathies :
 - Lateral view
 - Caudocranial view
 - Skyline view (intertubercular groove)
- ▣ Diagnosis - Ultrasound:
 - Calcified and non-calcified tendinopathies
 - Dynamic



Fossum, Theresa W. *Small Animal Surgery*
Textbook, 4th Edition. Mosby, 2013.

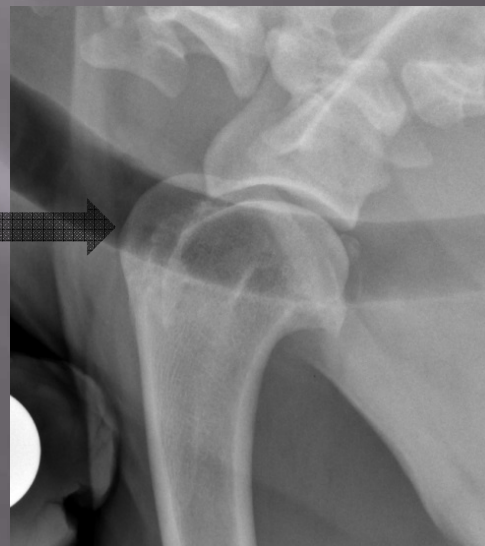
Biceps /Supraspinatus

- ▣ Diagnosis - Radiographs (lateral view):
 - Good for mineralization of supraspinatus
 - Difficult to see faint biceps opacity over greater tubercle
 - Difficult to distinguish biceps/supraspinatus
- ▣ Skyline – outlines intertubercular groove



Biceps /Supraspinatus

**Biceps
calcification**



Biceps / Supraspinatus

Supraspinatus
calcification



Biceps / Supraspinatus

- ▣ Arthrogram filling defects
 - Biceps tendon
 - Caution with interpreting irregularities as 'biceps tendinopathy'
 - Humeral head (OCD)



Biceps /Supraspinatus

□ Ultrasound

- Able to detect non-mineralized tendinopathies
- Fairly simple and inexpensive, but operator dependent



Lafuente et al. 'Surgical Treatment of Mineralized and Nonmineralized Supraspinatus Tendinopathy in Twenty-four Dogs' Vet Surg 2009

Biceps /Supraspinatus

□ Biceps impingement

- May not appreciate unless perform US or MRI
- Addressing supraspinatus treats biceps

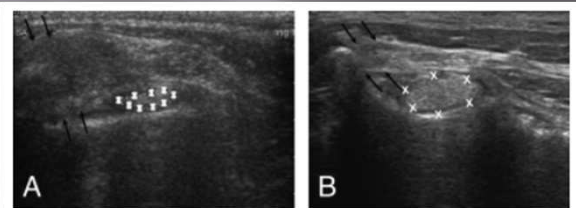


Fig 2. Ultrasonography (transverse plane) of a 4-year old male castrated Wheaten Terrier showing enlargement (arrows) of the supraspinatus tendon and impingement (small crosses) of the biceps tendon (A), and structures in a normal shoulder (B).

Lafuente et al. Surgical Treatment of Mineralized and Nonmineralized Supraspinatus Tendinopathy in Twenty-four Dogs. Vet Surg 2009

Biceps / Supraspinatus

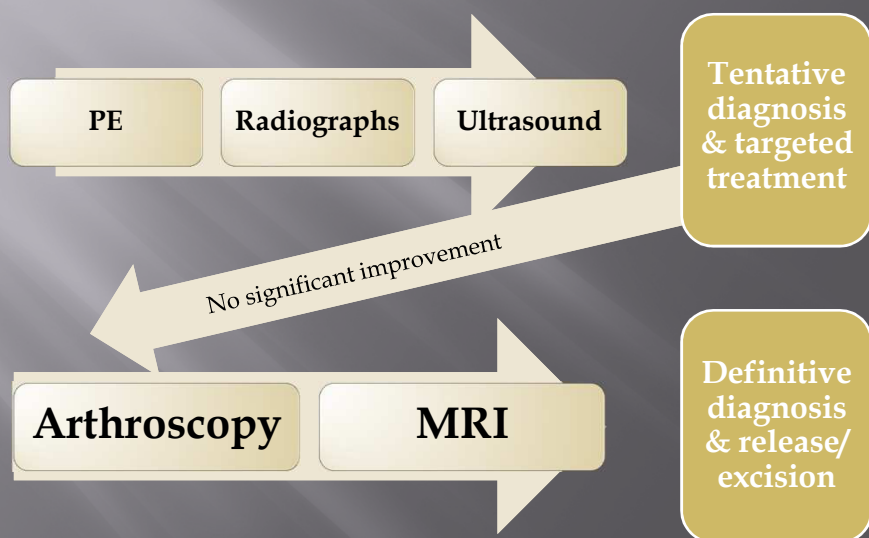
BICEPS TREATMENT

- ▣ PT/Rehab
- ▣ Medical
 - 5mg Triamcinolone (shorter duration, safer)
- ▣ Surgical
 - Tenodesis
 - ▣ Open
 - Tenotomy
 - ▣ Scope/ultrasound

SUPRASPINATUS TREATMENT

- ▣ PT/Rehab
- ▣ Medical
 - Shock wave
 - Stem cells/PRP?
- ▣ Surgical
 - Tendon resection
 - Release of transverse humeral ligament
 - Release incisions in supraspinatus

Biceps / Supraspinatus



Case example - whole body



PET/CT

- Positron Emission Tomography
 - Functional imaging
 - Positron emission → annihilation reaction → two, 511 keV photons, 180° apart
 - Radioactive Fluorine (^{18}F)
 - Most common radionuclide
 - 110 minute half life
 - Examples
 - Fluorodeoxyglucose (FDG) = glucose analog
 - NaF: skeletal imaging similar to Tc99mHDP scintigraphy
- Computed Tomography
 - Anatomy
- Fused together to improve diagnostic accuracy

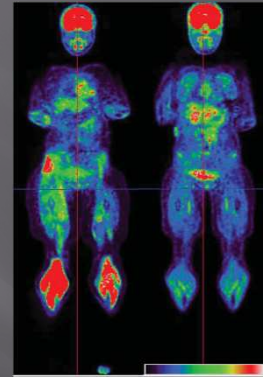
F 18 109.728 m β^+ 0.633 no γ	F 19 100 σ 0.0095
O 17 0.038 σ 0.00054 $\sigma_{n,\alpha}$ 0.257	O 18 0.205 σ 0.00016

References

- ▣ Asymmetric glucose uptake in leg muscles of patients with Multiple Sclerosis during walking detected by [18F]-FDG PET/CT. Rudroff et al. (2014) Neuro Rehabilitation 35:813-823.
- ▣ PET/CT imaging of age- and task-associated differences in muscle activity during fatiguing contractions. Rudroff et al. (2014) J Appl Physiol 114:1211-1219.



Integrative Neurophysiology Laboratory
<http://www.inplab.chhs.colostate.edu/index.aspx>



PET/CT

- ▣ Pilot study in canine patients
 - ^{18}F -FDG musculoskeletal imaging
 - Lameness with ill-defined clinical signs
- ▣ Prior to the PET/CT scan
 - Consistent, regular activity during the week preceding the PET/CT scan
 - All medications are continued without interruption
 - Fasting overnight prior to morning anesthesia
 - Leash-walking prior to anesthesia
 - ▣ Clinical patients with no treadmill experience
 - Blood glucose evaluation

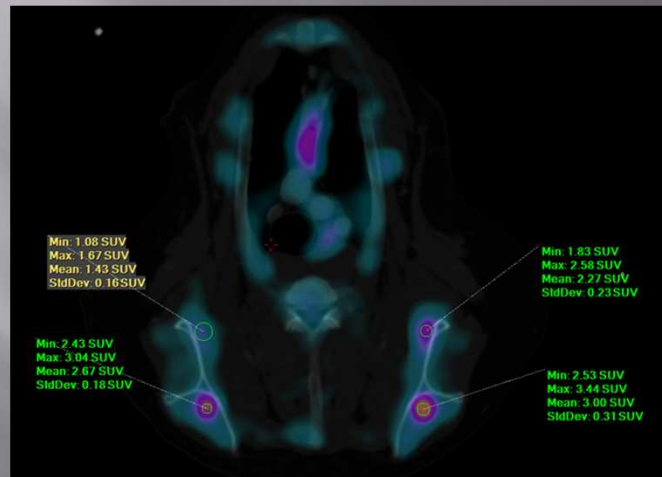
PET/CT

- ▣ Day of the PET/CT scan
 - ^{18}F -FDG intravenous injection
 - 60-minute uptake time
 - Whole body CT
 - Additional bone algorithm in area of interest (e.g., elbows)
 - Whole body PET scan
 - Whole body contrast-enhanced CT
 - Recovery from anesthesia is monitored in the nuclear medicine ward
 - Released by the end of the day ($<20\mu\text{Sv/hr}$)

PET/CT

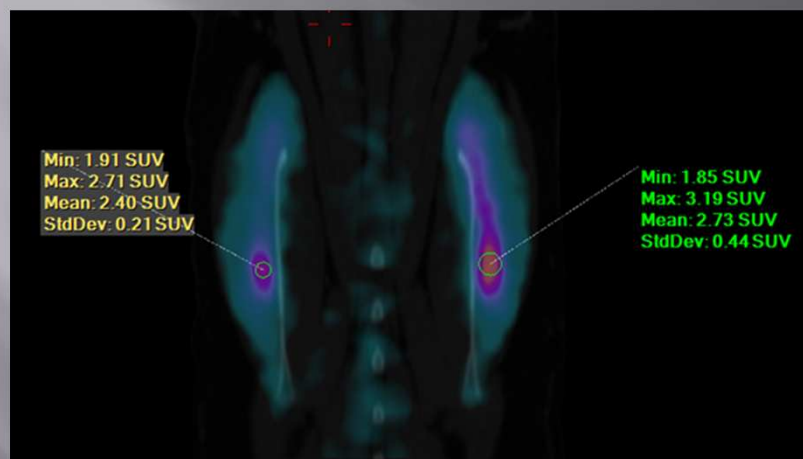
- ▣ 1st of 12 musculoskeletal imaging patients
 - History of elbow dysplasia
 - Contralateral muscle uptake due to compensation
 - Research benefit → proof of concept
 - Client/Patient benefit → bilateral, high detail elbow/shoulder CT
- ▣ 5yo, FS, Lab, 33.9kg
- ▣ 210 MBq (5.68 mCi) ^{18}F -FDG
 - Range 5.2-6.3 MBq/kg (0.14-0.17mCi/kg)

PET/CT



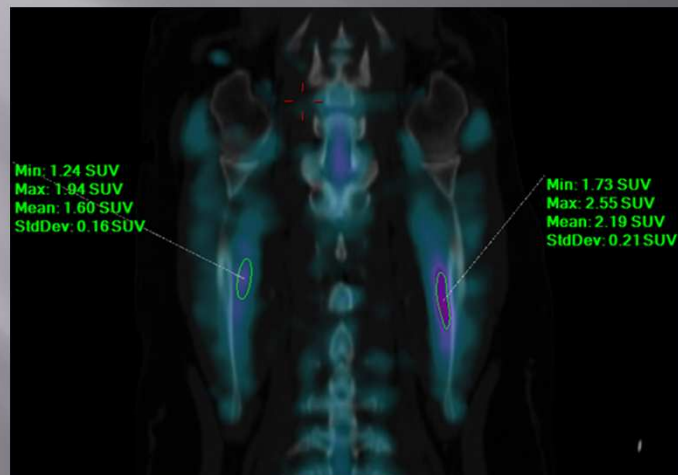
Transverse view. Left supraspinatus and Left subscapularis muscles demonstrate greater FDG uptake as compared to contralateral musculature.

PET/CT



Dorsal view. Left Supraspinatus uptake = slightly higher SUV and great volume of tissue with increased uptake when compared to Right Supraspinatus muscle.

PET/CT



Dorsal view. Left subscapularis muscle has greater FDG uptake than right.

PET/CT

- ▣ ^{18}F -FDG
 - Functional imaging of glucose metabolism
 - neoplasia, inflammation, muscle activity
- ▣ Forces driving ^{18}F -FDG imaging advances
 - Oncology
 - Musculoskeletal

PET/CT

- ▣ Exciting Future → Stem cell tracking
 - ^{18}F -FEAU – thymidine kinase reporter gene expression in transformed stem cells
- ▣ Philanthropists John and Leslie Malone propel regenerative medicine with \$42.5M gift (CSU Source article 29DEC14)
 - <http://source.colostate.edu/malone>
 - Institute for Biologic Translational Therapies

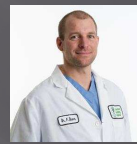


Summary

- ▣ Physical exam, Radiography and Ultrasound
 - Readily available and very useful
 - Stress/Positional radiography, Arthrography
- ▣ Advanced imaging (NM, CT, MRI, PET)
 - Subtle mineralization/lysis or soft tissue changes
 - Functional information + anatomical localization
 - Surgical planning
 - Stem cell tracking
- ▣ Repeated exams document response to therapy
 - Soft tissue healing, tumor regression, stem cell activity

Questions

- ▣ Felix Duerr, DVM, MS, Dr. med. vet.
 - Diplomate, American and European College of Veterinary Surgeons - Small Animal; Diplomate, American College of Veterinary Sports Medicine and Rehabilitation; Assistant Professor Small Animal Sports Medicine and Orthopedics
 - Felix.Duerr@ColoState.edu
 - www.caninesportsmed.ColoState.edu
- ▣ kelly.mann@colostate.edu



Colorado State University
COLLEGE OF VETERINARY MEDICINE
AND BIOMEDICAL SCIENCES