

What MRI has taught us about ultrasound



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Overview

- Ultrasound uses
- MRI
- Experimentally induced injury
- How does understanding MRI help
 - MRI sequences
 - Changes over time
- Clinical Implications
- Cases

Tendinitis: Diagnosis

- Careful palpation & evaluation
- Thermography
- *Ultrasonography*
- **MRI**
- CT



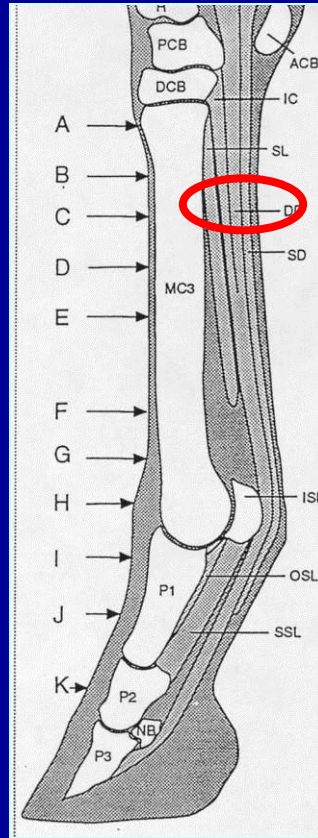
Ultrasonography

- Primary modality for tendon injury
 - Operator dependent
 - Non-invasive
- In humans orthopedics MR imaging is the modality of choice
 - Minimal operator dependence
 - Image reproducibility

Ultrasonography

A knowledge of anatomy is vital

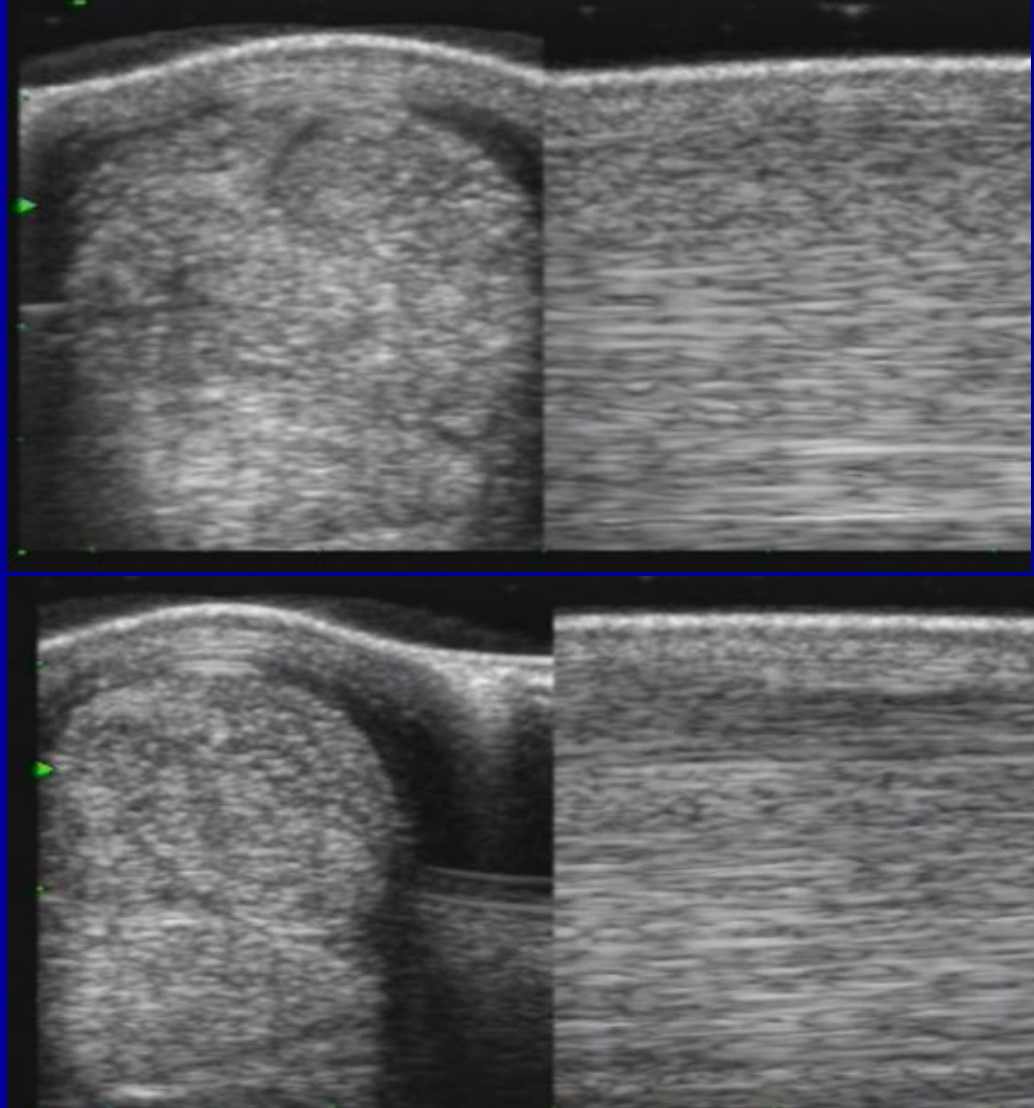
Establish normal to determine abnormal



Ultrasound Fundamentals

- used since the early 1980s
- high-frequency sound waves
 - typically between 2-13MHz
- transducer → reflected → processed
- sound propagates differently depending on the density of the tissue
- gray scale

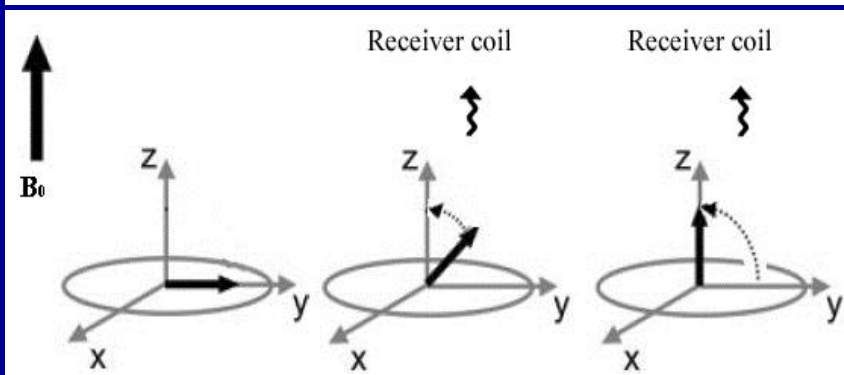
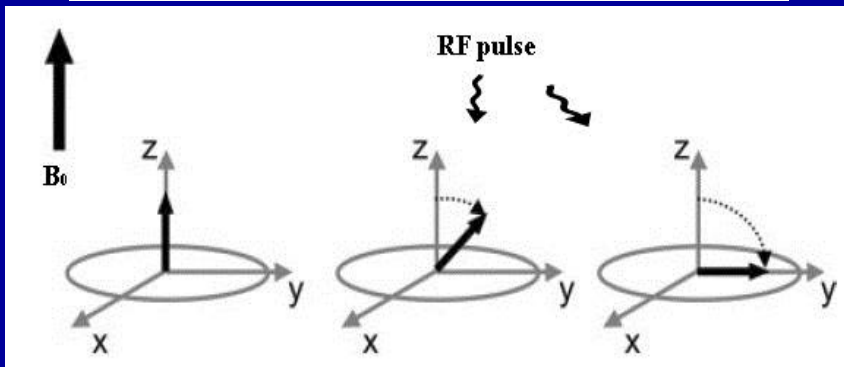
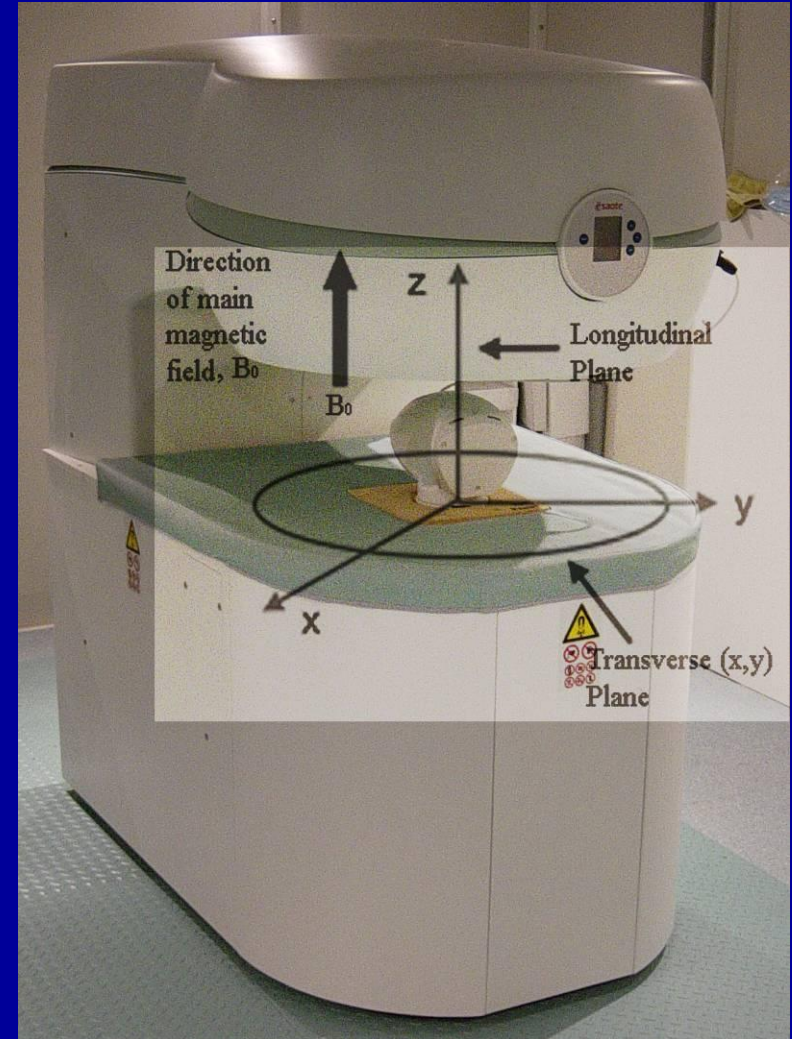
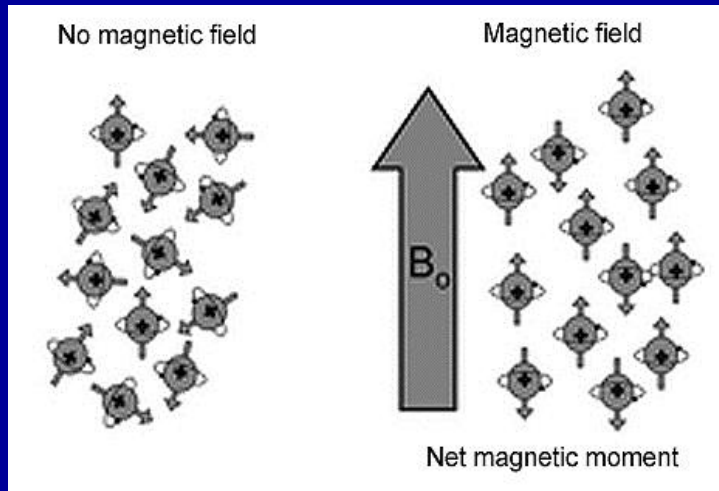
Ultrasound Appearance



MRI

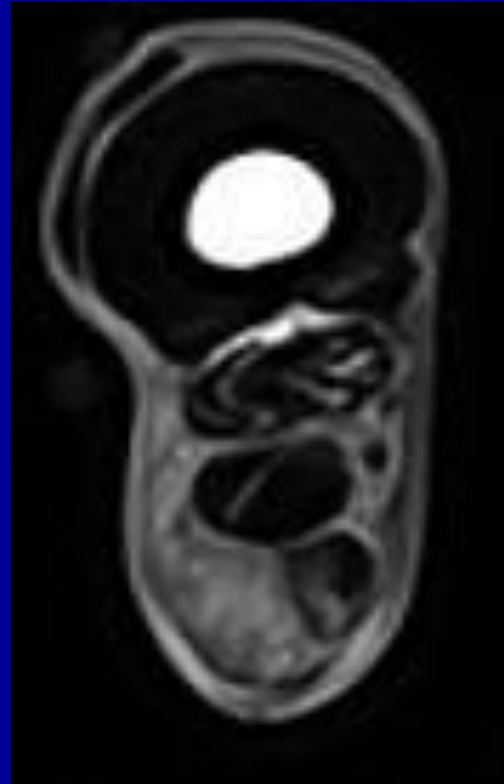
- Gold standard for soft tissue injuries
- In human orthopedics, magnetic resonance (MR) is the imaging modality of choice because of image reproducibility and minimal “operator dependence”
- The fibrous nature and low water content of normal equine tendon generates a low signal intensity

MRI fundamentals

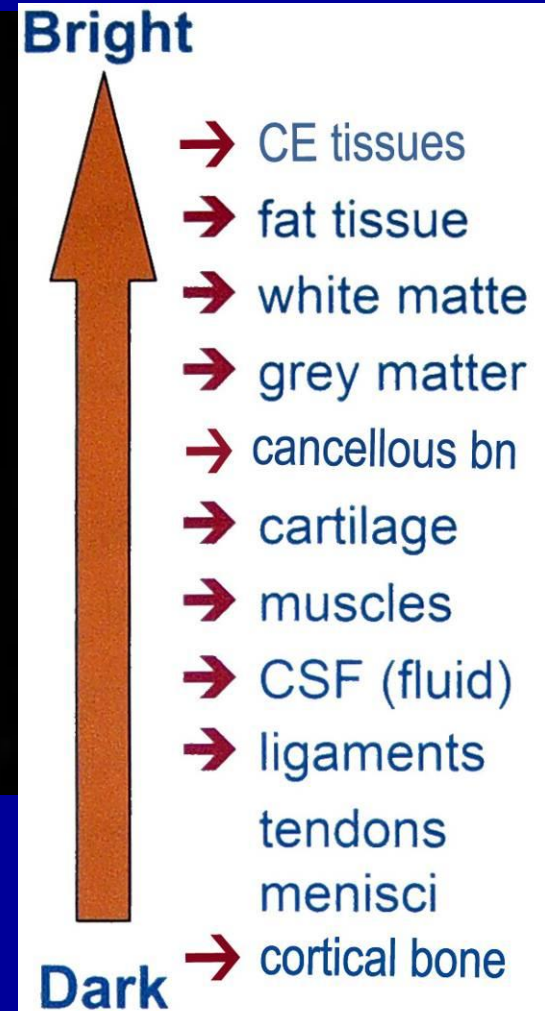


T1 weighted

- Good anatomic detail
- High SNR
- Low artifact susceptibility
- Used with contrast agents such as gadolinium

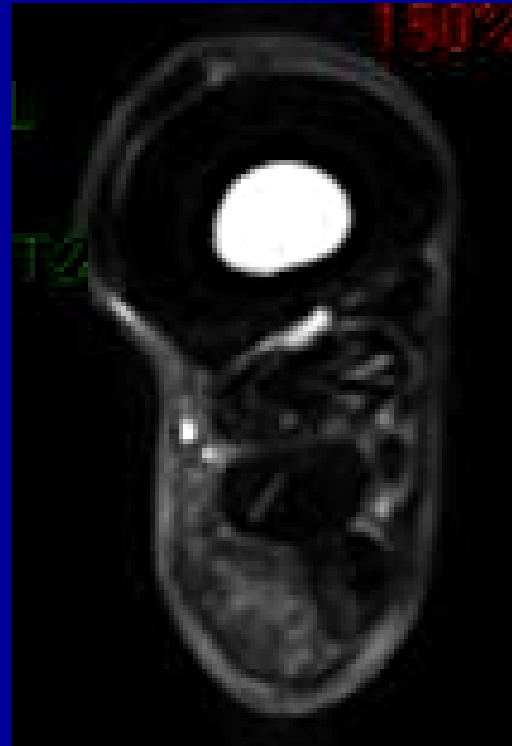


Fluid is hypo-intense
(gray to black)

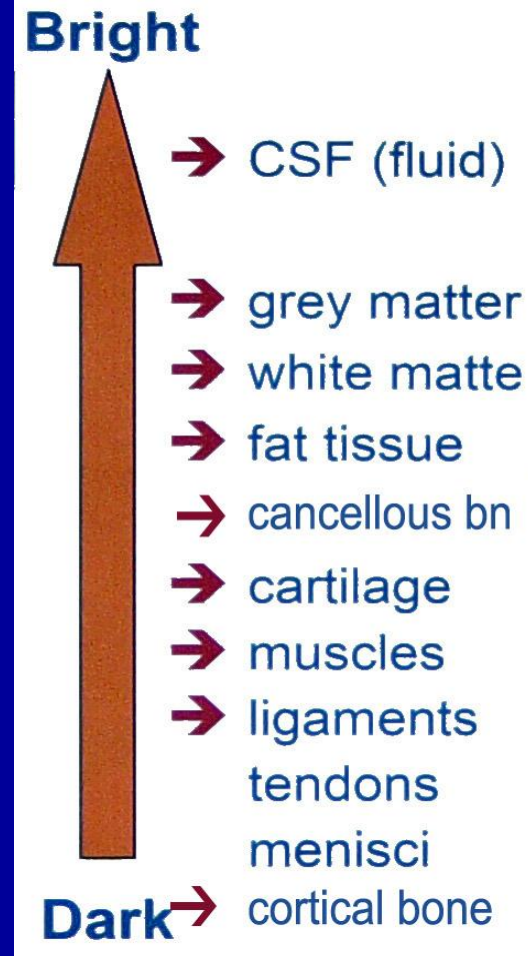


T2 weighted

- Shows pathology
- Best for fluid and soft tissue contrast
- SNR lower than T1
- Higher artifact susceptibility



Fluid is hyper-intense (white)

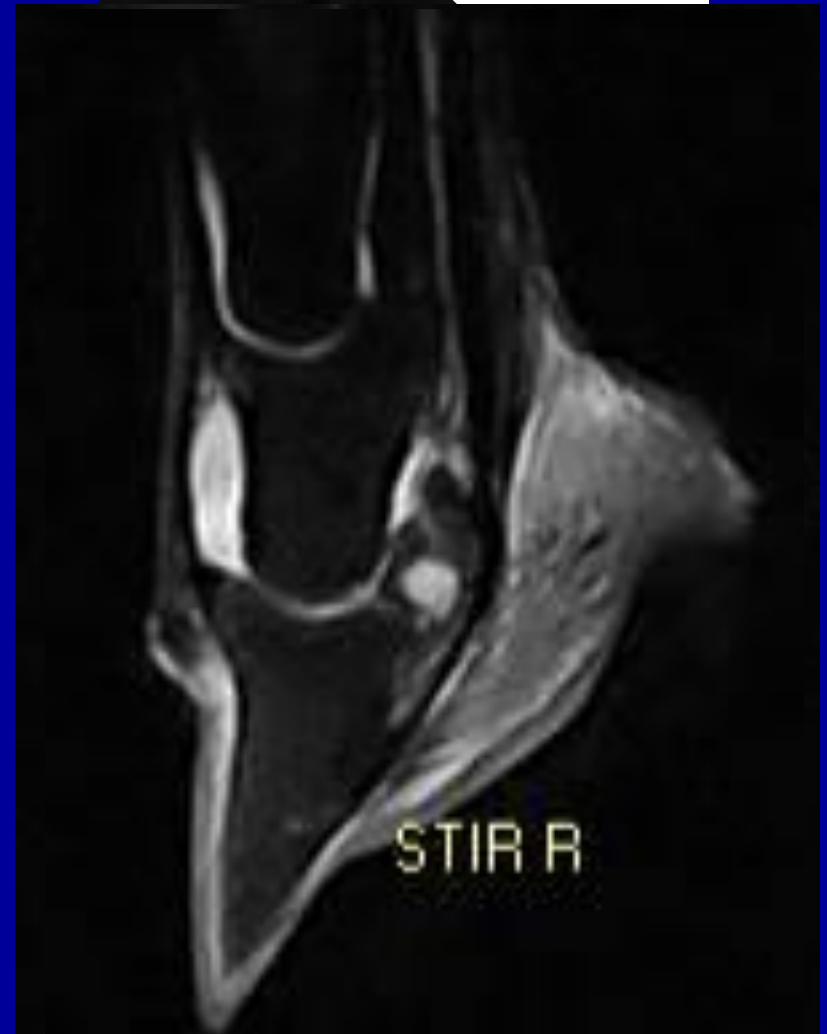


STIR

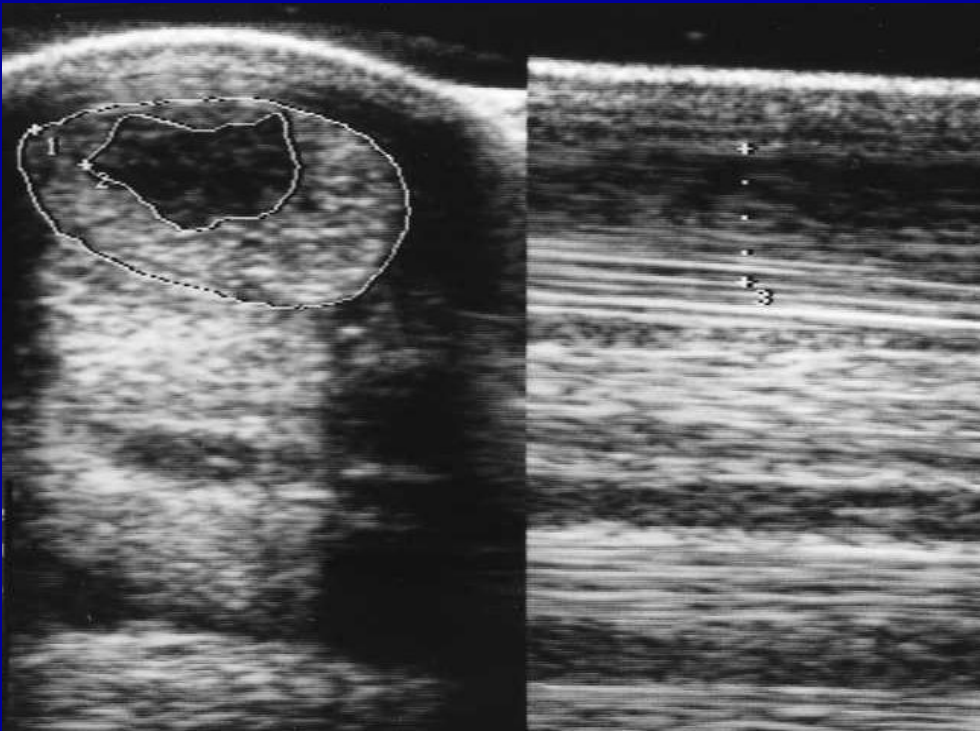
(Short Time Inversion Recovery)

- Fat suppression
- Lower SNR
- Separates fat from pathology
- Bone edema

Fluid is hyper-intense
(white)

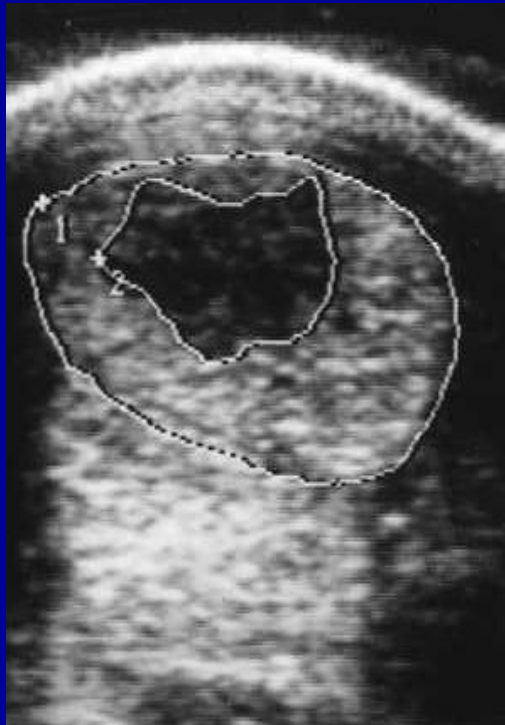


Lesions

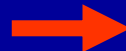
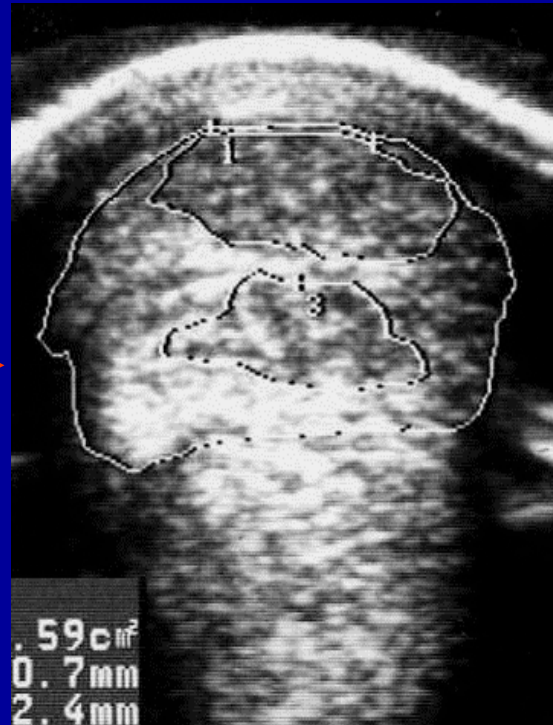


Goal

2 weeks



16 weeks



Materials and Methods

Collagenase inj.
In SDFT

Staggered injections of HL SDFTs

Time 0

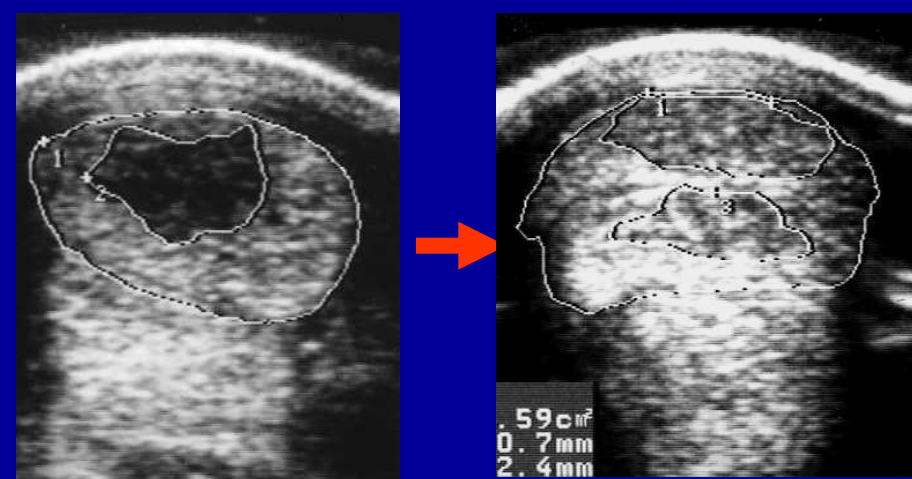
16 wks

Ultrasonographic and MRI
assessments carried out
at the end of the study

Statistical Analysis- 2 way
repeated measure
ANOVA



Materials and Methods



RF and LF

16 weeks (N=8)

LH at 3 weeks (N=2)

LH at 4 weeks (N=2)

LH at 6 weeks (N=2)

LH at 8 weeks (N=2)

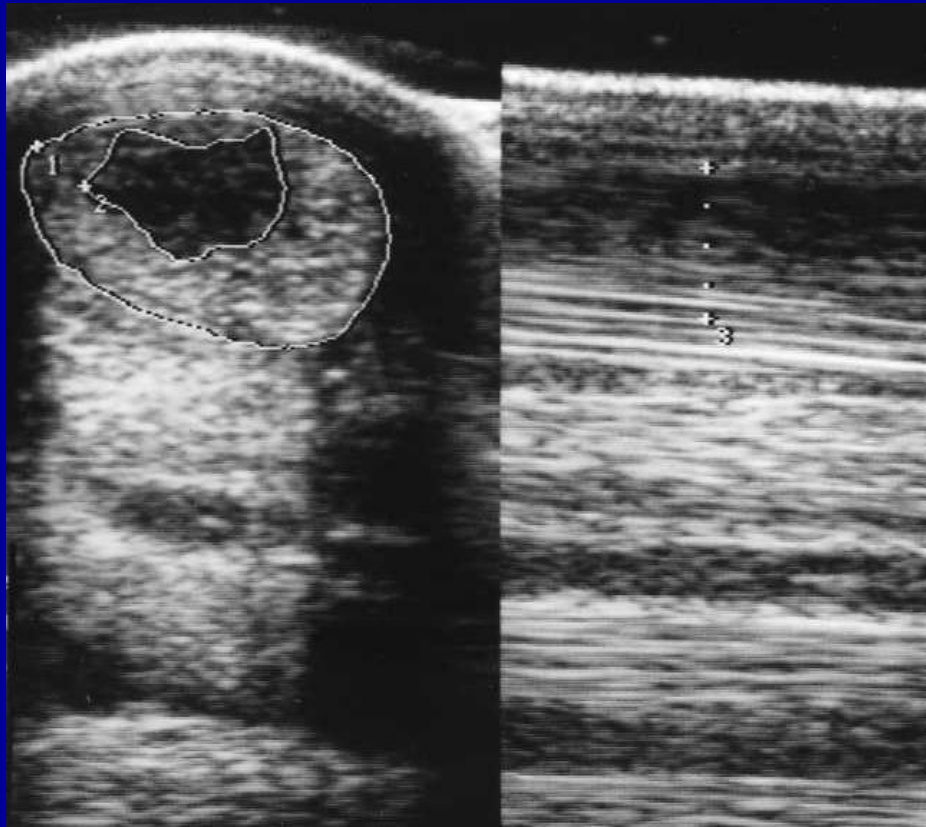
Total x-sectional area
in MIZ



T1, T2, STIR

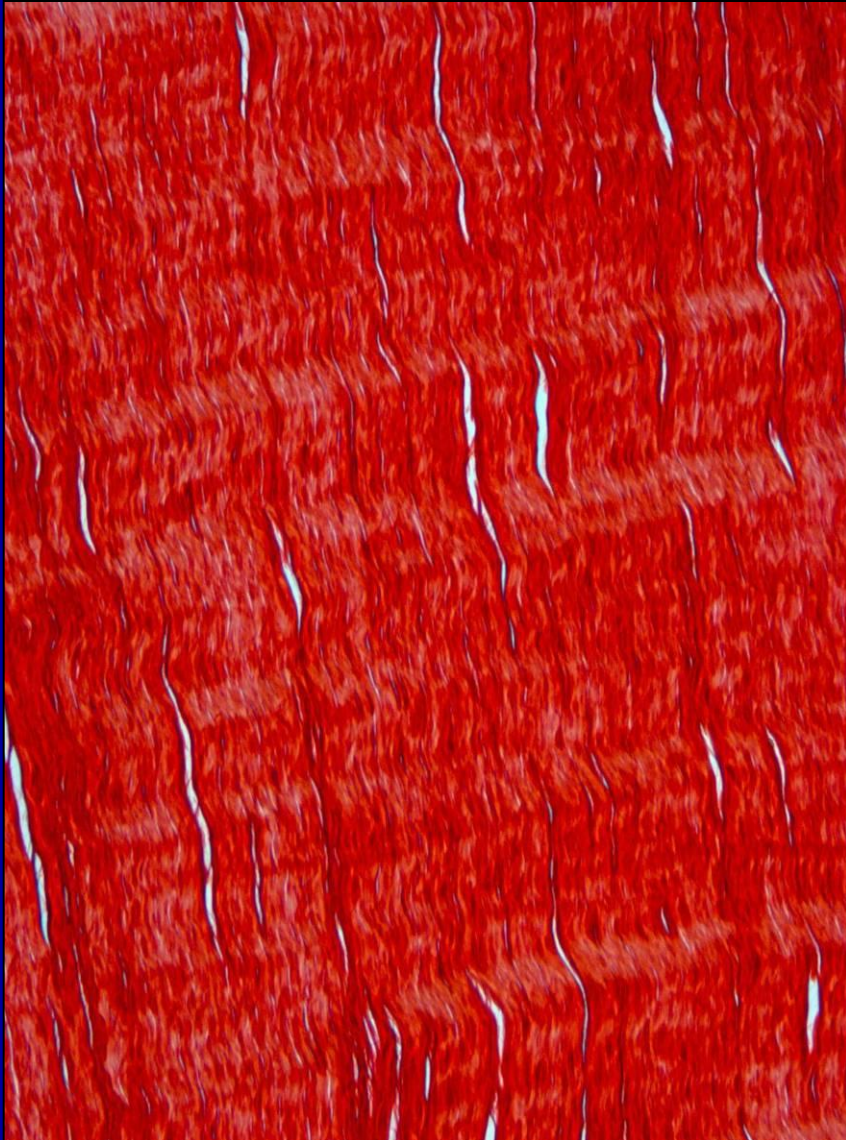
Total x-sectional area
Signal intensities

Lesion Example

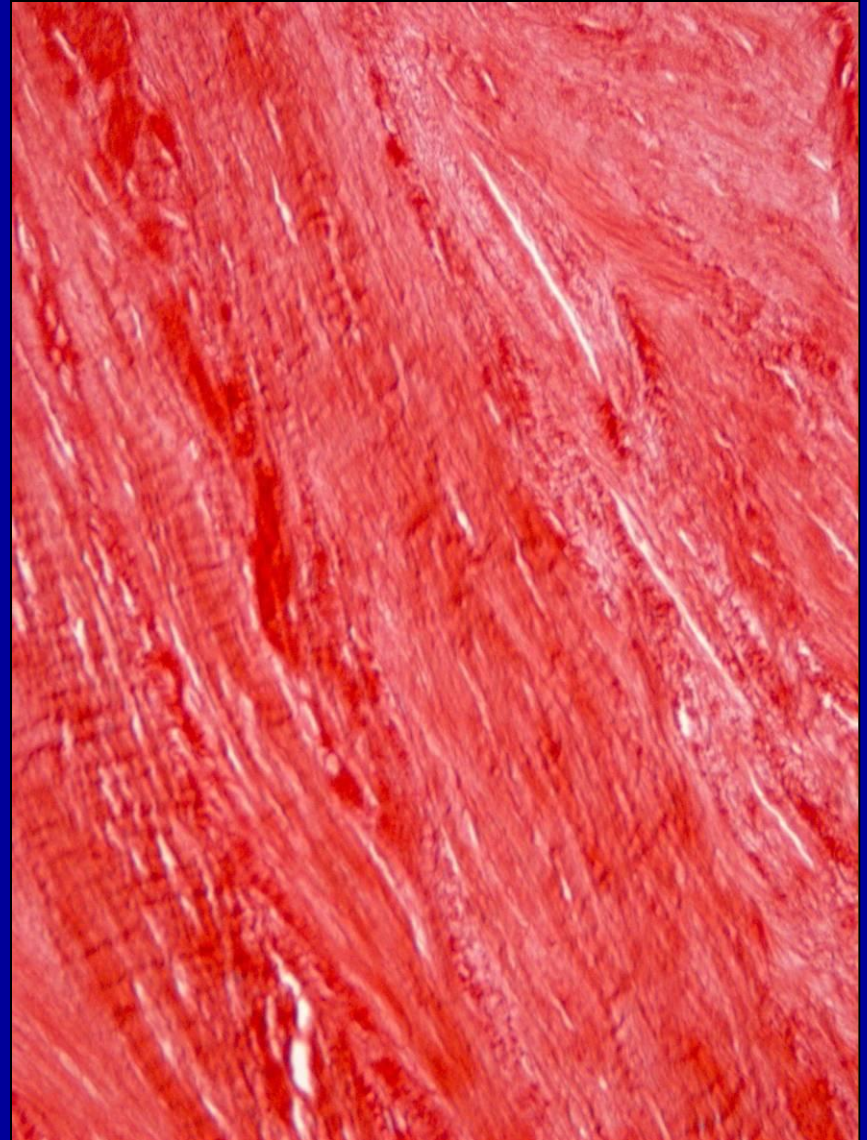


Collagen Content and Alignment

Normal Tendon



Injured Tendon

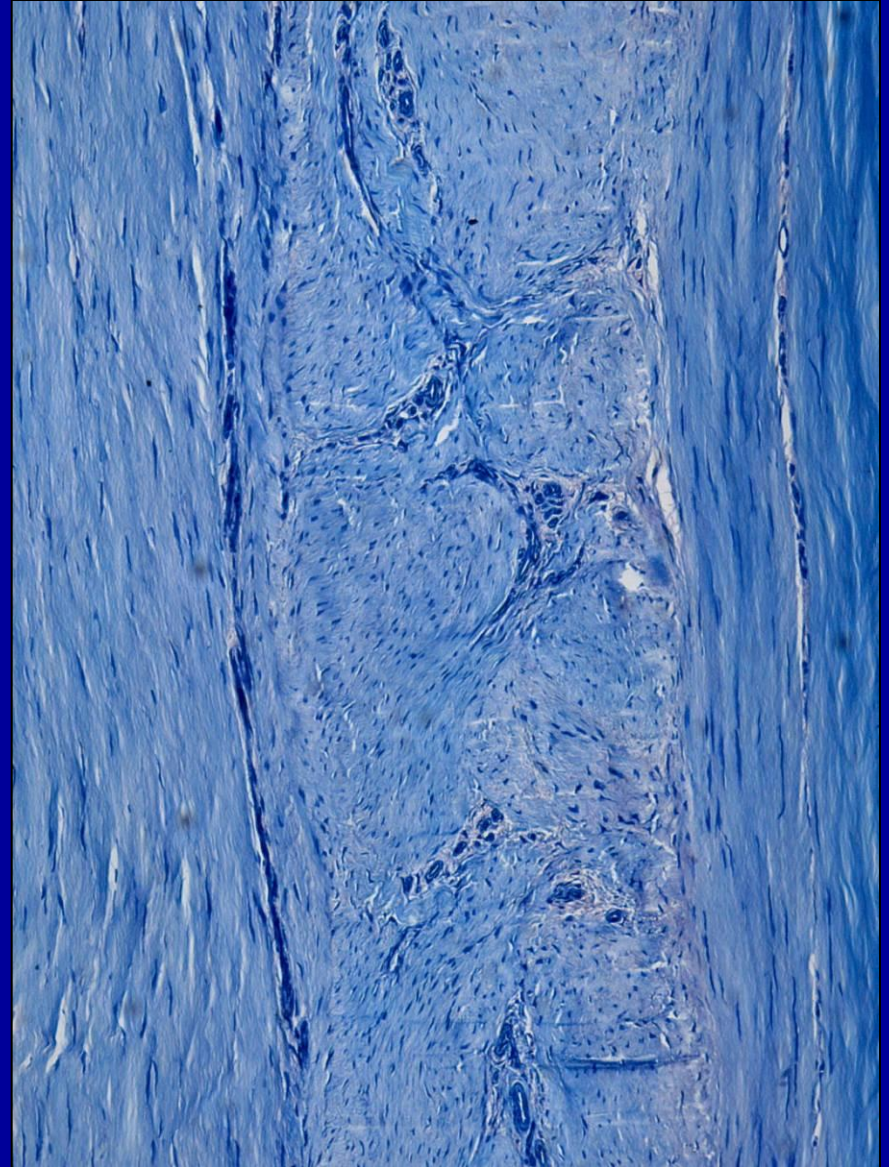


Proteoglycan Content and Alignment

Normal Tendon

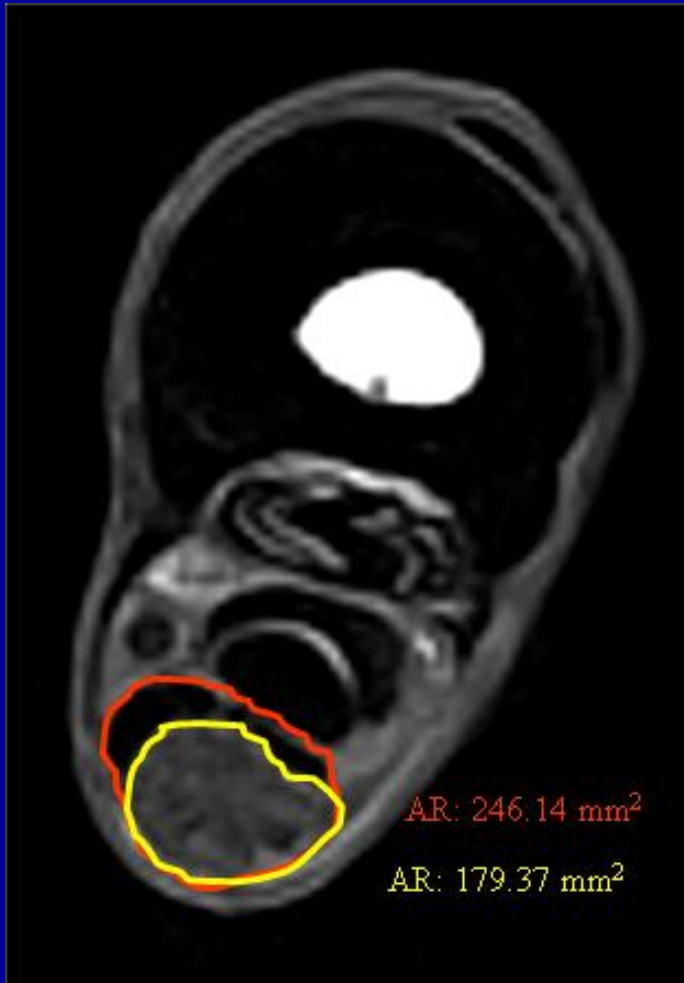


Injured Tendon



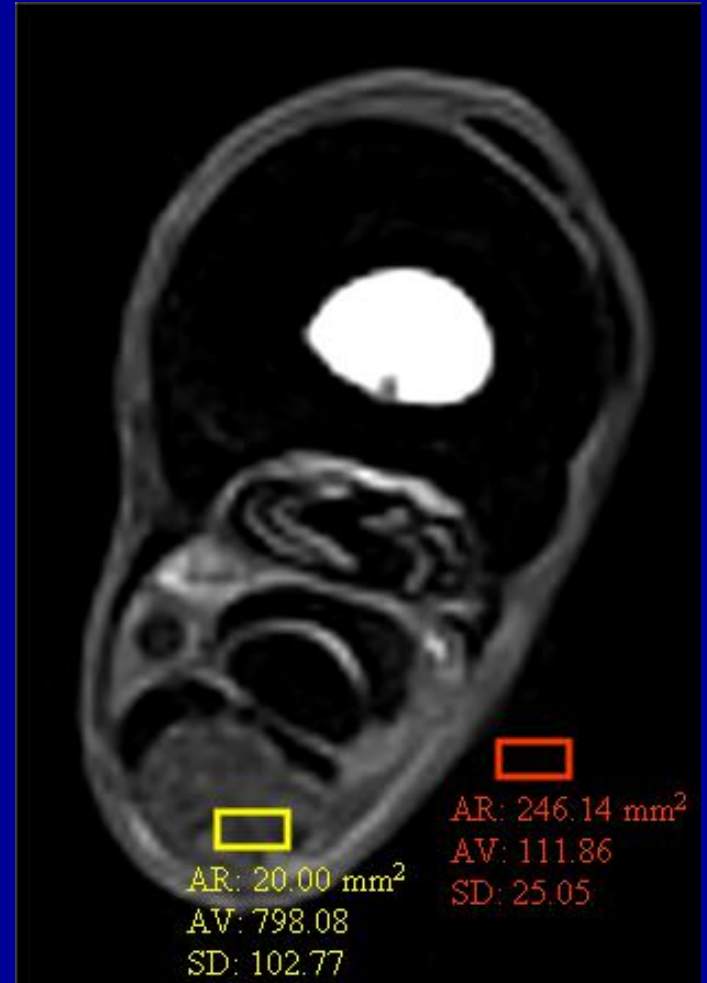
MR

Cross-sectional Area

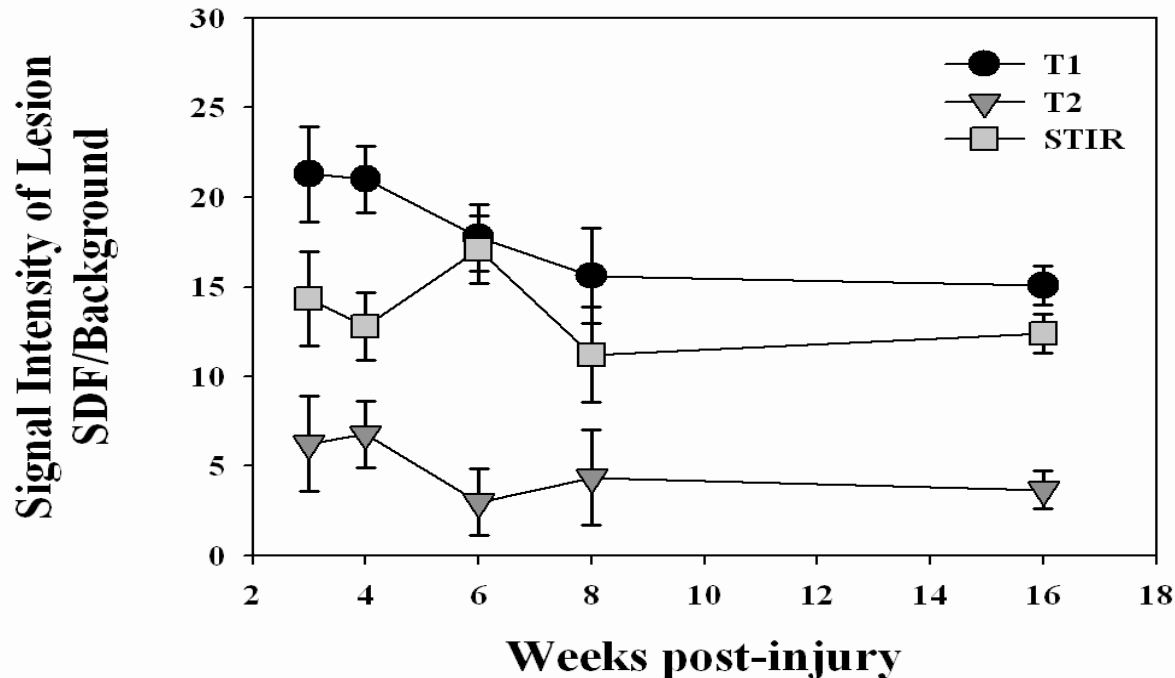


MR

Signal Intensity

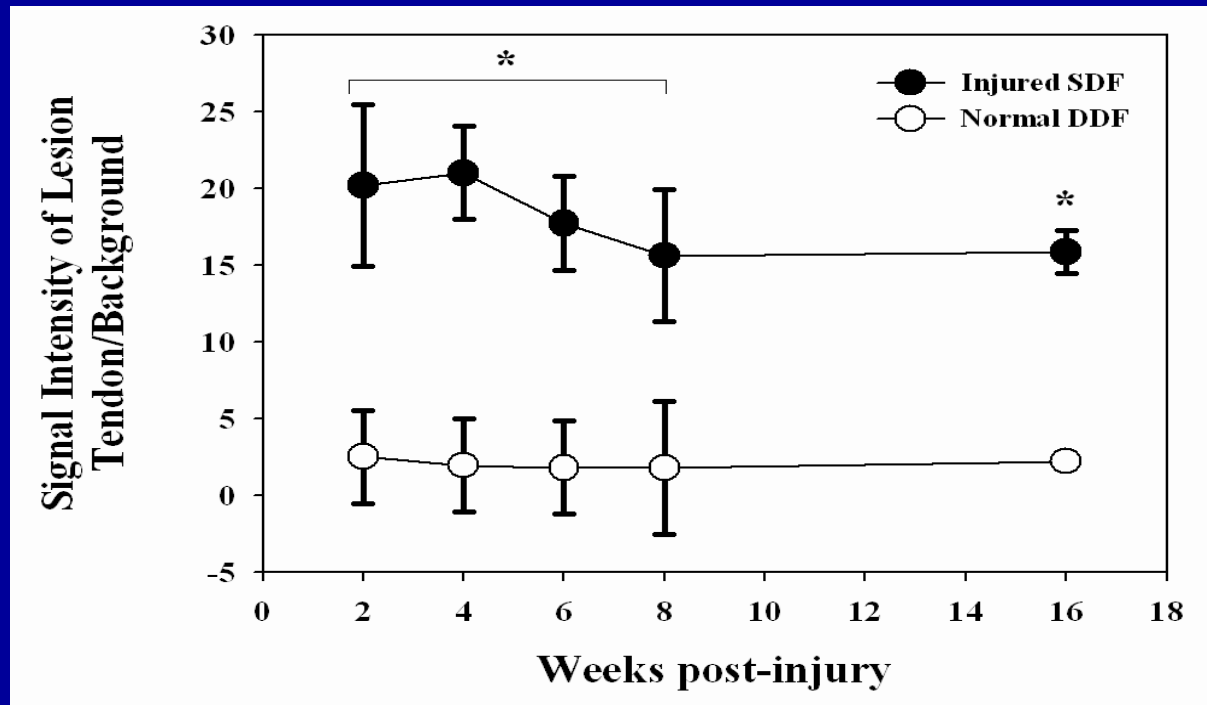


Results: Signal Intensities (SI)



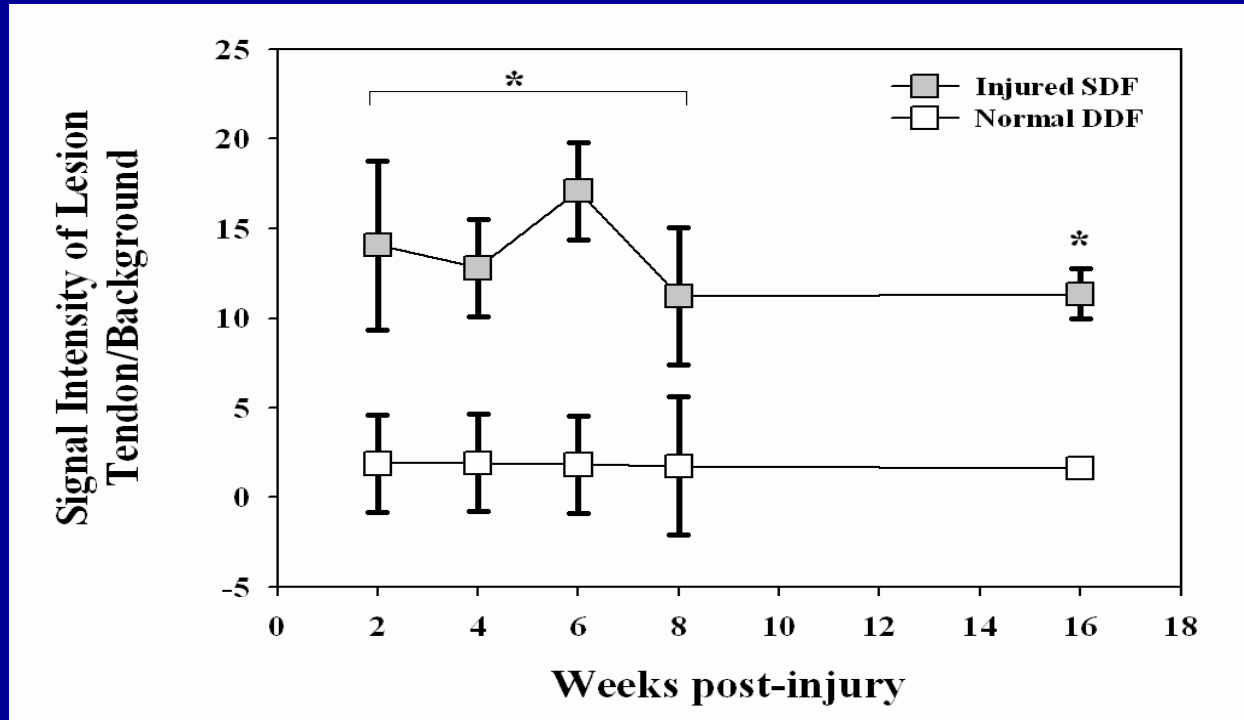
- * T1 SI levels were the highest, T2 SI levels were the lowest, and STIR SI was intermediate
- * There was no significant difference over time.

Results: T1-Weighted Signal Intensities (SI)



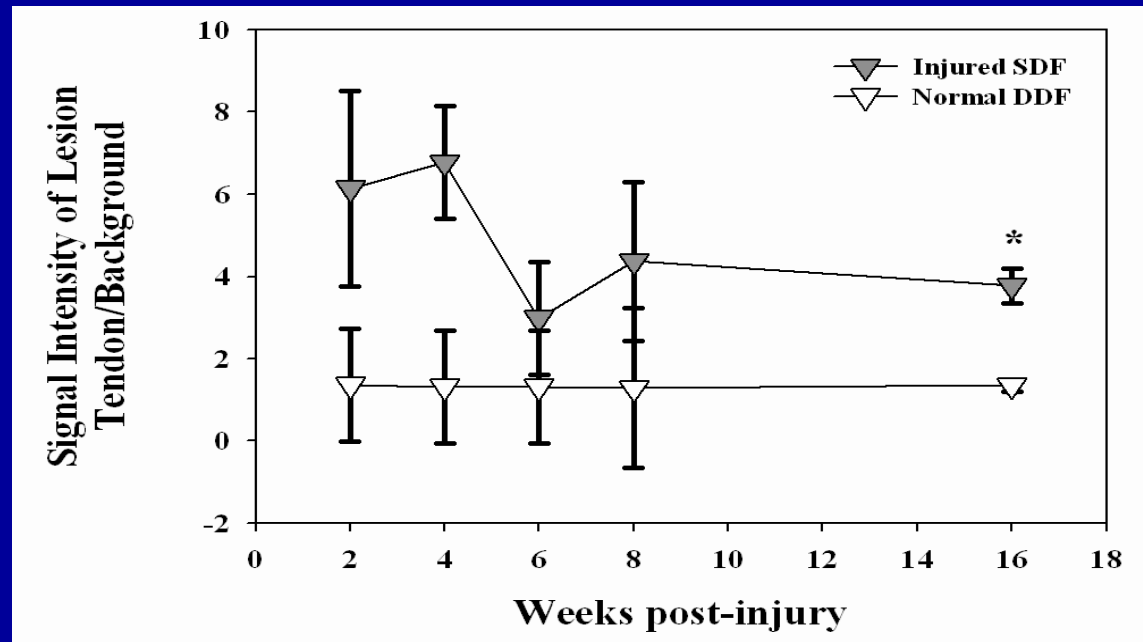
* T1 SI levels were significantly increased over the normal deep digital flexor tendon at all time points.

Results: STIR Signal Intensities (SI)



* STIR SI levels were significantly increased over the normal deep digital flexor tendon at all time points.

Results: T2-Weighted Signal Intensities

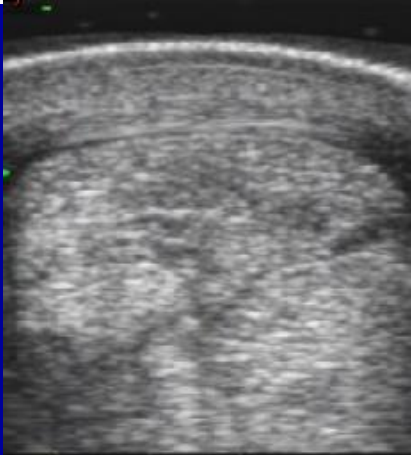


* T2 SI levels were equivocal over the normal deep digital flexor tendon at all time points.

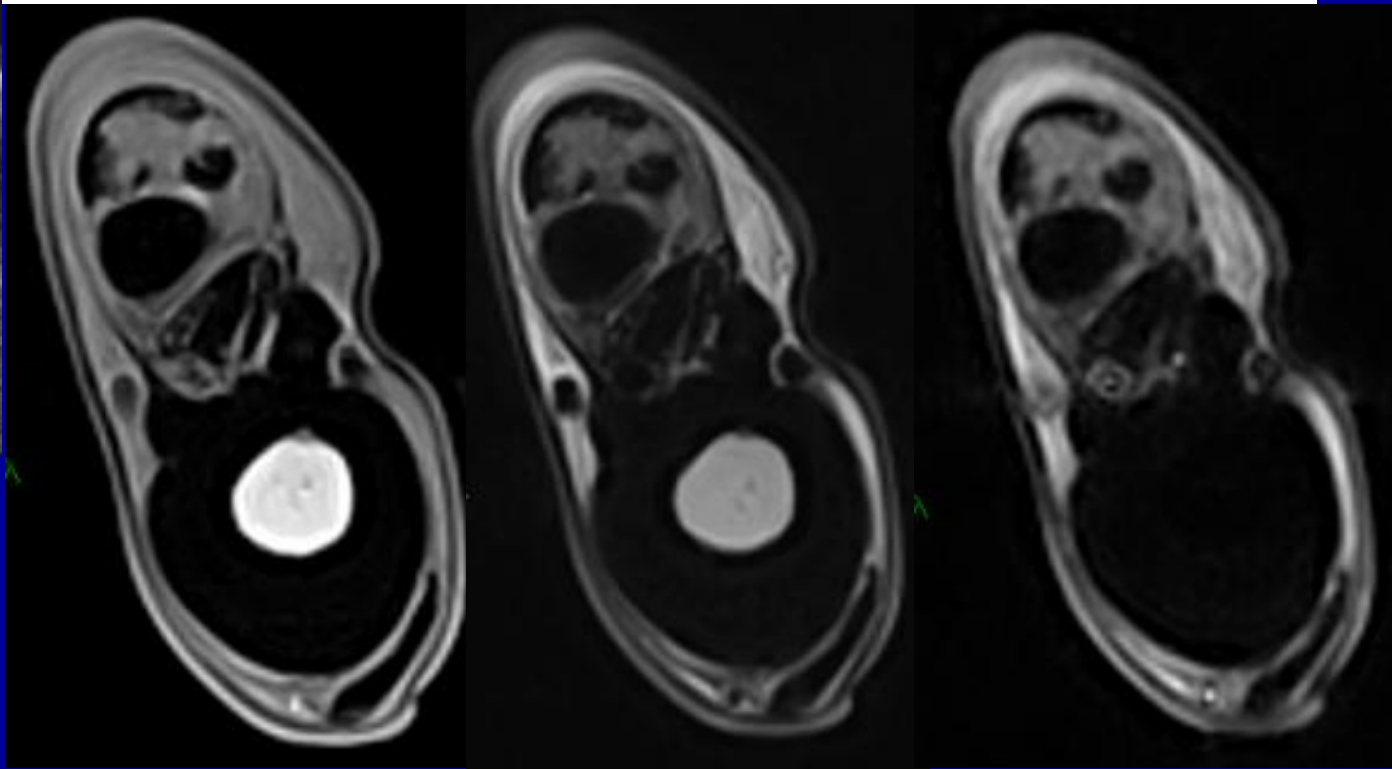
Results (x-sectional area)

% TCSEA in tendon injuries at ≤ 4 weeks $P=0.81$

US	T1	T2	STIR
51.2 ± 8.9	54.2 ± 9.6	52.4 ± 7.3	60.8 ± 0.7



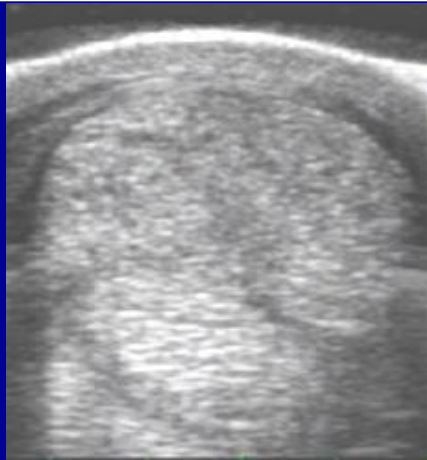
4 weeks



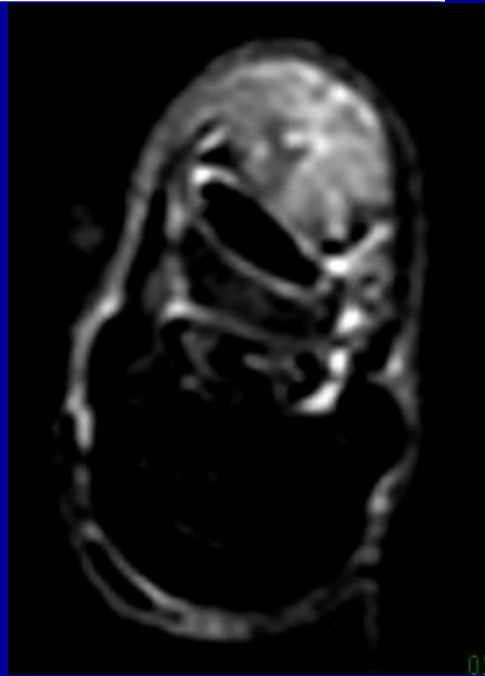
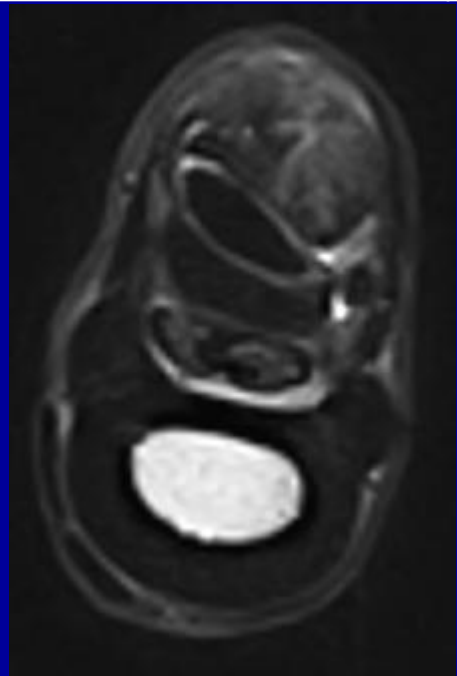
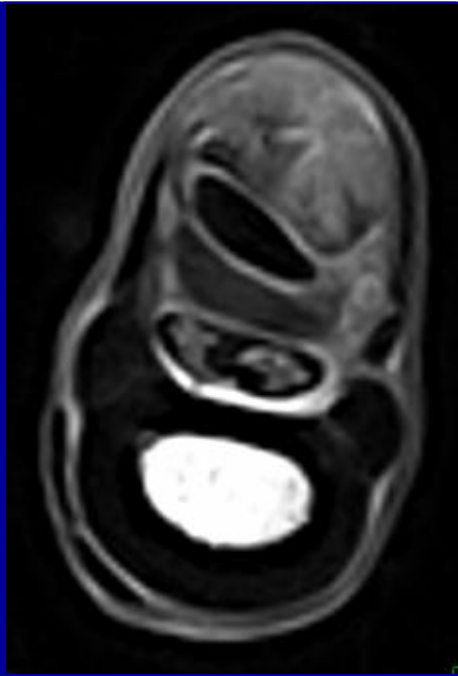
Results (x-sectional area)

% TCSEA in tendon injuries at 16 weeks $P < 0.001^*$

US	T1	T2	STIR
41.8 ± 6.0	$59.5 \pm 13.2^*$	$59.5 \pm 13.5^*$	$55.6 \pm 14.1^*$



16 weeks



Discussion

- In chronic injuries, ultrasonography and MRI indicated markedly different areas of injury during healing. US <<< MRI
- T1 sequence generated the highest signal intensity.
- The T1 and STIR signals remained elevated throughout the 16 weeks of the repair process. T2 data were equivocal.
- Subjectively, histological evidence of injury is more consistent with the MRI data.

Clinical Implications

- Ultrasonography still has a critical role in diagnosis and management of tendon injury.
- Interpret ultrasound findings during healing with caution.
 - Off-angled views may enhance subtle lesions.
 - Look for evidence of increased size in chronic injuries.
 - Improvement in ... Fiber alignment score (60%)*, Type score (70%), Lesion size (50%), TCSA (50%)
 - Genovese, unpublished data
- MRI guidelines ?
 - T2 weighted images should be normal or significantly improved

Case 1

- 4 yo, STB, Gelding
- 2/5 RF lameness
- Sore to palpation of SL and Inferior Check Lig
- Carpus injections helped for short duration
- Blocking
 - PD- N/C
 - Abaxial- 20% improvement
 - Low and High 4 point- N/C

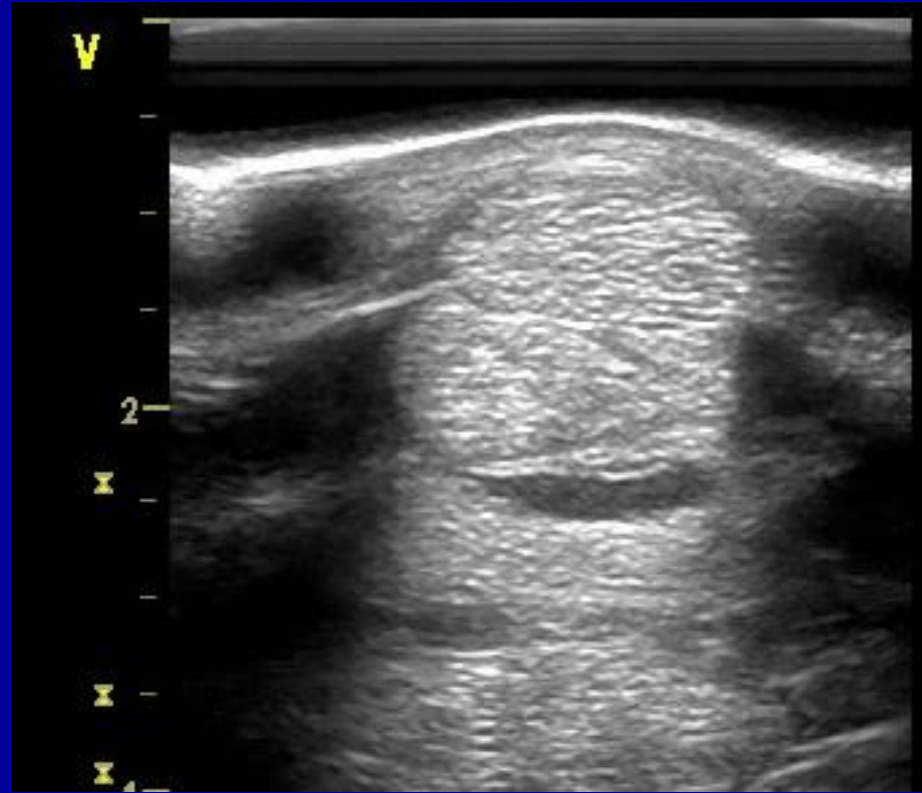
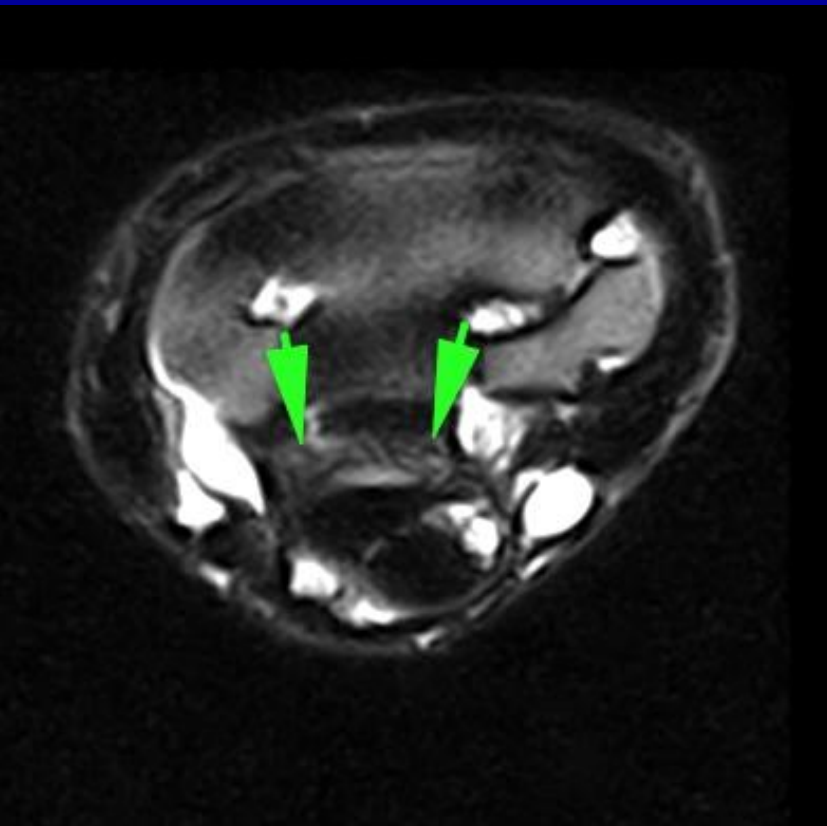
Case 1

- Nuclear Scintigraphy
 - IRU- R carpus, mild uptake L carpus
- U/S-
- MRI-

Case 1

- Nuclear Scintigraphy
 - IRU- R carpus, mild uptake L carpus
- U/S- irregularity to the fiber pattern of the check ligament
- MRI-
 - Fiber disruption of the junction of the distal palmar ligament and the inferior check lig

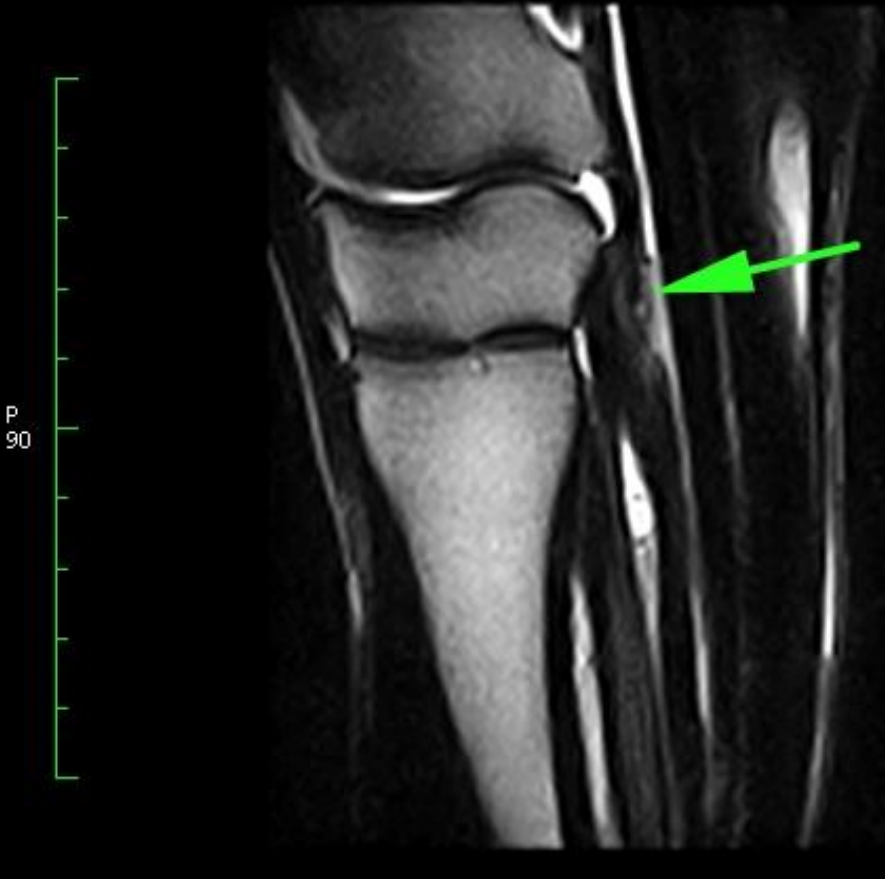
Case 1



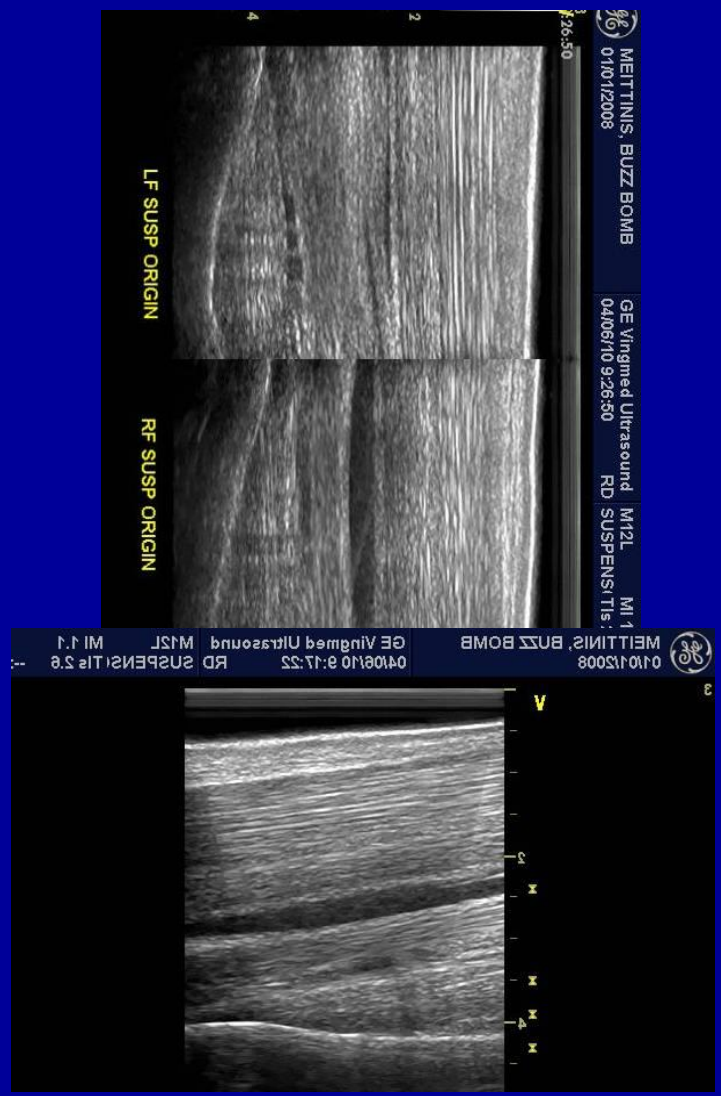
Case 1

Image size: 256 x 256
WL: 1315 WW: 2487
X: 187 px Y: 251 px Value: 0.00

I
R



P
90



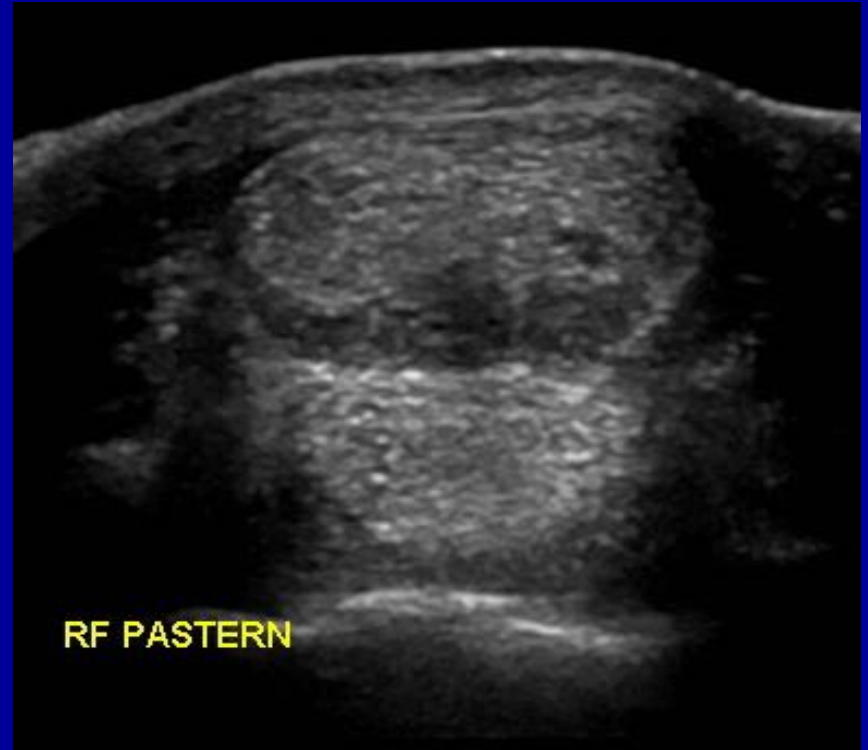
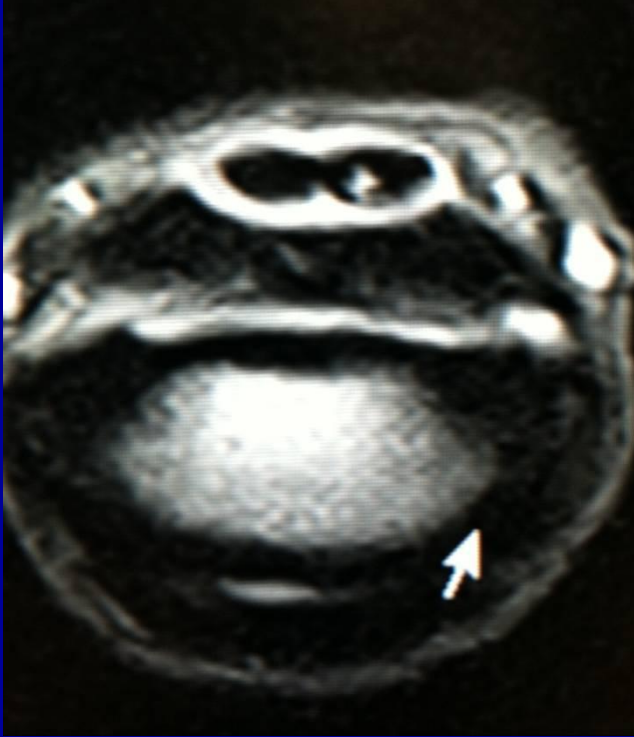
Case 2

- 12yo, Quarter Horse, Gelding
- incr digital pulse
- 3/5 RF
 - Distal limb flexion +
 - Blocks to a PD

Case 2

- U/S- core lesion in the medial lobe of the DDFT
- MRI- severe navicular changes and increased signal in the medial lobe of the DDFT

Case 2



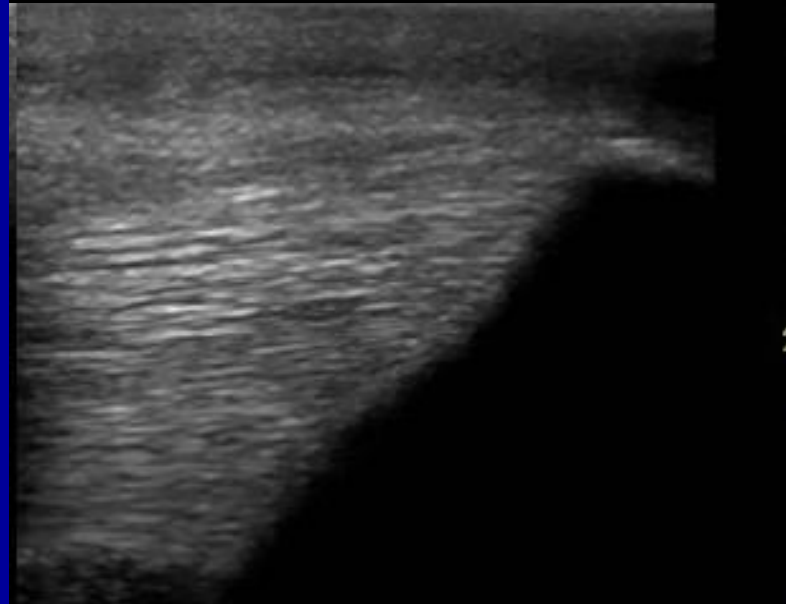
Case 3

- 15 yo, Irish Cob, Gelding
- LH- grade 2/5- several month hx
 - Very positive to flexion
 - blocked to a low-4 point

Case 3

- U/S- enlarged Lat SL Branch
- MRI-

Case 3



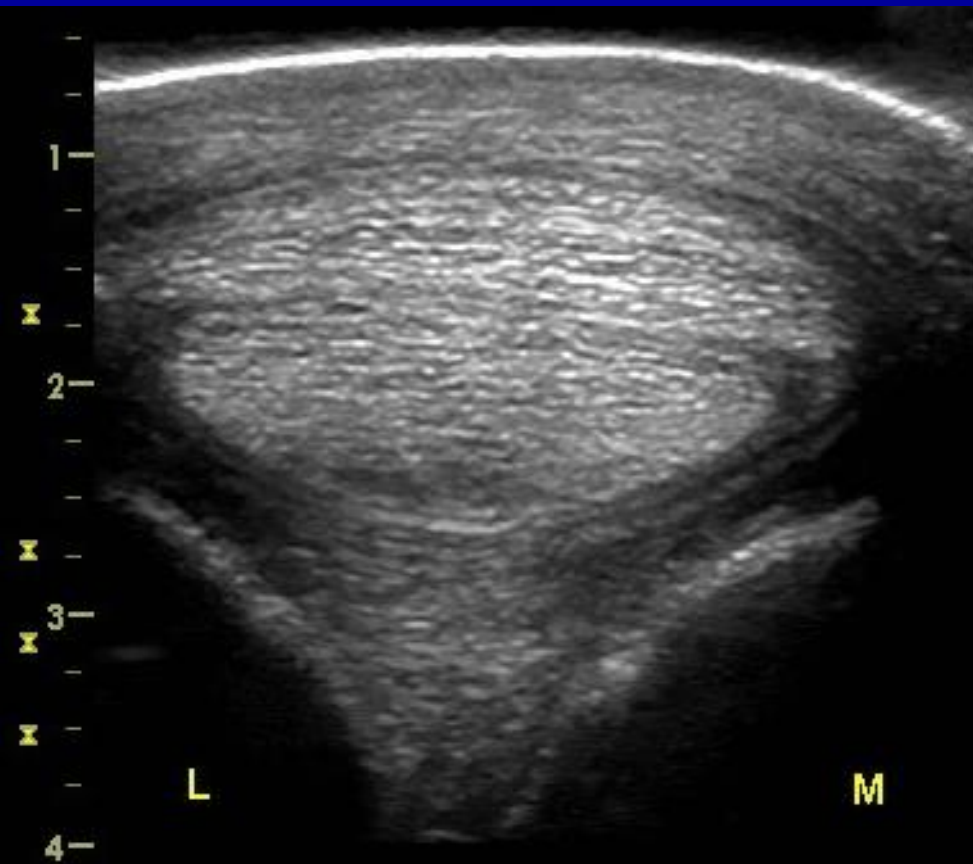
Case 4

- 12 yo, Oldenberg, Mare
- LH- grade 2+/5
 - Positive to digit flexion
 - Improved with analgesia of digital tendon sheath
- Moderate to severe effusion

Case 4

- U/S-
 - adhesions and possible lesion of the DDFT
- MRI
 - Thickening of the Manica Flexoria
 - DDFT

Case 4



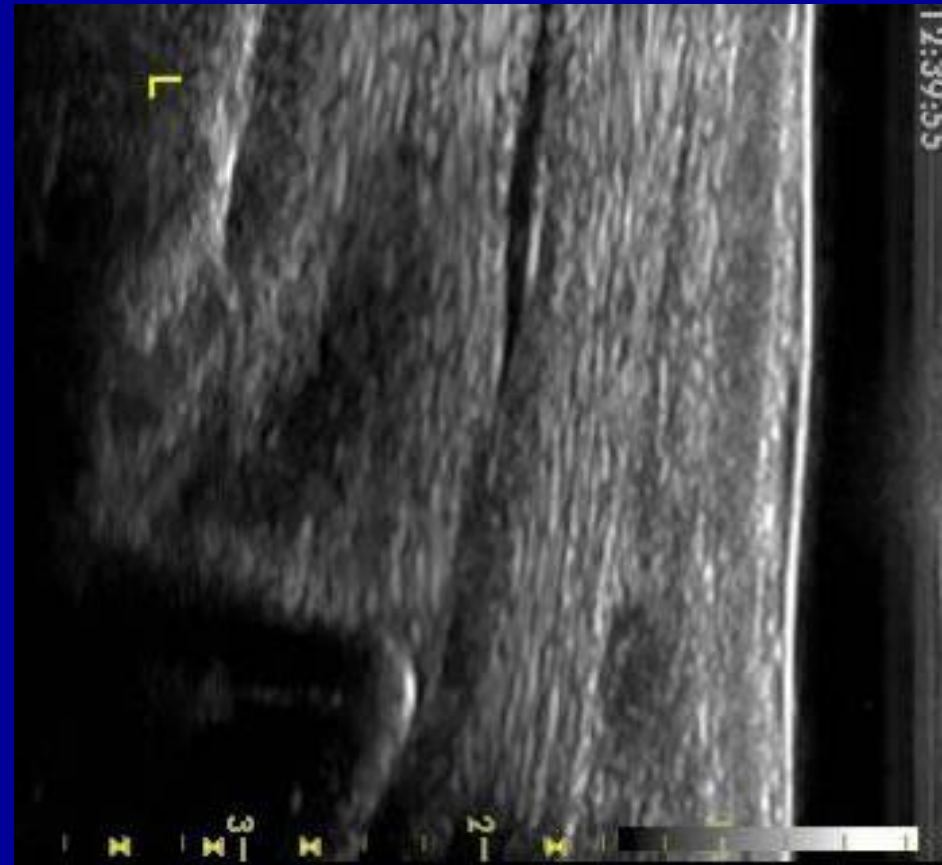
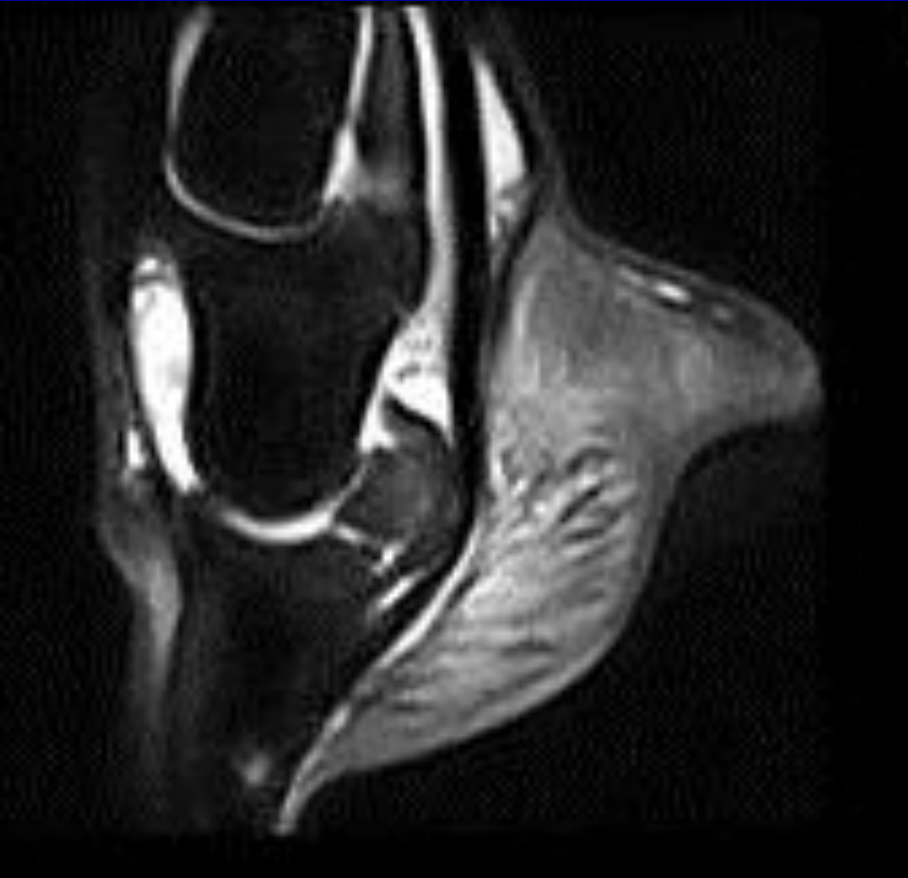
Case 5

- 10 yo, draft cross, mare
- 8 month history of LF lameness
 - Grade 2/5
 - 3+/5 circle to the left
 - 70% improvement with abaxial
 - Remainder with proximal suspensory
- Initially a Nuc Scan
 - no abnormalities

Case 5

- U/S-
 - Desmopathy of the straight sesamoidean
- MRI-
 - Desmopahty of the SSL
 - Navicular bone edema

Case 5



Case 5



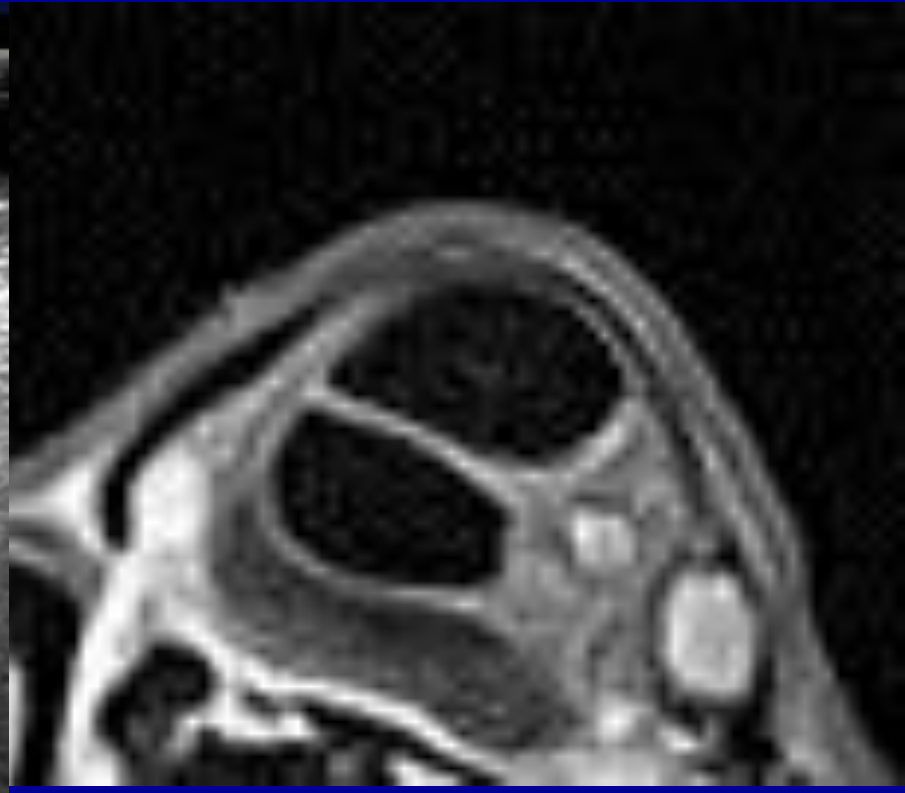
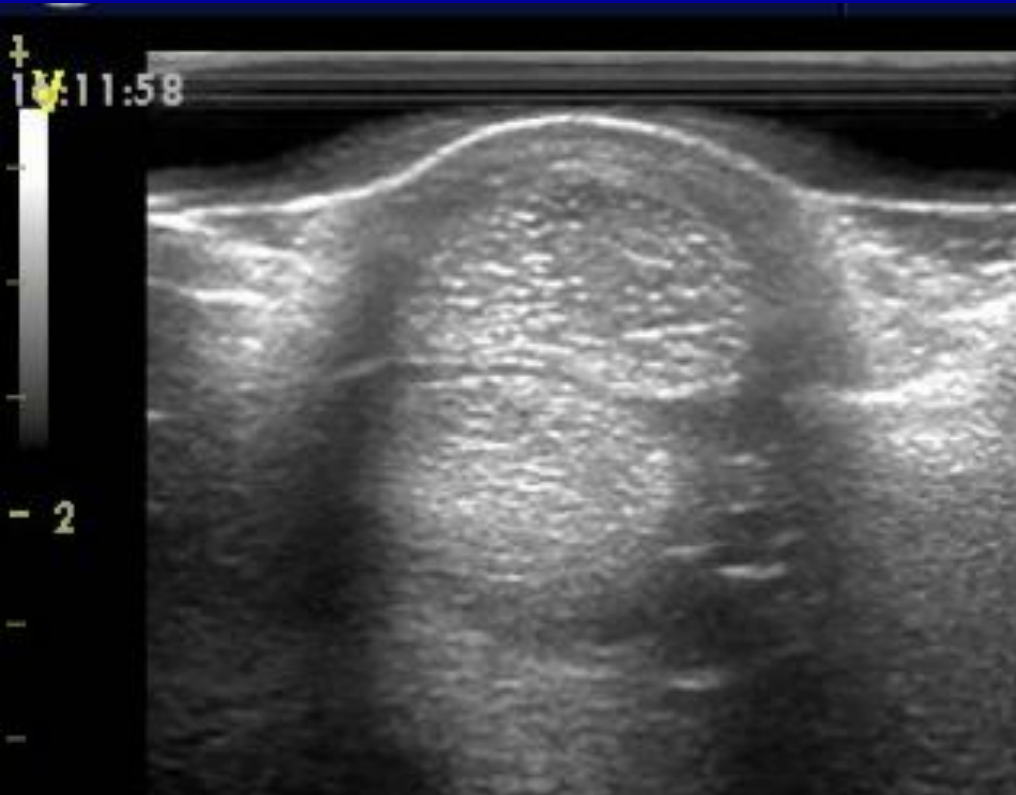
Case 6

- 7 yo, Warmblood, Mare
- 1 year hx of RF injury to the digital flexor tendon sheath
 - Tenoscopy and annular ligament resection
- Still lame RF- grade 2/5
 - Blocks to tendon sheath

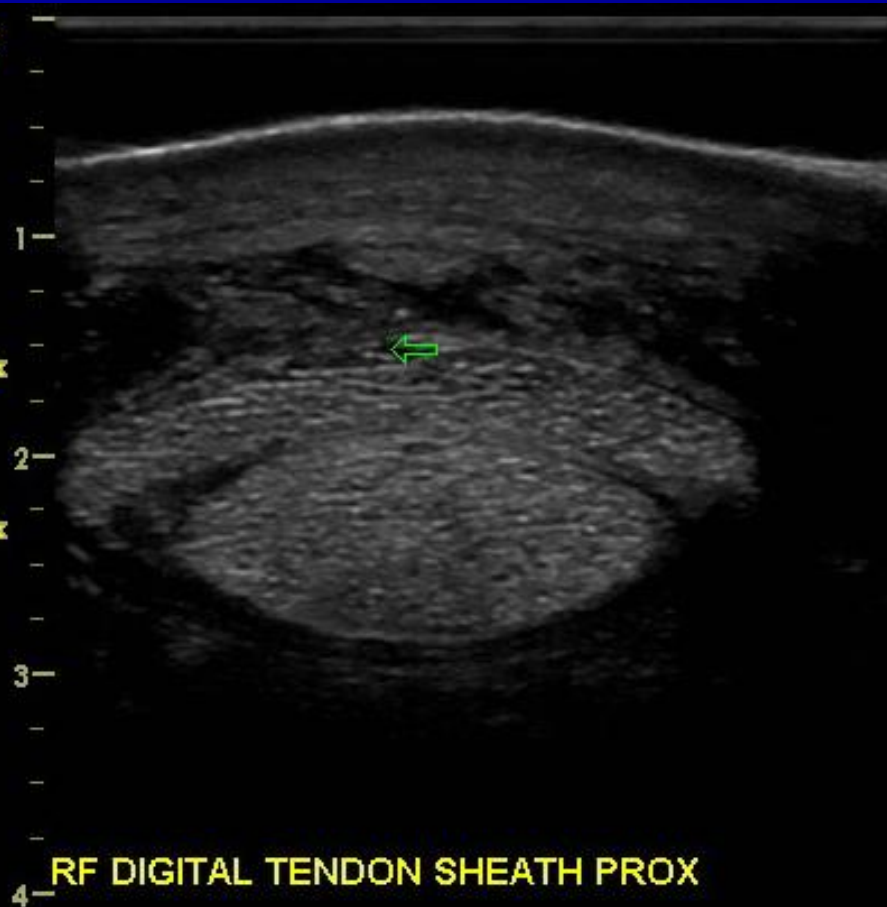
Case 6

- U/S
 - Core lesion in the SDFT
 - Scar tissue within the digital tendon sheath
- MRI
 - SDFT lesion
 - Scar tissue and adhesions

Case 6



Case 6



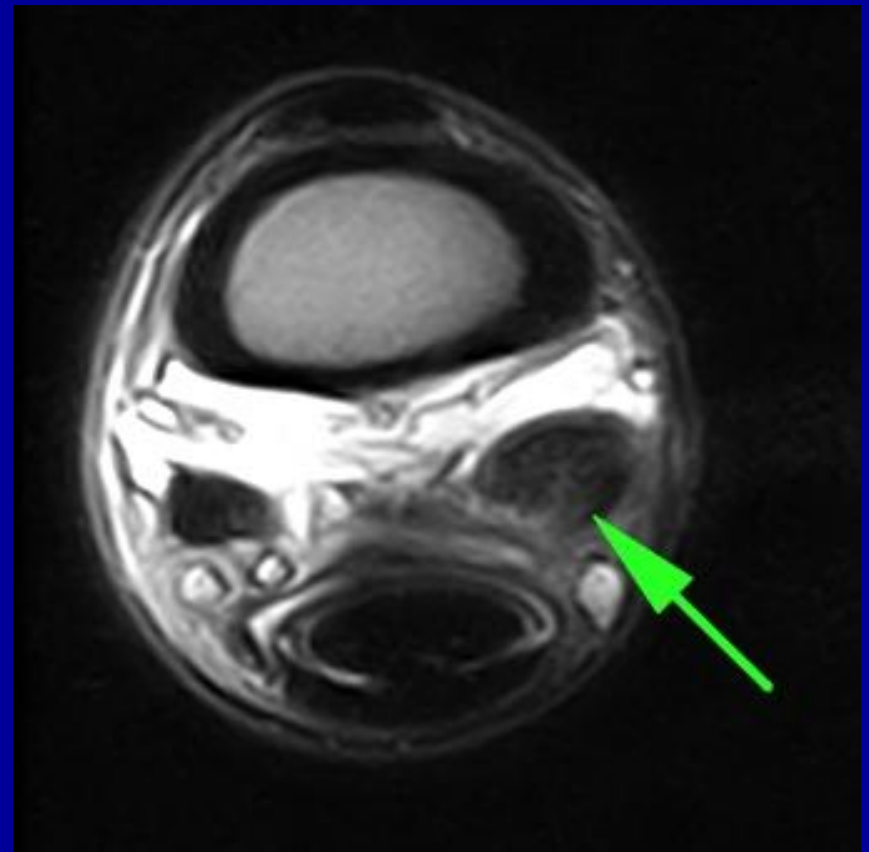
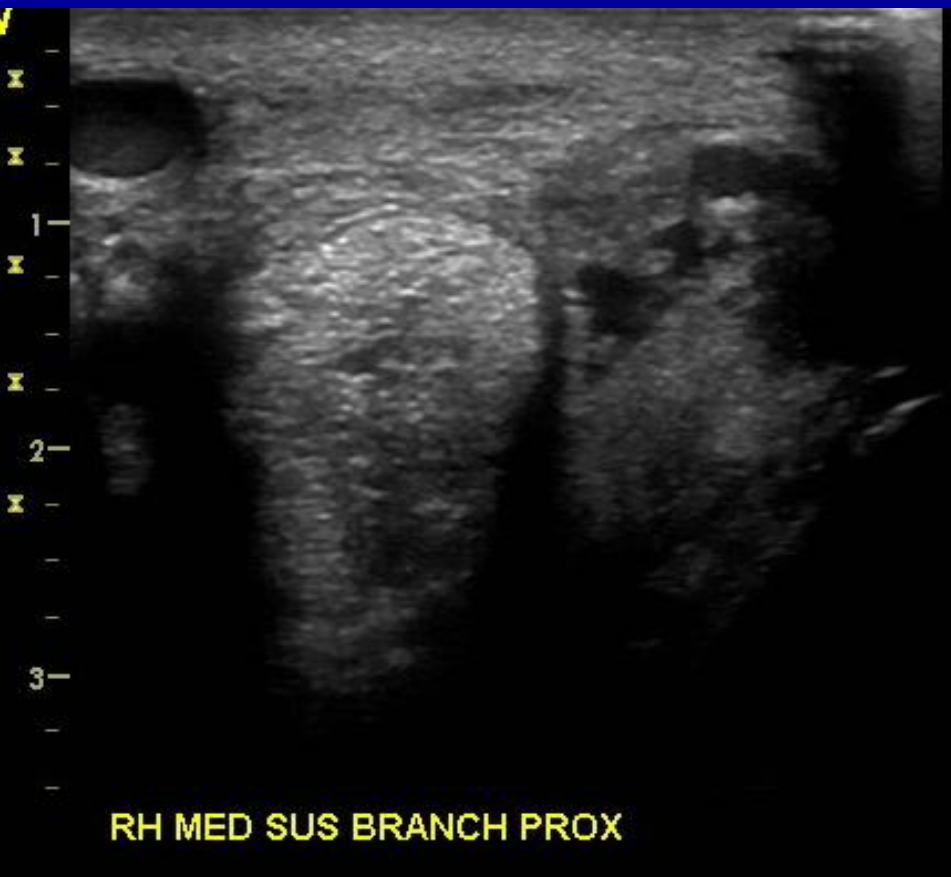
Case 7

- 15 yo, Warmblood, gelding
- Several months of RH lameness 3+/5
 - Severely positive to digit flexion
 - Low-4 point- 80% improvement
 - High suspensory- switched

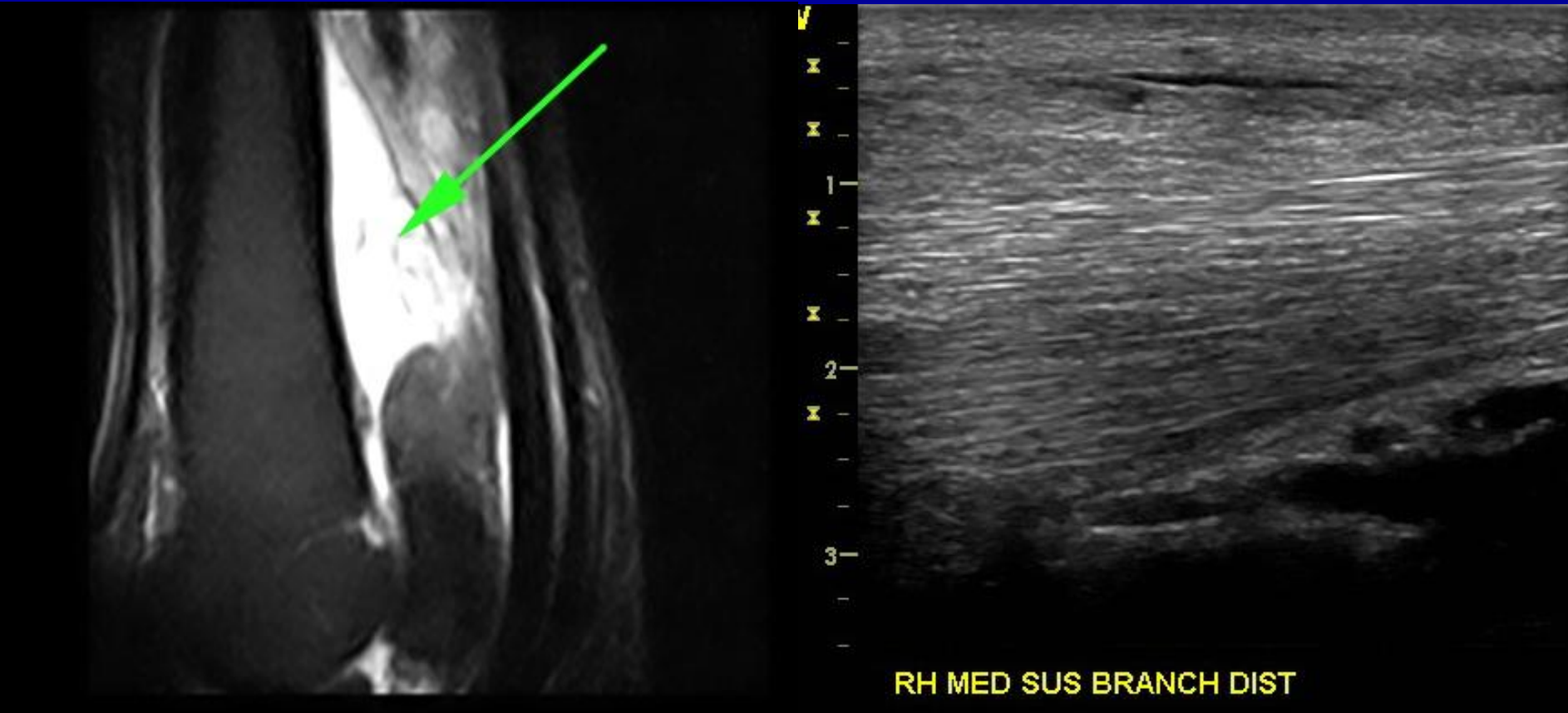
Case 7

- U/S- Enlargement of the medial SL Branch and disruption of the fiber pattern
- MRI-

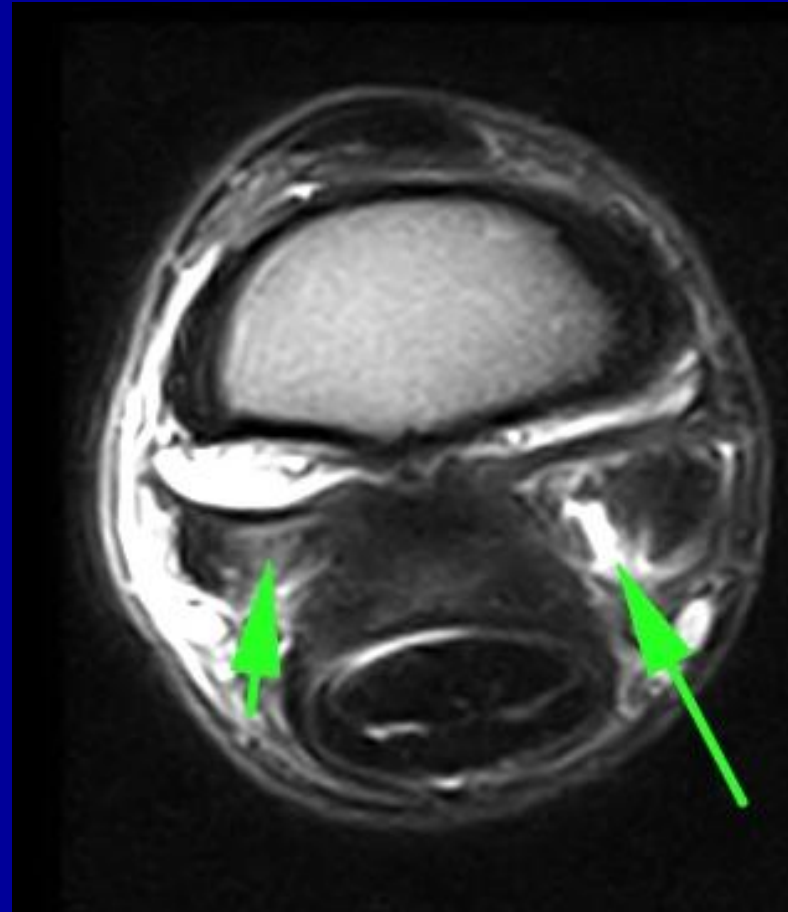
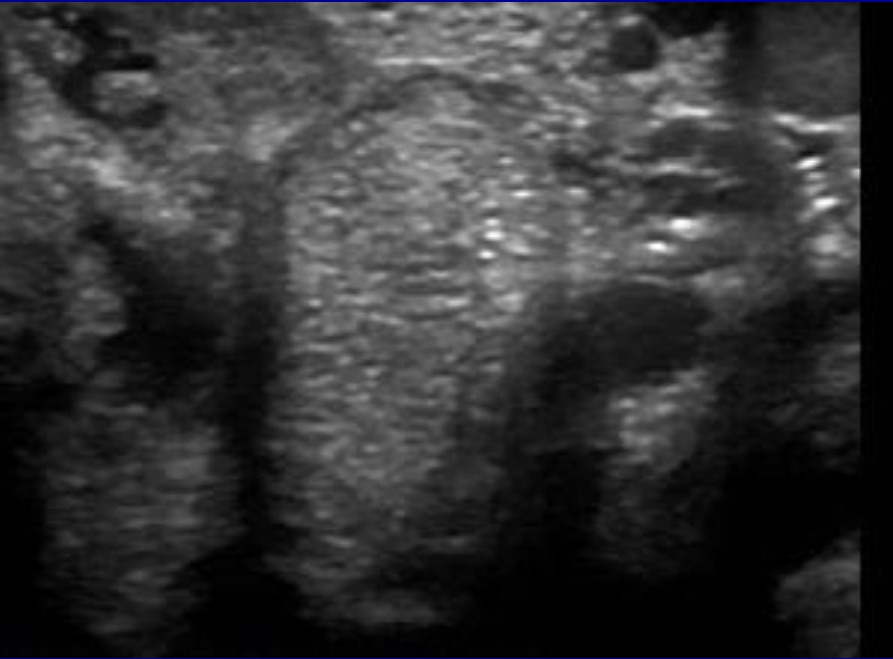
Case 7



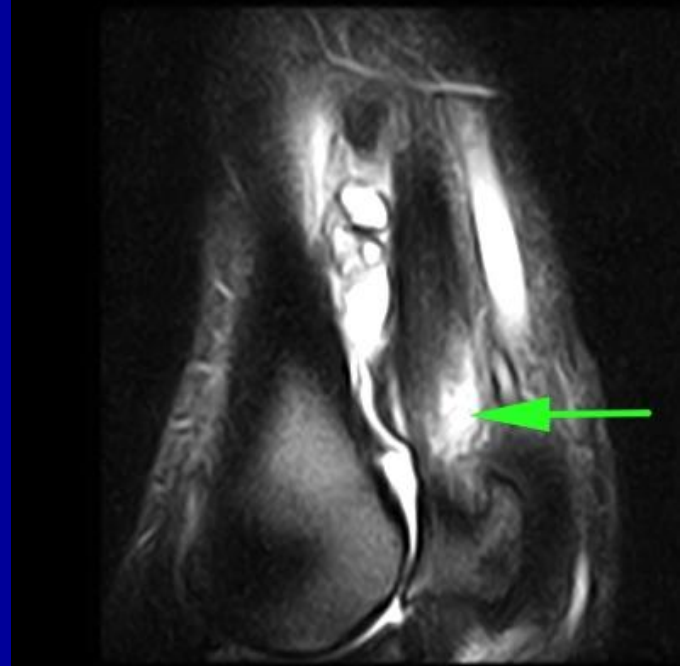
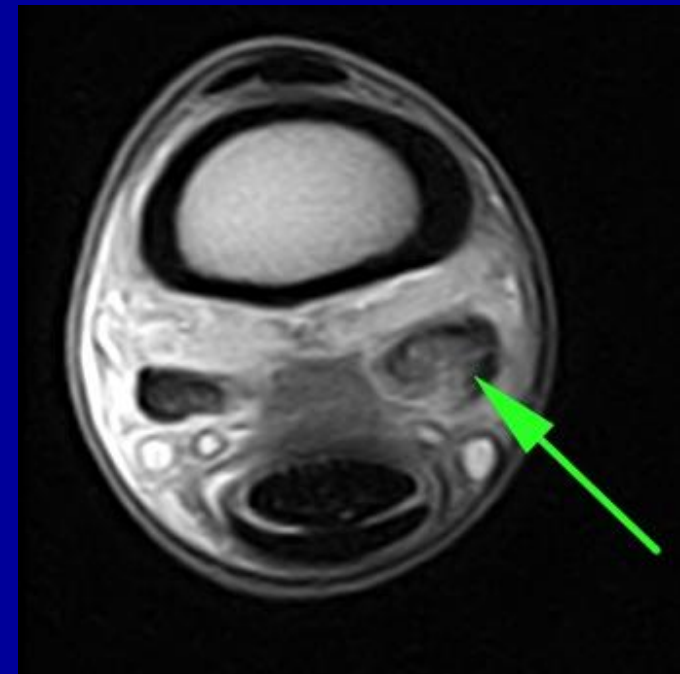
Case 7



Case 7

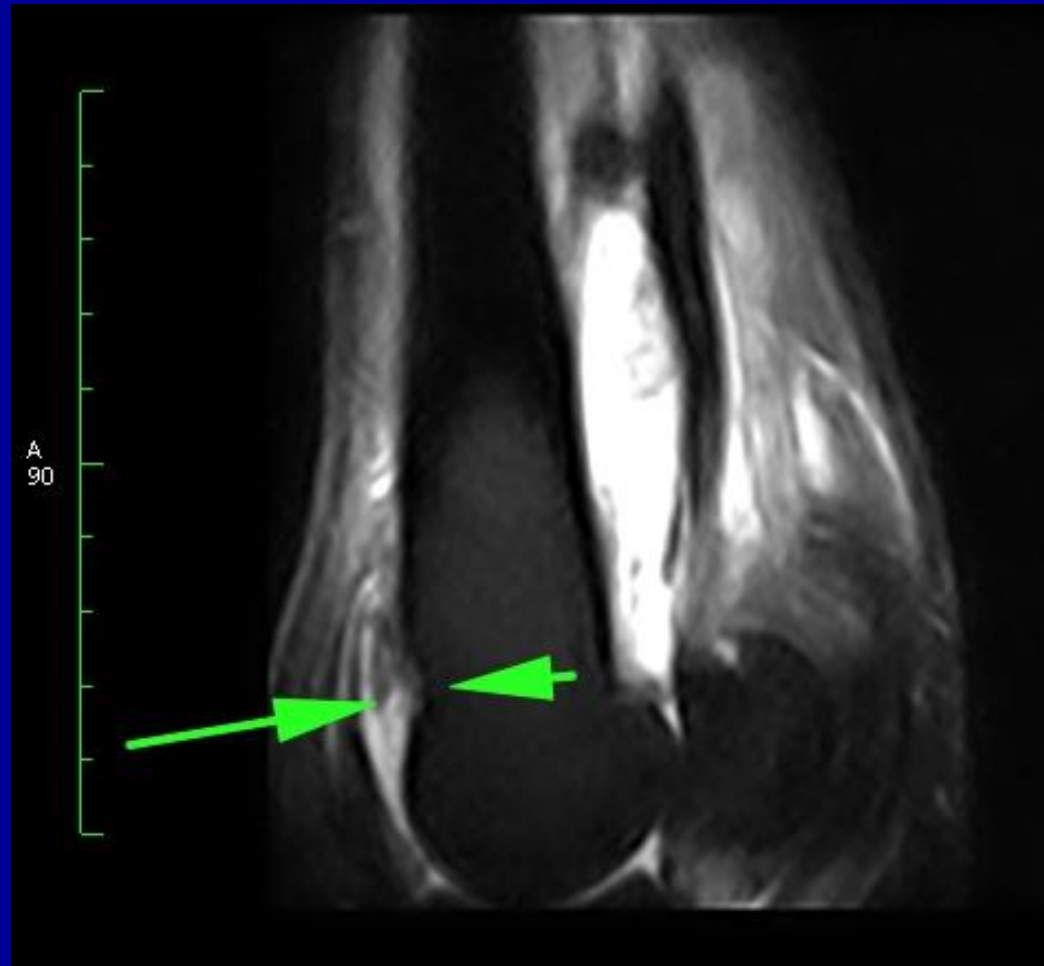


Case 7



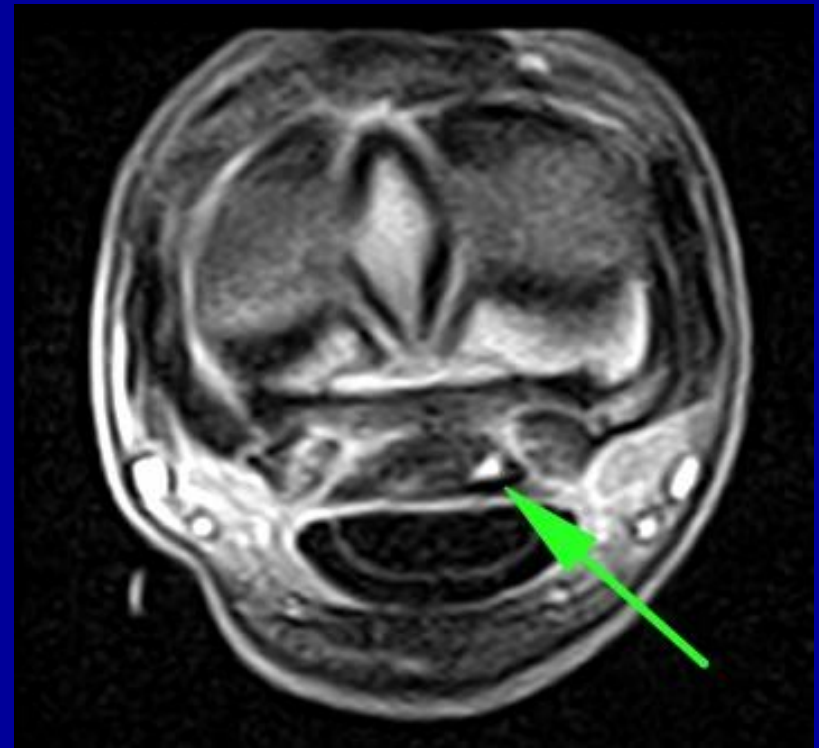
Case 7

- Dorsolateral distal MTIII condylar absorption
- secondary to villonodular synovitis?



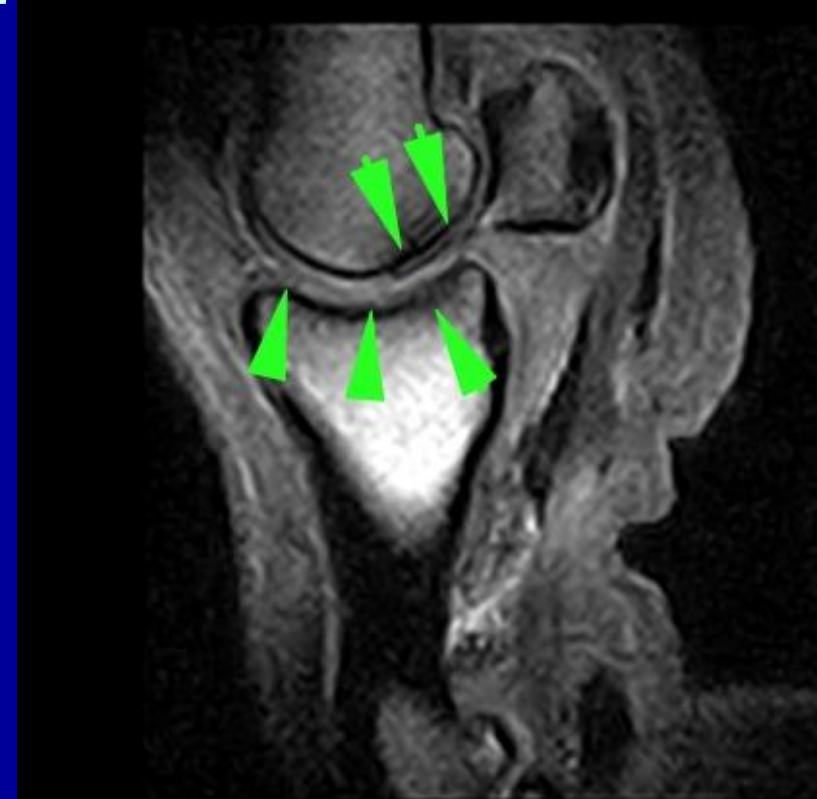
Case 7

- Tear of the proximal straight sesamoidean ligament



Case 7

- Subchondral bone plate demineralization



Questions?

