Diagnostic Musculoskeletal Ultrasound
A Guide for Rehabilitation in Canine Patient

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Certified Veterinary Acupuncturist
Musculoskeletal Ultrasound
Small Animal Medicine

- Clinical Use in Small Animals Increasing

- Currently
  - Higher resolution equipment
  - Better image quality
  - Better diagnostic/monitoring capability for smaller structures

- Diverse Applications
Low/High Resolution

KRAMER 1999 7.5MHZ

2010 13.6MHZ

Proximal Patellar Tendon
Musculoskeletal Ultrasound

- Great Soft Tissue
- Quick, Non-Invasive
- No Anesthesia
- Lower Cost vs MRI
- Allow for Rechecks
- Monitoring Rehab
- Dynamic Evaluations
MSK Ultrasound

- Withstands Scientific Rigor
- Valid/Reliable Method
  - Muscle size
  - Indicator of Muscle Activity
  - Tendon/Ligament Integrity

GENERAL GUIDELINES

- **Tendon, ligament, muscle**
  - Size
  - Texture
    - Homogenous
      - Smooth, even
    - Non-homogenous
      - Mottled
  - Echogenicity
    - Normal
    - Hyperechoic
      - More white
    - Hypoechoic
      - More black
    - Anechoic
      - Absent

USUAL FACTS

- Biceps more hyperechoic than supraspinatus
Tendon Injury

- **Gross Findings**
  - Rupture
  - Dynamic Function
- **Tendon Ligament Grading System**
  - Ligament – Sprain
  - Tendon - Strain
- **Tissue Stiffness**
  - Elastography
- **Vascularity**
  - Fine flow color doppler
Dynamic Function

NORMAL BICEP

BICEP RUPTURE
Tendon/Ligament
Standard Grading Scale

- **Grade 1**
  - Minimal Structural Involvement
    - Microscopic Tears
    - Inflammation

- **Grade 2**
  - Partial Tear
    - Possible minor/partial instability
    - Painful

- **Grade 3**
  - Complete Tear
  - Unstable

[www.spinalphysio.co.uk](http://www.spinalphysio.co.uk)
Ultrasound Shoulder Pathology Rating Scale - USPRS

- 0=normal (hyperechoic, fibrillar echotexture),
- 1=mild tendinosis (heterogeneous echotexture with ill-defined hyperechoic regions),
- 2=severe tendinosis (diffuse abnormal hypoechogenicity, but without tendon volume loss),
- 3=intrasubstance abnormality (focal, well-defined, hypoechoic or anechoic area not extending to either the bursal or articular tendon surface),
- 4=partial-thickness tendon tear (focal, well-defined, hypoechoic or anechoic area extending to either the bursal or articular tendon surface),
- 5=focal full-thickness tendon tear (focal, well-defined, hypoechoic or anechoic area extending to both the bursal and articular tendon surfaces with tendon volume loss),
- and
- 6=massive full-thickness tear (non-visualization of tendon with retraction).
Ultrasound Shoulder Pathology Rating Scale (USPRS) Canine

**I. Biceps Tendinosis/Tendinopathy**
- 0 = Normal fibrillar pattern and echogenicity
- 1 = Mild loss of fibrillar pattern and/or echogenicity
- 2 = Moderate loss of fibrillar pattern and/or echogenicity
- 3 = Calcified area of tendon
- 4 = Clear longitudinal tear
- 5 = Partial rupture
- 6 = Full rupture/absence of tendon

**II. Supraspinatus Tendinosis/Tendinopathy**
- 0 = Normal fibrillar pattern and echogenicity
- 1 = Mild loss of fibrillar pattern and/or echogenicity
- 2 = Moderate loss of fibrillar pattern and/or echogenicity
- 3 = Calcified area of tendon
- 4 = Clear tear partial thickness
- 5 = Clear tear full thickness

**III. Biceps Groove Humeral Cortical Surface**
- 0 = Smooth hyperechoic cortical surface
- 1 = Mild cortical irregularity
- 2 = Moderate cortical irregularity
- 3 = Marked cortical irregularity or pitting

**IV. Static/Dynamic Biceps Impingement by Supraspinatus**
- 0 = No evidence of impingement
- 1 = Mild impingement: supraspinatus contact biceps, no change in motion
- 2 = Moderate impingement: mild to moderate irregularity in motion with mild to moderate supraspinatus impingement of the biceps (changing shape of biceps on cross section view)
Diagnostic Ultrasound
Elastography (EUS)

- Assess Mechanical Properties of Tissue
  - Apply Stress
  - Measure tissue displacement
- Strain/Compression
  - Free Hand EUS
- Elastogram
  - Strain readings superimposed over US image

www.intechopen.com
MSK Elastography

- **Tendons/Ligaments**
  - Homogenous
  - Moderate Stiffness
    - Blue/Green

- **Injury**
  - Non homogenous
  - Soft
    - Red/Yellow
  - Hard/Fibrous/Scar
    - Blue

- **Strain Ratio**
  - Objective
  - Compare values thru Rehab program
Elastography Supraspinatus

Initial Injury

NORMAL
Low Flow Color Doppler

- **Tendon/Ligament**
  - Normal = low flow

- **Injury/Stage of Healing**
  - **Hypovascular scar tissue**
    - No flow
  - **Inflammatory Granulation Tissue**
    - Increased blood flow
    - Grade I
      - Blinking
    - Grade II
      - Pulsatile
    - Grade III
      - Streaming
  - **Regenerative Medicine**
    - Increase blood flow
    - Stimulate Healing
Rehabilitation Case Examples
Iliopsoas Tendinopathy

- “Stella”
- Right Iliopsoas Insertionopathy
- Right StemCell/PRP
  - US guided inj
- Rehab Plan
  - Restricted activity
    - 8-12 weeks
    - Cold Laser, Manual Therapy
    - Home Exercise Program
Initial MSK US Scan

Fiber Disruption & Fibrous Tissue
Initial MSK US Scan

LEFT ILIOPSOAS TENDON
MORE NORMAL

RIGHT ILIOPSOAS TENDON
FIBROUS
## 45 days Post Stem cell Injections

<table>
<thead>
<tr>
<th>EXPECTED</th>
<th>REALITY</th>
</tr>
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<tbody>
<tr>
<td>Restricted Activity</td>
<td>Non Compliance!!</td>
</tr>
<tr>
<td>• Leash Walks Only</td>
<td>• No modality treatment</td>
</tr>
<tr>
<td>• Weekly cold laser/manual therapy</td>
<td>• Therapist allowed to go to lake house</td>
</tr>
<tr>
<td>• Reduced Lameness</td>
<td>• Swimming, Dock Diving etc</td>
</tr>
<tr>
<td>• MSK US</td>
<td>• No improvement in lameness</td>
</tr>
<tr>
<td>• Expect better fiber pattern</td>
<td>• Now L ilio sensitive also</td>
</tr>
<tr>
<td>• Less Inflammation</td>
<td></td>
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<tr>
<td>• Less Hypoechoic Changes</td>
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</tbody>
</table>
45 days Post Stem cell Injections

Moderate Inflammation

Left side initially NORMAL
45 days Post Stem cell Injections

Generalized Increased Inflammation and Fiber Disruption

NOT EXPECTED!!
Change In Rehabilitation Plan

- **Modality Usage**
  - Cold Laser 2X week
- **Manual therapy**
- **Strict Home Exercise Program**
  - Isometric to build support muscles
- **NO running, jumping, playing, swimming etc**
60 days Post Stem Cell Injection
With Compliance!
60 days Post Stem Cell Injection
With Compliance!

[Images of ultrasound scans labeled LONGITUDINAL and CROSS SECTION]
No further injections needed – Gradually returned to normal activity
12 weeks
Compensatory Tendinopathy

“Pax”
- 8 yr old Lab
- Prior Elbow DJD
  - R FCP
  - R Grade I cartilage lesion
- Acute right biceps tendinopathy
Mild Degenerative Joint Disease R Elbow

NORMAL LEFT ELBOW

RIGHT SCLEROSIS
Initial Diagnostic Ultrasound

- Bursitis
- Abnormal fiber pattern
Post Rehabilitation therapy

- 8 weeks Post Injury
  - Weekly rehab
  - Therapeutic Ultrasound
  - Home Exercises
  - Restricted Activity
- Decreased lameness
- Mild resistance on bicep stretch
- Concern @ residual tendinopathy

Remember Engages Elbow!!
Recheck Diagnostic Ultrasound

Appears Improved
Recheck
Comparison to Initial Injury
Resolved Bursitis and improved biceps fiber pattern

8 wks post rehab

Initial scan

instead of continuing rehab and restricted activity

Residual resistance due to elbow DJD – Began UWT to increase muscle with reduced joint impact, Resumed normal activity
Biceps Tendinopathy with Medial Shoulder Syndrome Hobble

“Cap”
- 5 yr old border collie
- Agility

Poor performance

Short Strided
- L front

Diagnosis/Treatment
- L MSS
  - Shoulder arthroscopy/RF
- L biceps tendinopathy
  - Stem cell/PRP inj

Post op Hobbles
Left Shoulder Initial MSK Scan

- Disrupted Joint Capsule
- Disrupted Bicep fibers
Right Shoulder Initial MSK Scan

Normal

Good bicep fiber pattern
90 days Post Treatment/Rehab

STATUS

- Tendinopathies should be healed
- Equal muscle mass
- Controlled conditioning performed
- Now
  - Gradual return to function/free activity/sport

LEFT BICEPS HEALED
90 days Post Treatment/Rehab

INITIAL R BICEP

CURRENT R BICEP

Mottled R bicep
Rehabilitation Plan Changed

- Did not “release” to full activity
- Continued restricted activity
- Initiated therapeutic ultrasound to R biceps
- Returned in 6 wks with improvement and then returned to sport
Gastrocnemius and Common Tendon Tear

“Pilot”
- 1 yr M Whippet
- Lure Coursing
- Caught up in lure line
- ER Vet
  - Laceration – Stapled
  - No other injury
  - Long time client
    - Maint. therapy
      - Flyball – Whippets
  - Classic Claw Foot
    - Rupture of calcaneal tendon with only SDF component withstanding
    - Confirmed US & MRI
Initial Achilles Tendon Injury
10 days Post Injury
Swelling Reduced
10 days Post Injury
Swelling Reduced

PROXIMAL ACHILLES

DISTAL PROGRESSION

Losing Fiber
Pattern
10 days Post Injury
Swelling Reduced

HYPERECHOIC, LOSS OF TENSION

INSERTION = CLOSE TO NORMAL

Gastroc

SDF Thick

Calcaneus
10 days Post Injury
Swelling Reduced

SWELLING AT INSERTION

INSERTION INTACT
10 days Post Injury
Swelling Reduced

Lack of fiber engagement with standing

RIGHT ACHILLES  NORMAL  LEFT
2 weeks Post Fiberwire Repair
Stem Cell/PRP Injection

STEM CELL FILLING

AVOID FIBERWIRE

Stem Cell Inj

Needle

Fiberwire
6 weeks post surgery
4 weeks post Stem cell inj

medial
13 weeks post sx Achilles repair
9 weeks post Stem Cell Inj

3.5 months - Normally would dynamize to neoprene and gradually increase activity

Some fiber pattern improvement
17 weeks post sx Achilles repair
14 weeks post Stem Cell Inj

IMPROVED FIBER PATTERN STILL IMAGE

DYNAMIC VIEW
14 weeks Post Injection Neoprene Brace
Full Sport Recovery

16 wk post – Gradual Return to full function, Flyball, equal muscle mass, No lameness
Patellar Tendon Injury

- “Lola”
  - 3yr old F(S)
  - Owned by RDVM
- Acute traumatic injury
  - Right Stifle
Patellar Tendon
Patellar Tendon Grade 3 Strain
Tendon Fiber Disruption
Tendon Comparison
Measurements

RIGHT

A 0.41cm

B 0.22cm
Lack Of Healing

4 WK POST INJURY

OWNER/RDVM OPINION

- Doing great
- Allowing free activity
- Appears less painfull
- Appears less swollen

THINKS
  - Maybe we don’t need stem cells/PRP

Normal side
Stem Cell/PRP Injection
Most Stifle Braces

Prevents tibial translation & minimizes biomechanical load while cranial cruciate ligament heals...but need lockable
Stifle Brace – Lock Out Stifle Flexion

- 0-6 wks = no stifle flexion
- 6 weeks post injection
  - Gradually dynamized
  - 1-2 notch/wk
    - No increased lameness
    - Static exercises
- 8-12 wks post inj
  - Fully dynamized
  - UWT begins
  - Start removing brace
4 weeks Post Stem Cell Injection
8 wks Post Injection

Half the size of 4 wk

NO COMPLIANCE – DOWNGRADED TO DUCT TAPE BRACE “SOME OF THE TIME” 😊
Improved Fiber Pattern Integrity/Function??

Waited 4 wks with gradual increased activity, **Back to complete function**
US allowed me to educate owner as to potential risk and outcomes
“Radar”
- 9yr old cocker spaniel
- Companion

Acute lameness after jumping off embankment

US DX - Grade 3 Strain/Traumatic Rupture
- FCU – Ulnar Head
Most Common FCU Injury
Humeral Head Tendon Strain/Rupture

- **Acute**
  - Traumatic Event
- **Chronic**
  - Repetitive Injury
  - Multiple minor tears
- Swelling at or just proximal to accessory carpal bone

“RADAR’S SWELLING MORE PROXIMAL”
Flexor Carpi Ulnaris Injury

- **FCU**
  - **Humeral Head**
    - Classic
  - **Ulnar Head**
    - Insertion deep to HH
- **Injury**
  - Tendon Strain
  - Avulsion
  - Muscle Tears
FCU – Ulnar Head Tendon Rupture - Ultrasound
FCU – Ulnar Head Tendon Rupture - Ultrasound
FCU – Ulnar Head Tendon Rupture - Dynamic
FCU – Ulnar Head Tendon Rupture - Surgery
FCU Ulnar Head Rupture Humeral Head Intact
FCU – Ulnar Head Tendon Rupture – Surgical Repair

- Surgical fixation
- Stem cell harvest Fat
  Culture at Virginia Tech
- Flexed post op cast to prevent tension on healing tendon
- Casted for orthotic
Immediate Post Op Flexion Cast
Stem Cell/PRP Injection

- 2 weeks post op
  - Suture removal
  - Stem cell/PRP injections into tendon repair
- Cast flexion reduced
Conclusion

Canine Musculoskeletal Ultrasound

- Excellent soft tissue diagnostic tool
- Valuable in precise regen med application
- Excellent tool to monitor healing
- Available and economical when compared to other similar diagnostic tools
- INDISPENSABLE TOOL
  - Guide in Canine Rehabilitation

So…Hopefully I have convinced…at least some
## Addt’l US Training

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<tr>
<th>BEGINNER/ADVANCED COURSE</th>
<th>VOSM PRIVATE COURSE</th>
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<tr>
<td>1 day course</td>
<td>1-2 day course</td>
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<tr>
<td>Diagnostic US Scanning techniques</td>
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</tr>
<tr>
<td>• Learn/Review anatomy</td>
<td>• Tailored to area of interest</td>
</tr>
<tr>
<td>• Probe Position</td>
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<tr>
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<tr>
<td>• Advanced</td>
<td>• Pathology</td>
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<tr>
<td>• Extensive Pathology Review</td>
<td>• Full day clinical cases</td>
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<td>• Regenerative Medicine</td>
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<tr>
<td>• Cadaver Injection practice</td>
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VOSM Private Course
1 week Course +

- Diagnostic US Scanning techniques
  - Tailored to area of interest
  - Wider scope
  - Anatomy
  - Probe Position
  - Live dog demo and practice
  - Cadaver Injections
  - Sports Medicine

- Plus 3-4 days full of clinical cases
  - Pathology
  - US Diagnostic Scans
  - US Rechecks
    - Case Progression
  - US Guided Injections
    - Regenerative Medicine
      - Tendons
      - Ligaments
    - Joints
    - Cortisone
    - HA
    - PRP
Thank you!!