# Musculoskeletal Ultrasound (MSUS)

Joanna Cunnington
SpR Rheumatology

- Why MSUS is of interest to us?
- MSUS basics
- Normal MSUS
- Pathology
- Intervention

# Why and how

- High resolution anatomical images
- Instant
- Dynamic
- No radiation
- Low cost
- Patient acceptable
- Change management instantly
- Laptop size / portable
- Multiple joints at one sitting

- More sensitive than clinical examination detecting synovitis
- More sensitive than x-ray detection erosion and progression of destruction over time
- MSUS correlates with inflammation visualised at arthroscopy and MRI in RA and PsA
- Better than clinical examination for enthesitis


1. Fiocco, U., L. Cozzi, et al. (1996). "Long-term sonographic follow-up of rheumatoid and psoriatic proliferative knee joint synovitis." Br J Rheumatol **35**(2): 155-63.
2. Kane, D., P. V. Balint, et al. (2003). "Ultrasonography is superior to clinical examination in the detection and localization of knee joint effusion in rheumatoid arthritis." J Rheumatol **30**(5): 966-71.
3. Ostergaard, M., M. Court-Payen, et al. (1995). "Ultrasonography in arthritis of the knee. A comparison with MR imaging." Acta Radiol **36**(1): 19-26.
4. Scheel, A. K., K. G. Hermann, et al. (2006). "Prospective 7 year follow up imaging study comparing radiography, ultrasonography, and magnetic resonance imaging in rheumatoid arthritis finger joints." Ann Rheum Dis. **65**(5): 595-600. Epub 2005 Sep 28.
5. Szkudlarek, M., M. Court-Payen, et al. (2001). "Power Doppler ultrasonography for assessment of synovitis in the metacarpophalangeal joints of patients with rheumatoid arthritis: a comparison with dynamic magnetic resonance imaging." Arthritis Rheum **44**(9): 2018-23.

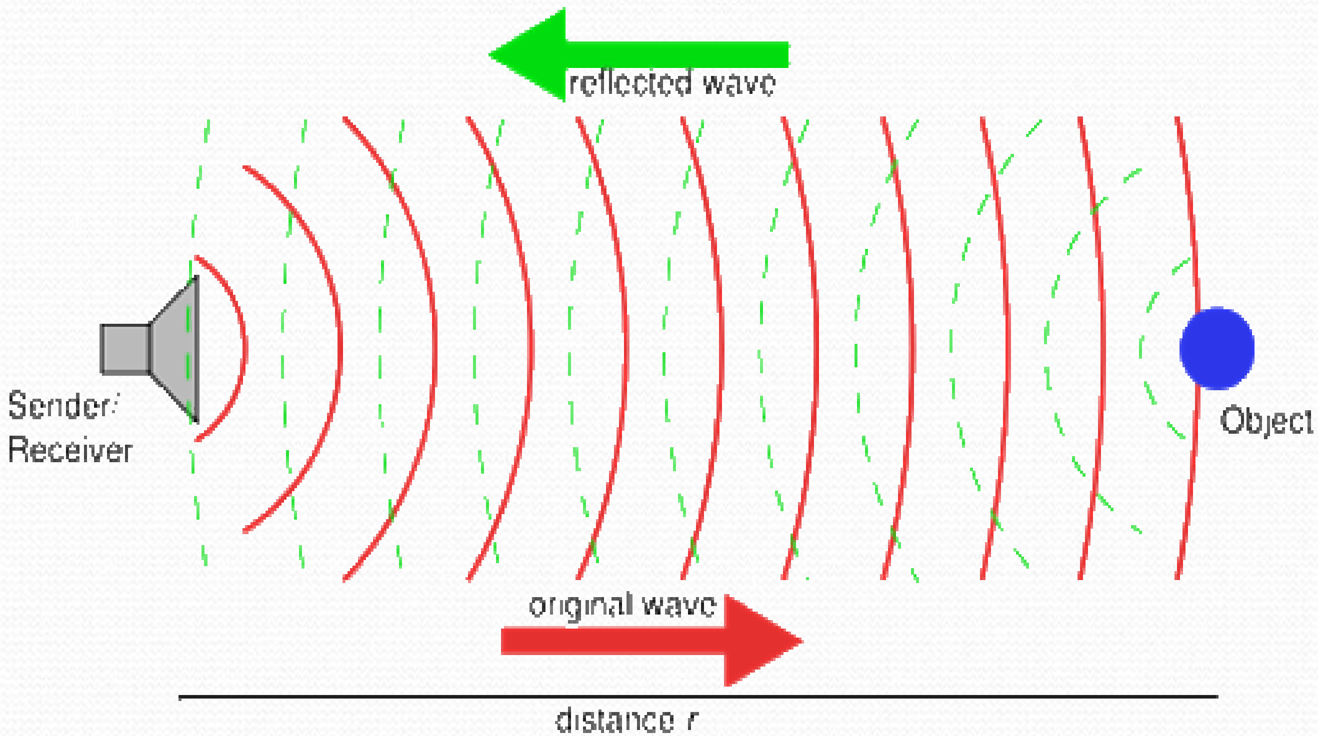
| Tissue | Proven indication | Potential indication |
|---|---|---|
| Effusion | Diagnosis /aspiration /differentiation | US microscope |
| Synovium | Diagnosis | Research / outcome / classify extent |
| Bursa | Diagnosis /aspiration / injection | Actual pathology |
| Bone | Erosion (active or in active) | Bone tumours / fractures |
| Tendon / ligament | Damage / rupture / tendonitis / tenosynovitis / enthesitis / injection | Response to treatment |
| Skin | Thickness / sub cutaneous oedema | Atrophy / abscess / calcification |
| Cartilage | Defects / calification | Osteoarthritis |
| Muscle | Trauma / tumour/ abscess / calcification | Diagnosis / monitoring muscle inflammation |
| Vasculature | Inflammation / morphology vasculature | Diagnosis vasculitis / raynauds |
| Nerve | Entrapment / guided blocks | Diagnose axonal loss / demyelination |

# Training

- No consensus or formal pathway
- Suggested guidelines and curriculum have been published
- Individualised /targeted – trade off between added clinical value and time to achieve competence
- Courses beginners / advanced
- Mentors
- Practice
- Websites and textbooks

# Ultrasound basics

- Ultrasound is a sound with a frequency above the frequency audible by humans >20 000hz




The original Somascope from Howry, Bliss, Posakony and Cushman as it appeared in the Medicine section of the Life Magazine® in 1954.


Sonosite Titan system (Sonosite Limited, Bothwell, USA) with a 5-10 MHz transducer.

# Technology

- Image resolution greater with higher frequency probes
- Penetration greater with lower frequency probes
- Our probes 5 -20 hz
- Power Doppler
- Tissue harmonics and cross beam technology
- 3D
- Contrast agents

# Clinical utility

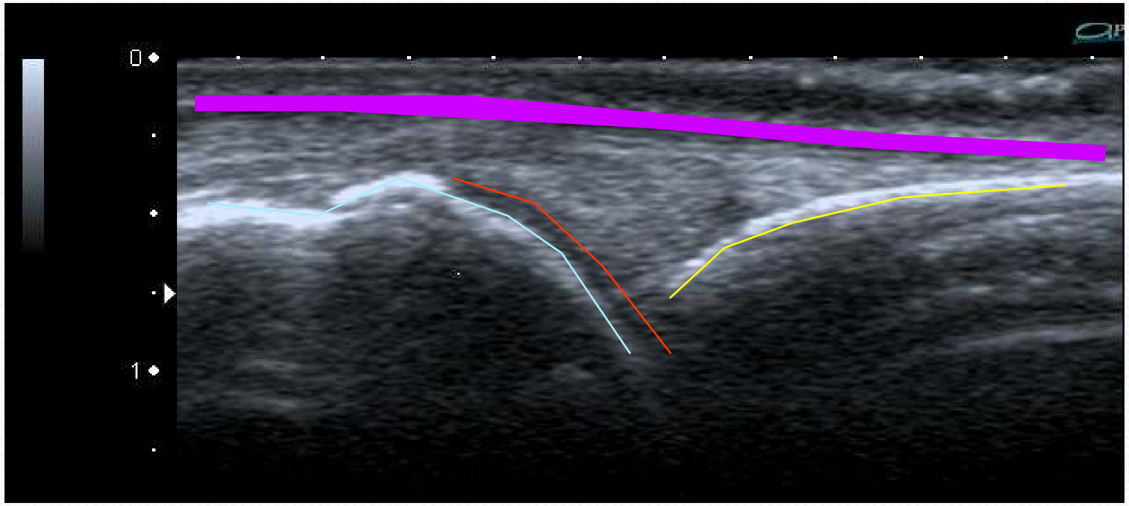
- OMERACT definitions of pathology [1]
- Reproducibility [2]
- Impact on clinical practice [3]

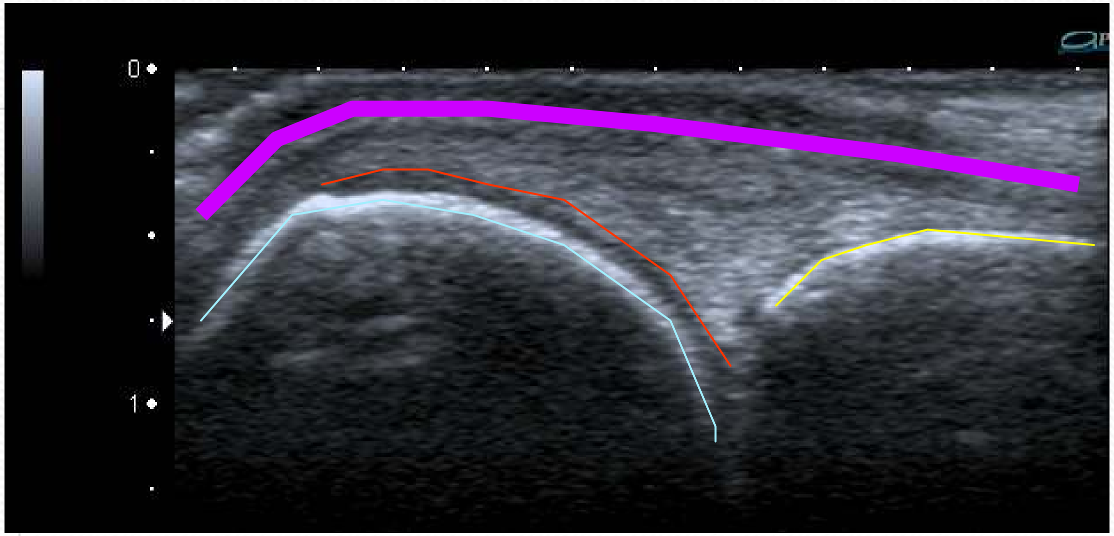
1. Wakefield, R. J., P. V. Balint, et al. (2005). "Musculoskeletal ultrasound including definitions for ultrasonographic pathology." J Rheumatol. **32**(12): 2485-7.
2. Szkudlarek, M., M. Court-Payen, et al. (2003). "Interobserver agreement in ultrasonography of the finger and toe joints in rheumatoid arthritis." Arthritis Rheum **48**(4): 955-62.
3. Karim, Z., R. J. Wakefield, et al. (2001). "The impact of ultrasonography on diagnosis and management of patients with musculoskeletal conditions." Arthritis Rheum **44**(12): 2932-3.

| OMERACT Definitions | |
|---|---|
| RA bone erosion | An IA discontinuity of the bone surface that is visible in 2 perpendicular planes. |
| Synovial fluid | Abnormal hypoechoic or anechoic (relative to subdermal fat, but sometimes may be isoechoic or hyperechoic) IA material that is displaceable and compressible and which may exhibit Doppler signal. |
| Synovial hypertrophy | Abnormal hypoechoic (relative to subdermal fat, but sometimes may be isoechoic or hyperechoic) IA tissue that is nondisplaceable and poorly compressible and which may exhibit Doppler signal. |
| Tenosynovitis | Hypoechoic or anechoic thickened tissue with or without fluid within the tendon sheath, which is seen in 2 perpendicular planes and which may exhibit Doppler signal. |
| Enthesopathy | Abnormally hypoechoic (loss of normal fibrillar architecture) and/or thickened tendon or ligament at its bony attachment (may occasionally contain hyperechoic foci consistent with calcification), seen in 2 perpendicular planes that may exhibit Doppler signal and/or bony changes including enthesophytes, erosions, or irregularity. |

# Hands – normal and pathology

# MCP – dorsal longitudinal





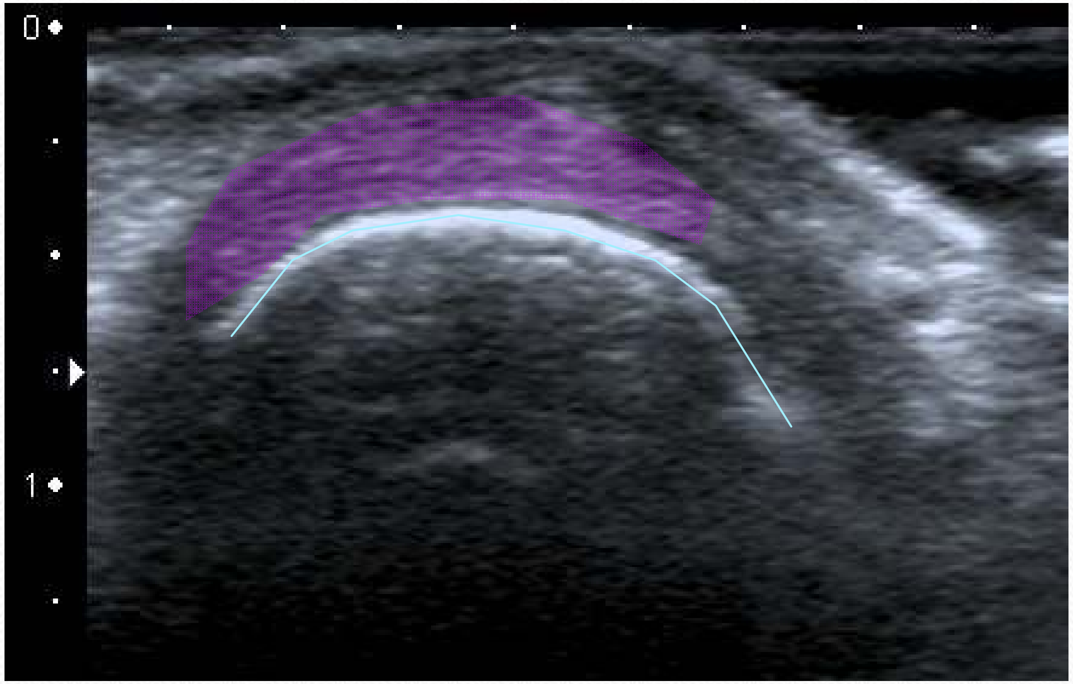
MCP head

Phalangeal head

Cartilage

Extensor tendon

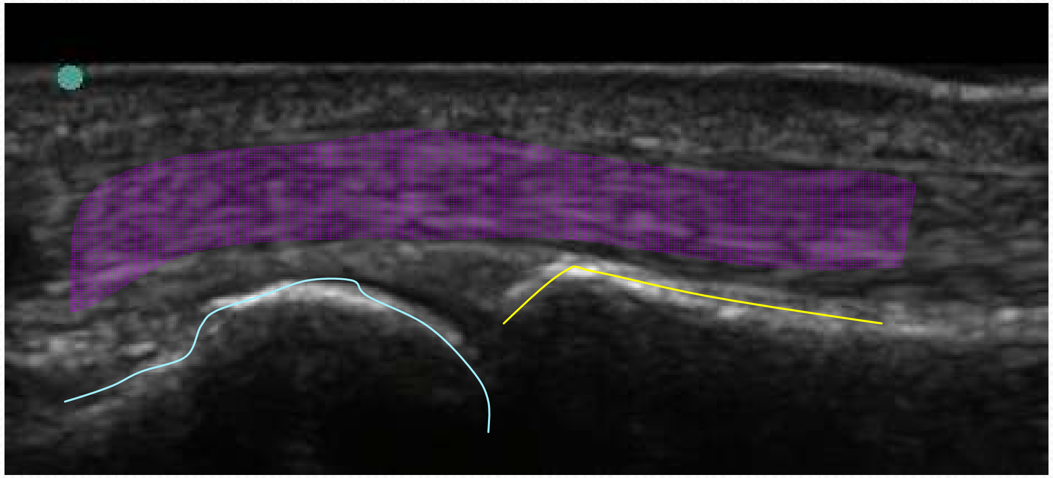
# MCP – transverse




Metacarpal

**Extensor tendon**

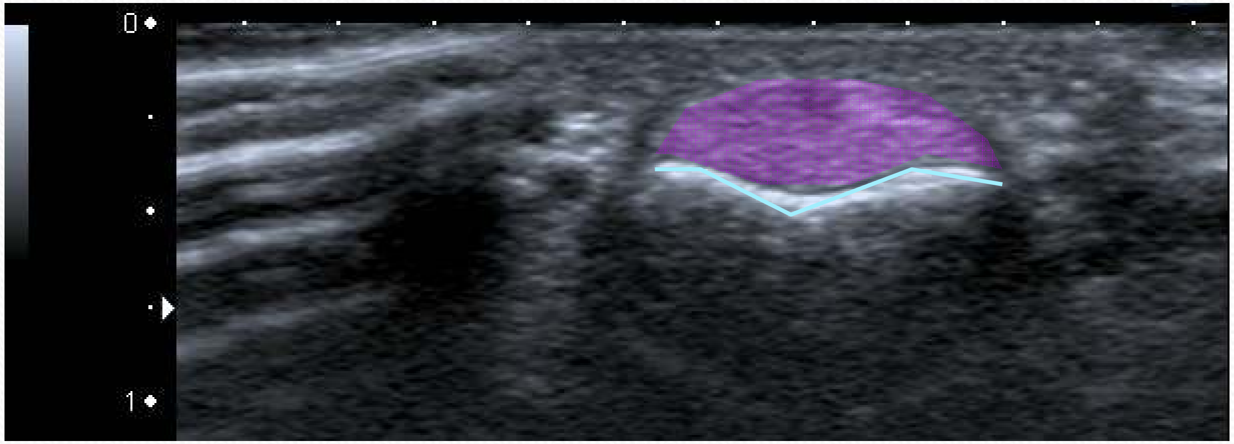
# MCP – palmar longitudinal and transverse



MC Head

Proximal Phalanx

Flexor tendon

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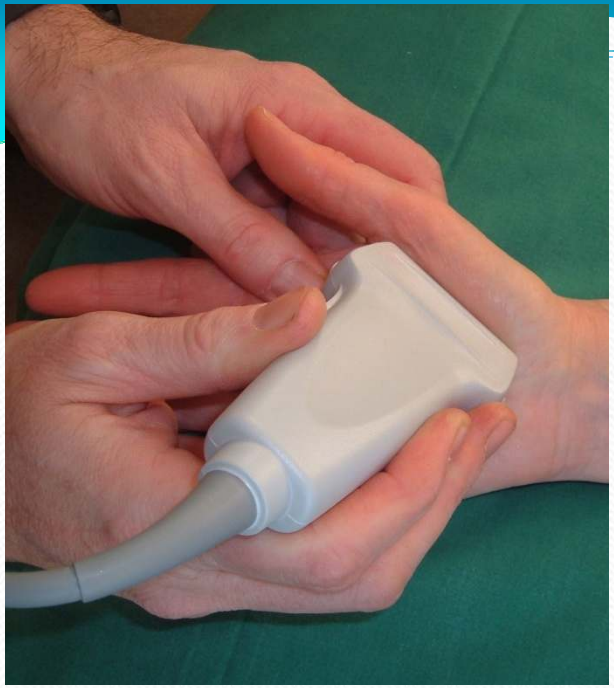
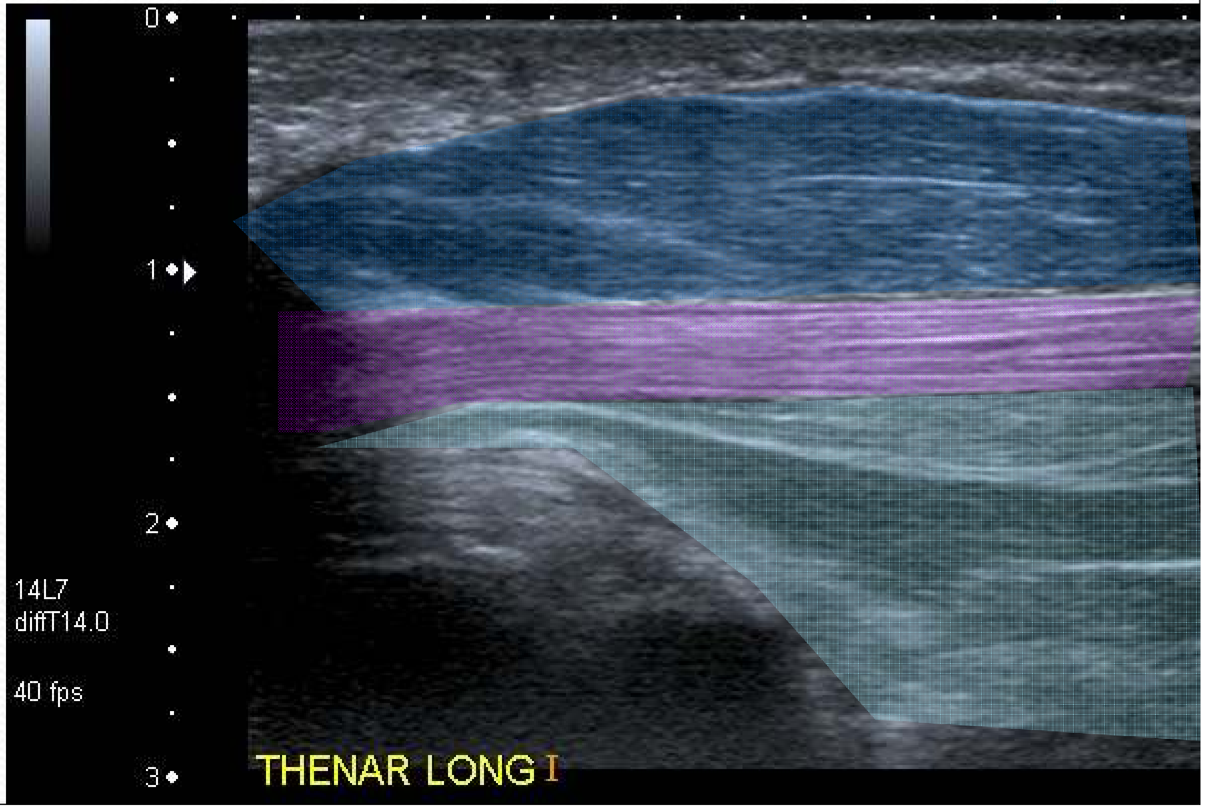


# Thenar - longitudinal




**Flexor pollicis**

**Thenar muscles**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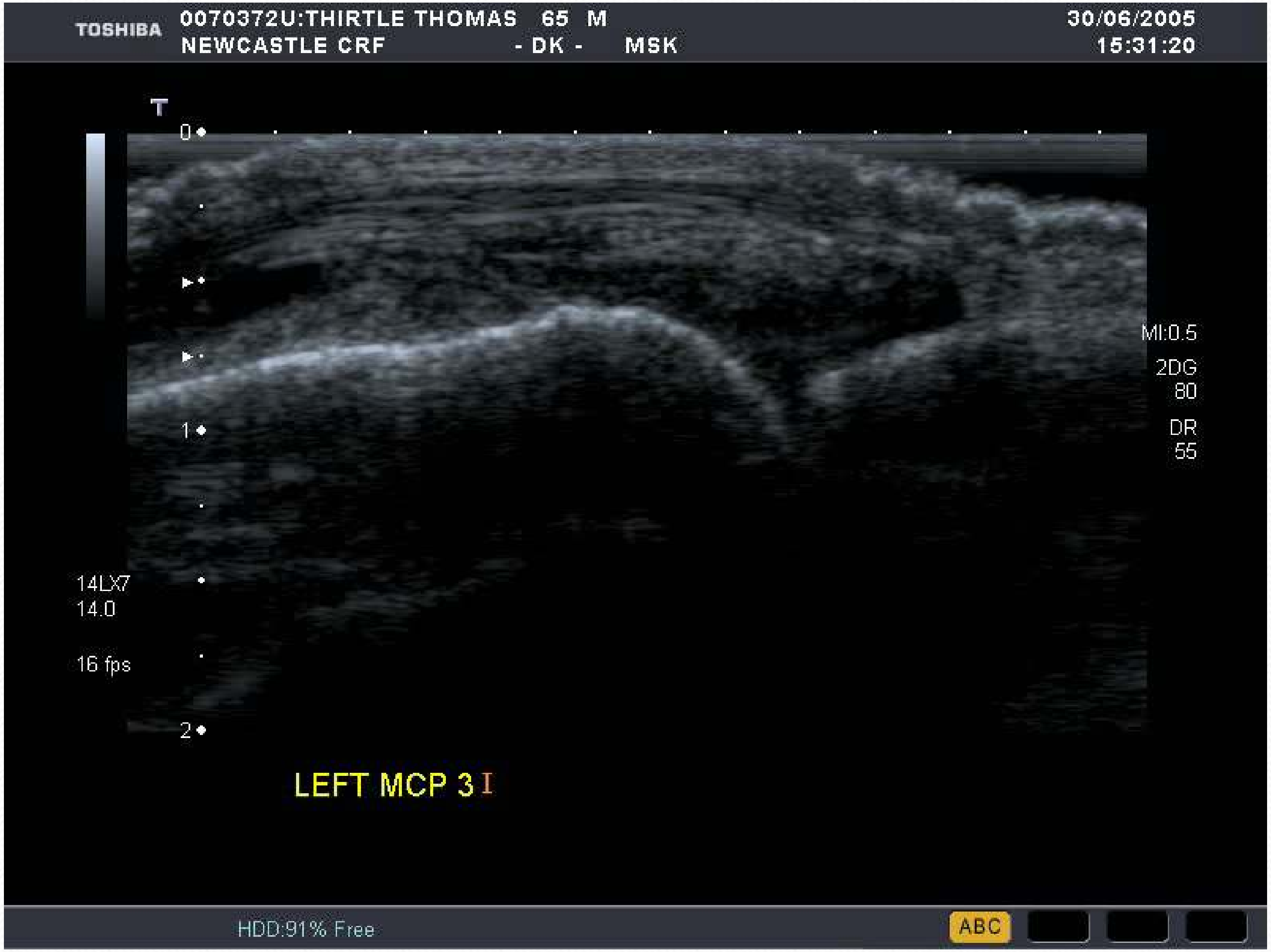
# Synovitis of MCPJ with CPD signal

# Synovitis - compressibility

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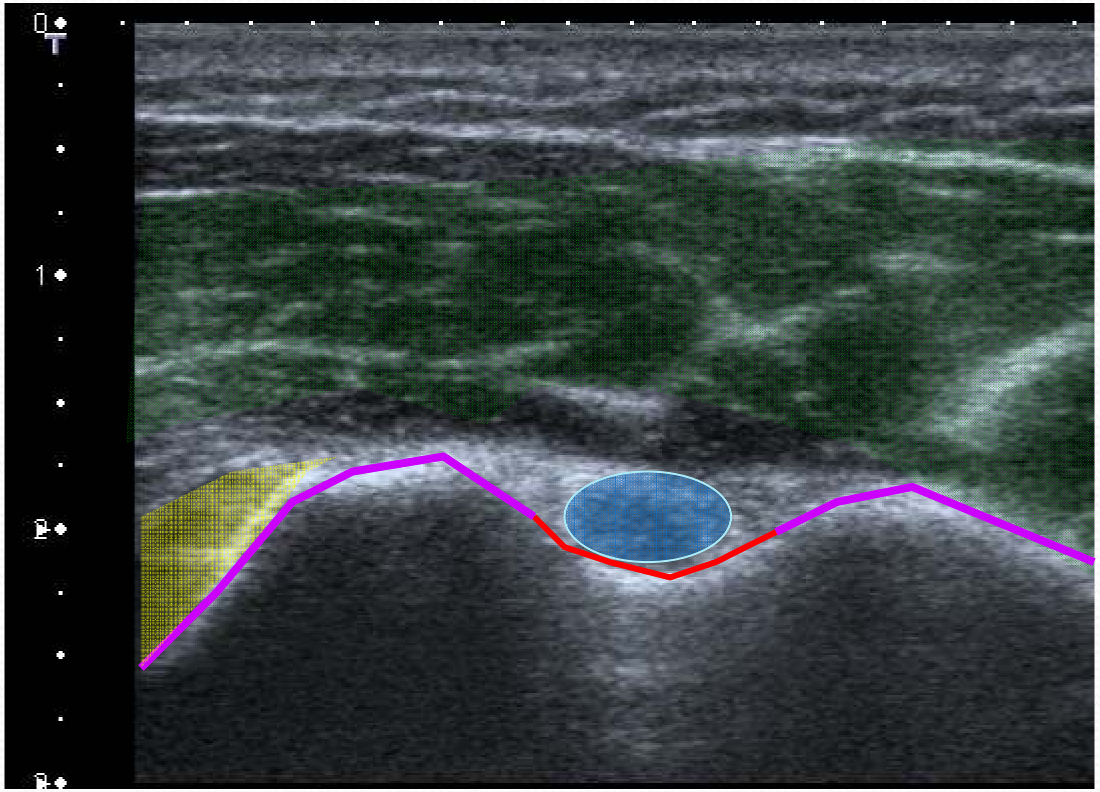
# Tenosynovitis

# Shoulder – normal and pathology

# Shoulder – Anterior Transverse Neutral Position



**Humerus**

**Bicipital groove**

**Biceps tendon**

**Subscapularis**

**Deltoid**

# Anisotrope

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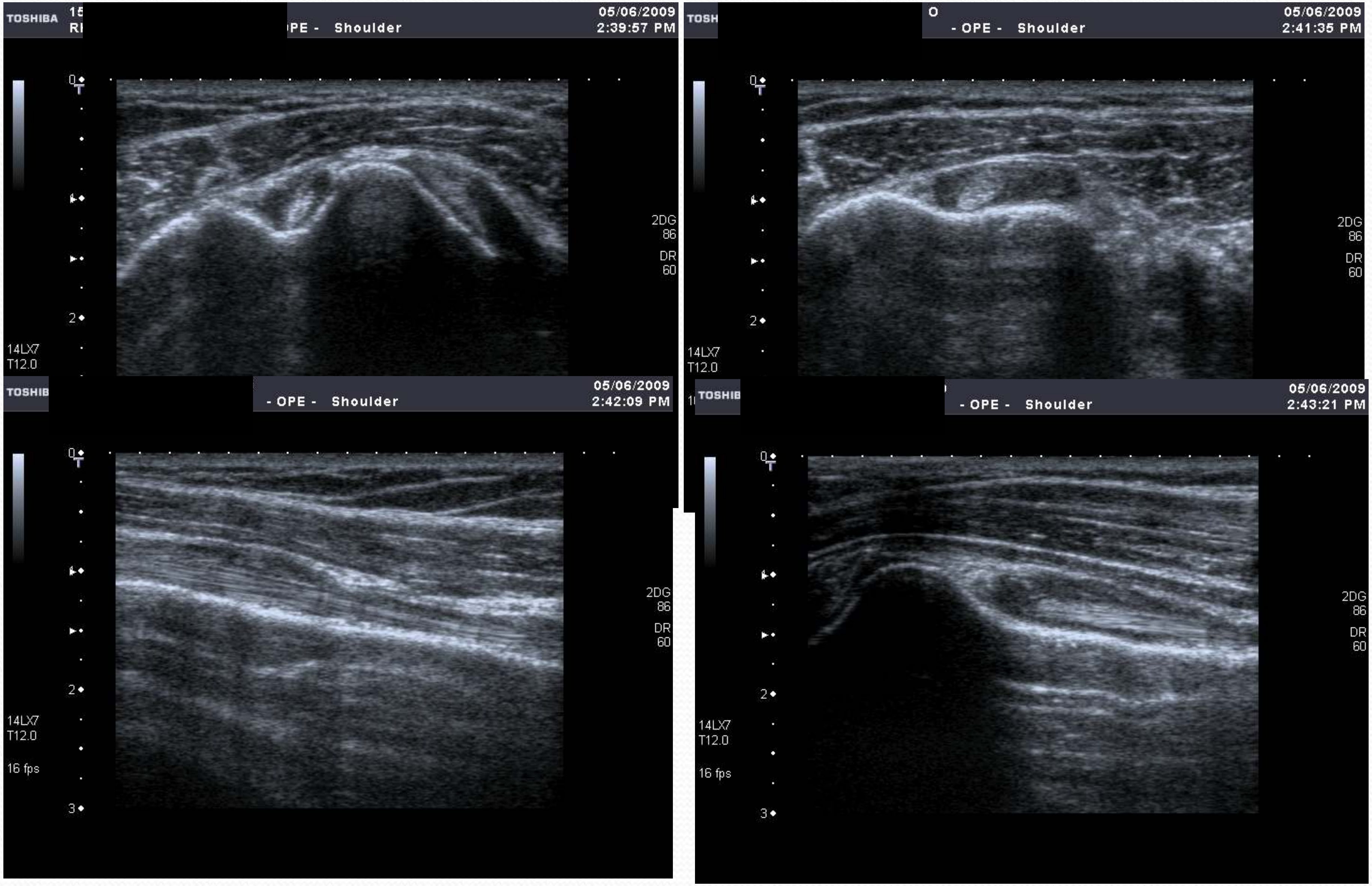
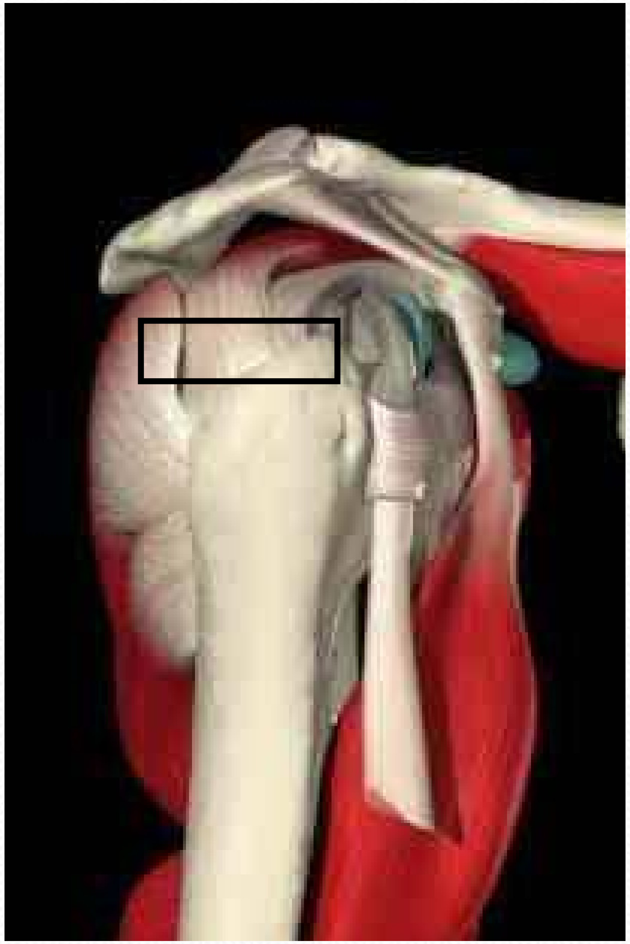
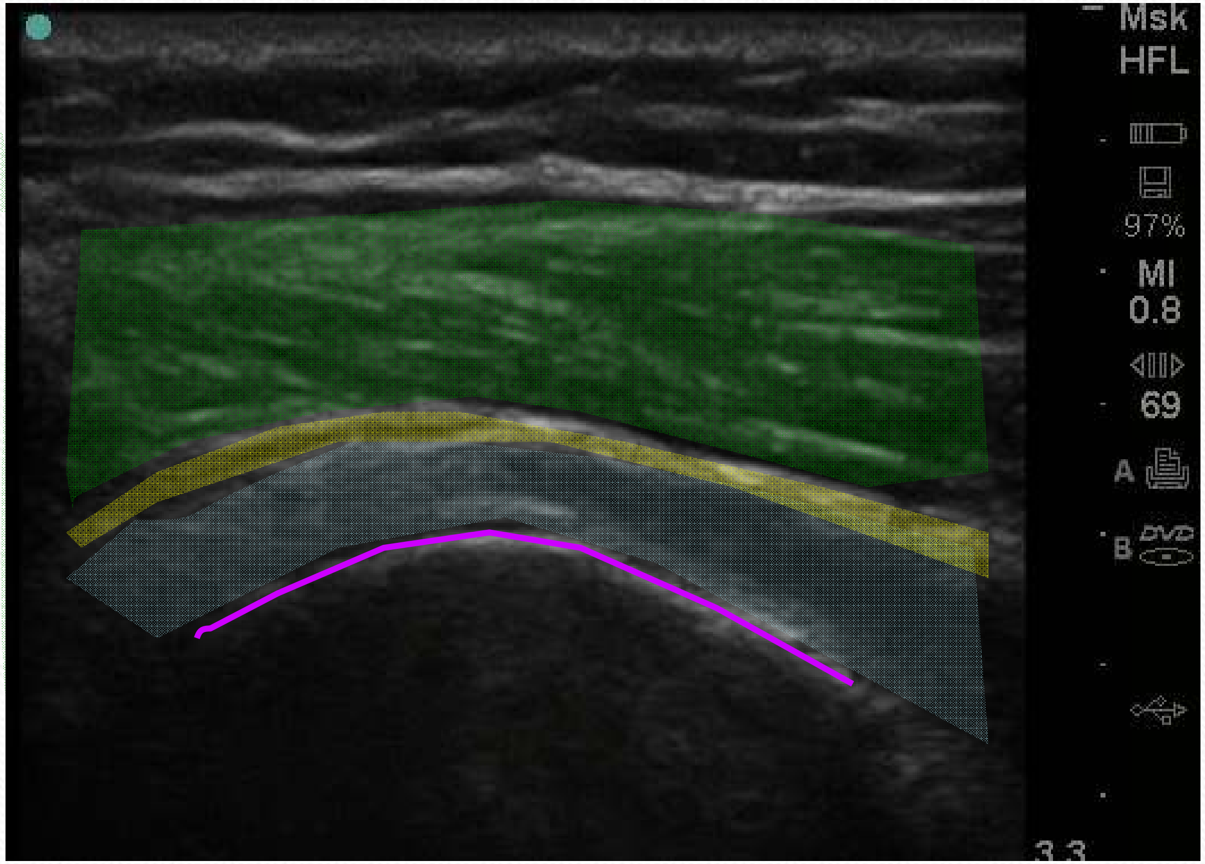
# Biceps tendon effusion



# Shoulder – Anterior Transverse Maximal Internal Rotation



# Shoulder – Anterior Transverse Maximal Internal Rotation



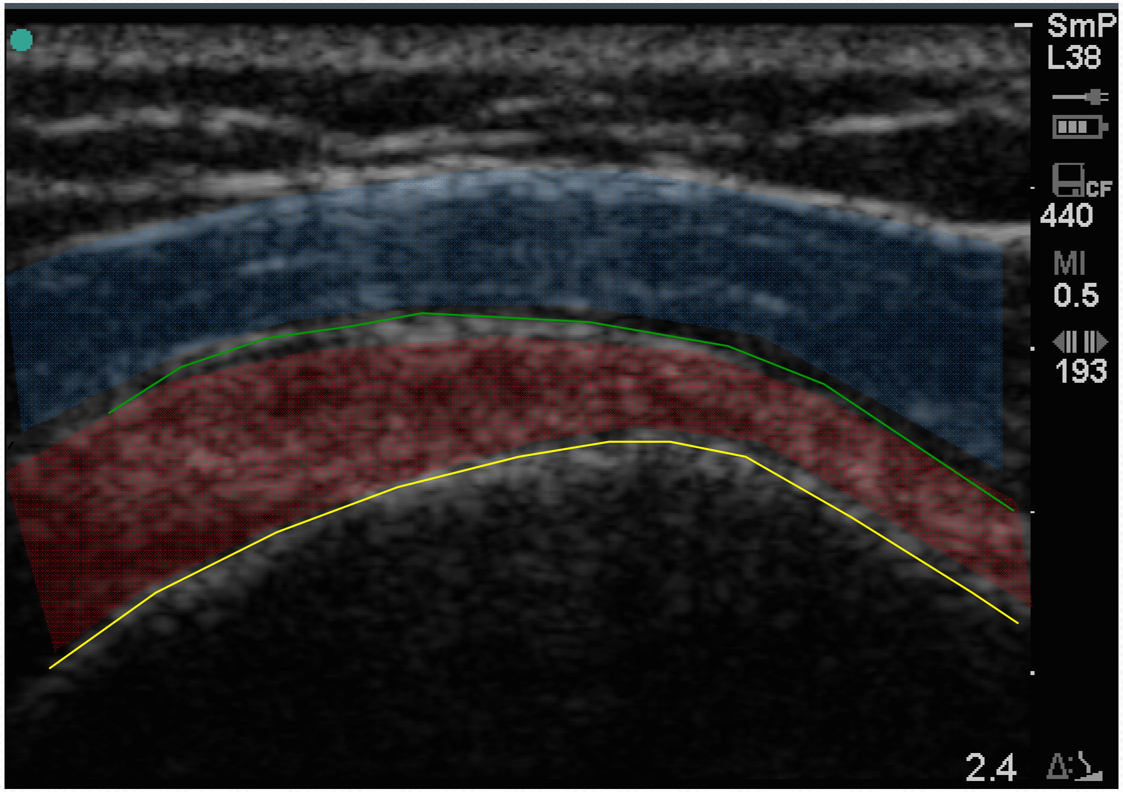

**Humerus**

**Supraspinatus**

**Subdeltoid bursa**

**Deltoid**

# Shoulder – Anterior Longitudinal Maximal Internal Rotation



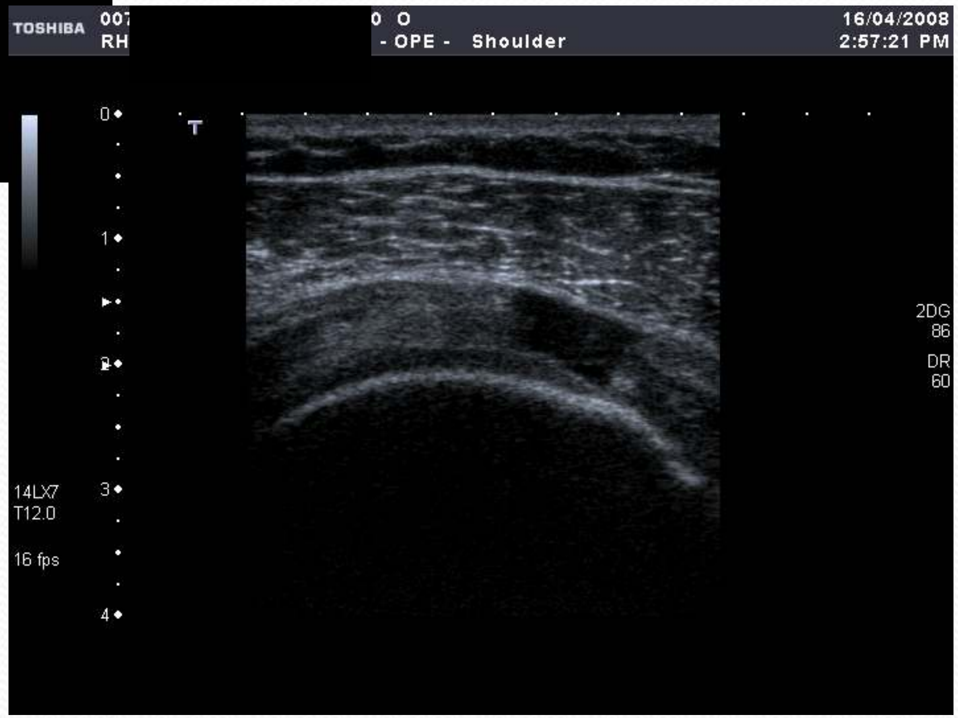

Head of Humerus

Supraspinatus

Sub-deltoid bursa

Deltoid

# Supraspinatus tear

# Impingement test

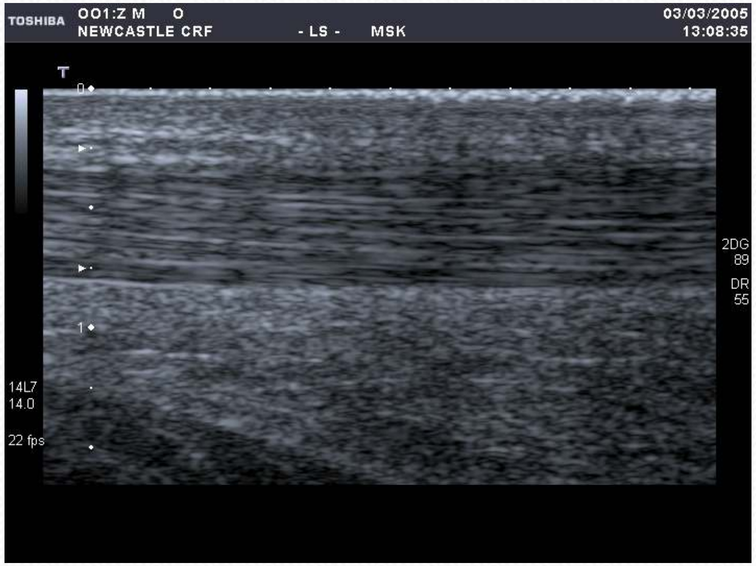
# Subscapularis

# Shoulder effusion

# Calcific tendonitis

# Achilles and patella tendons

# Achilles tendon – longitudinal view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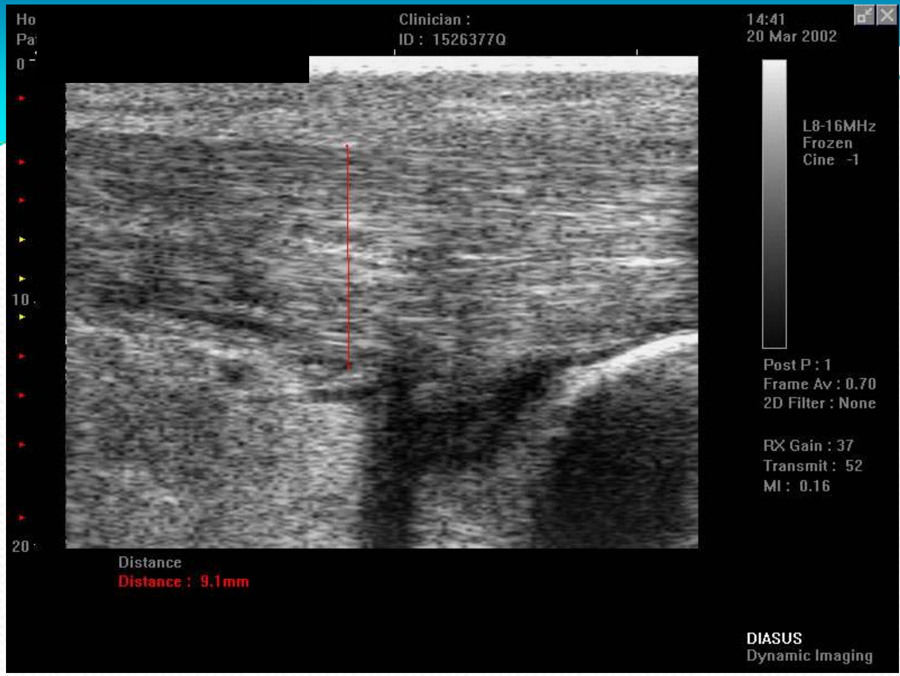
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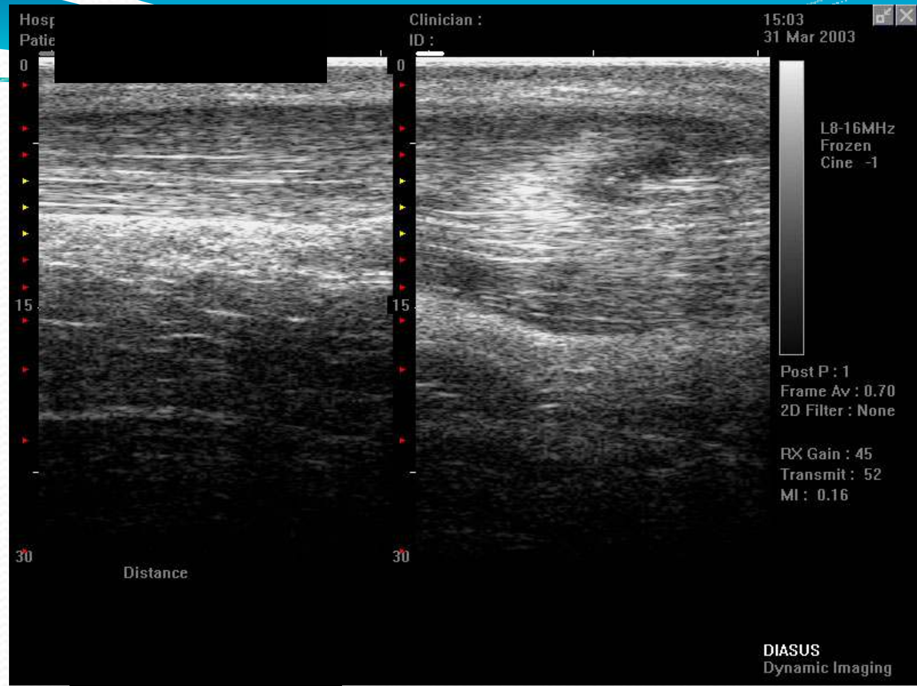
DIASUS
Dynamic Imaging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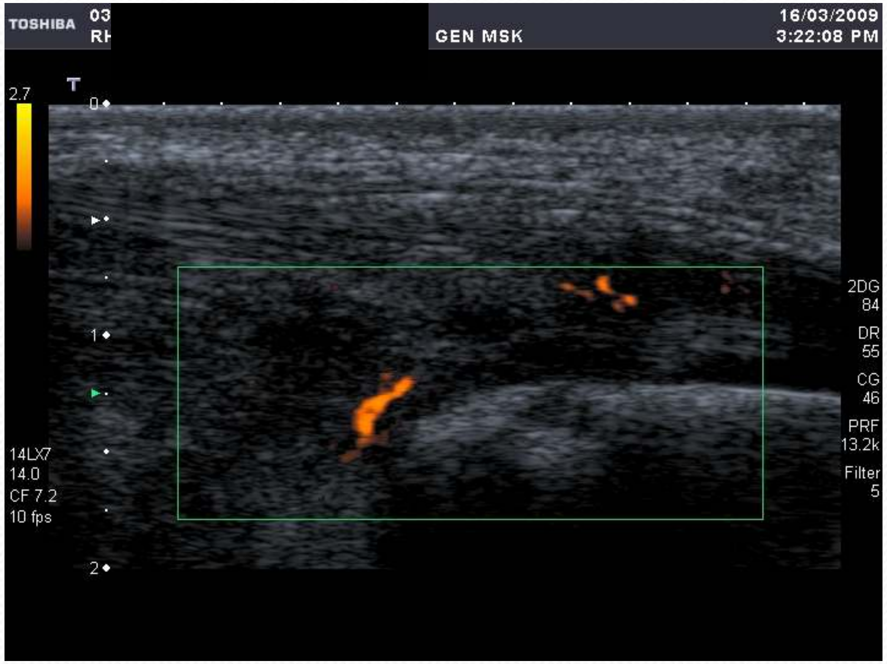
Dynamic Imaging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Distance
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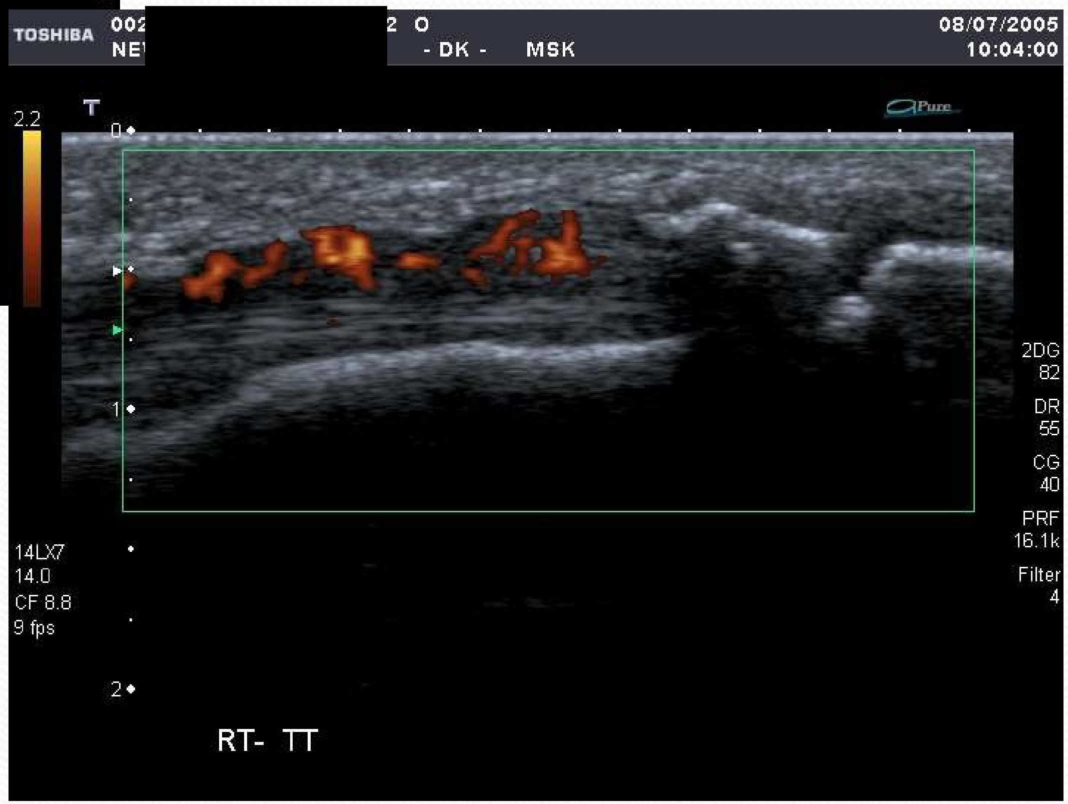
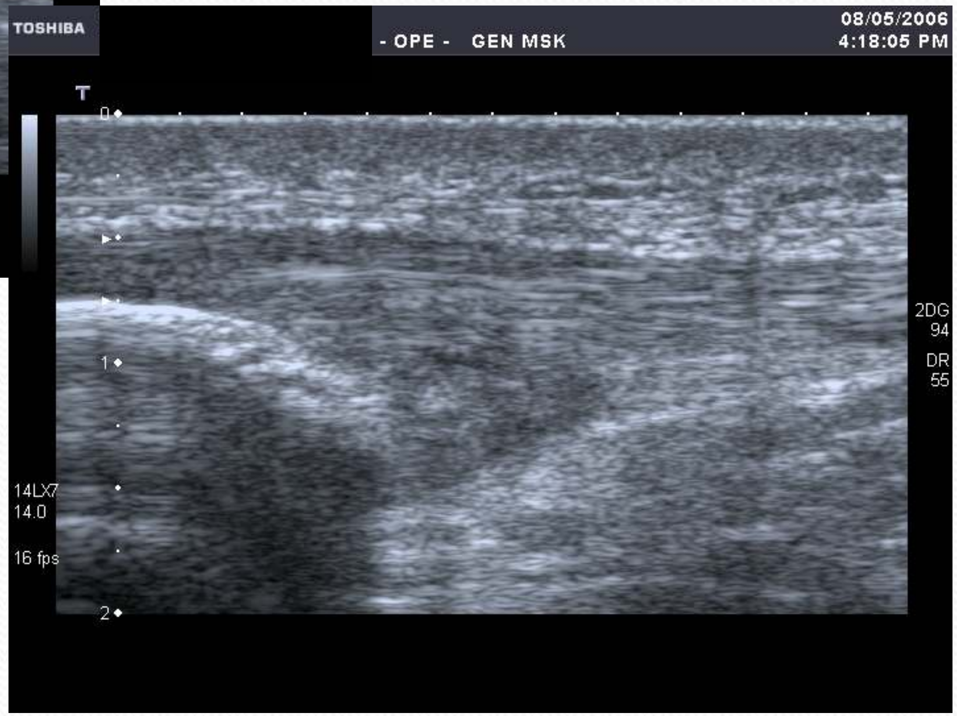
Dynamic Imaging

# Patella tendon trauma

# Patella tendon insertion

# Intervention

# Why?

- **Clinically guided injections are inaccurate (25% - 60%)[1,2]**

- Diagnosis - accurate aspiration of fluid
  - Culture
  - Microscopy
- Intervention - accurate delivery of therapeutic agent
  - Corticosteroid
  - Hyalgan
  - ?anti-TNF

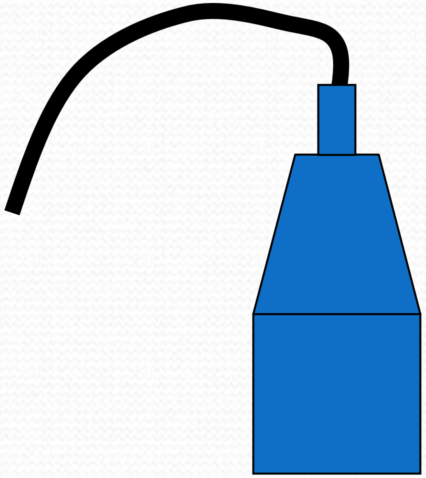

1. Eustace, J. A., D. P. Brophy, et al. (1997). "Comparison of the accuracy of steroid placement with clinical outcome in patients with shoulder symptoms." Ann Rheum Dis. **56**: 59-63.
2. Jones, A., M. Regan, et al. (1993). "Importance of placement of intra-articular steroid injections." BMJ **307**(6915): 1329-30.

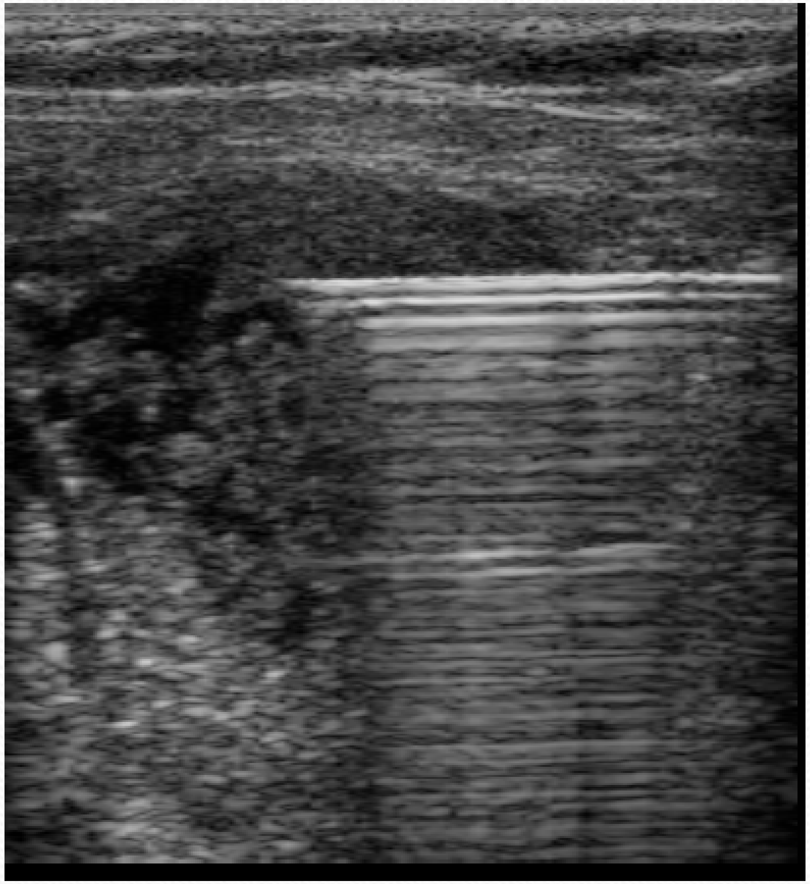
# Accuracy with US guidance versus clinical guidance

| Joint injected | Accurate by MSUS | Accurate by clinical guided | P value |
|---|---|---|---|
| All Joints | 76/92 (83%) | 61/92 (66%) | 0.010 |
| Shoulder | 12/19 (63%) | 8/20 (40%) | 0.137 |
| Elbow | 10/11 (91%) | 7/11 (64%) | 0.100 |
| Wrist | 11/14 (79%) | 12/16 (75%) | 0.817 |
| Knee | 32/35 (91%) | 27/33 (82%) | 0.242 |
| Ankle | 11/13 (85%) | 7/12 (58%) | 0.131 |

Cunnington J, Marshall N et al (2010). "A randomized, double-blind, controlled study of ultrasound-guided corticosteroid injection into the joint of patients with inflammatory arthritis." Arthritis Rheum. 62(7):1862-9

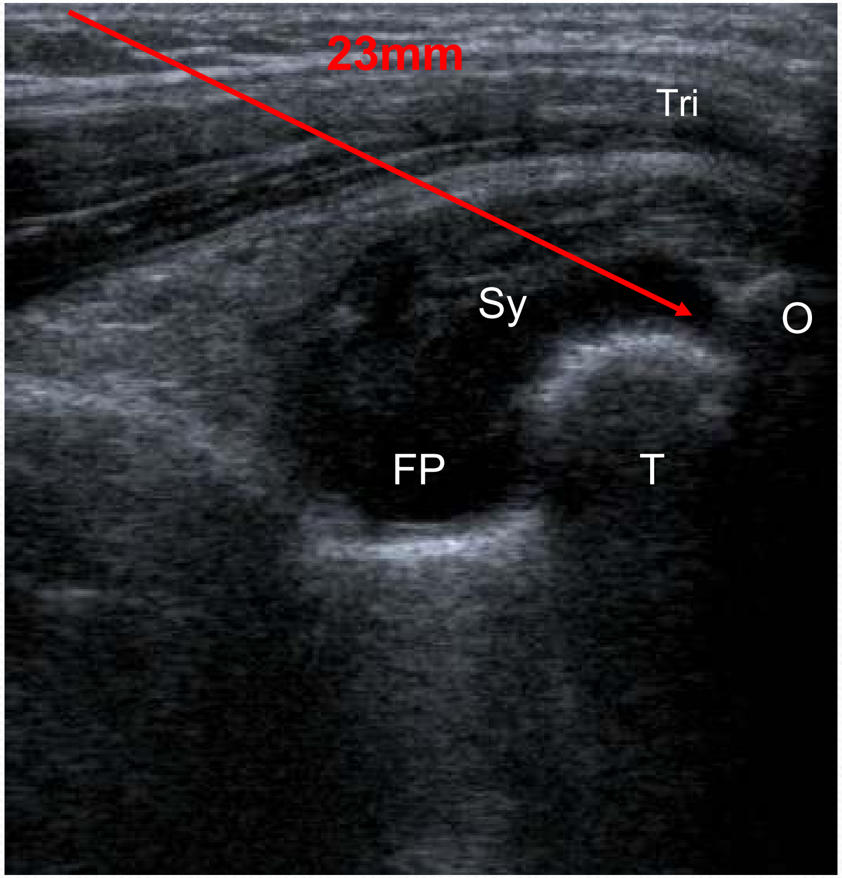
# Guiding  Needles with Ultrasound

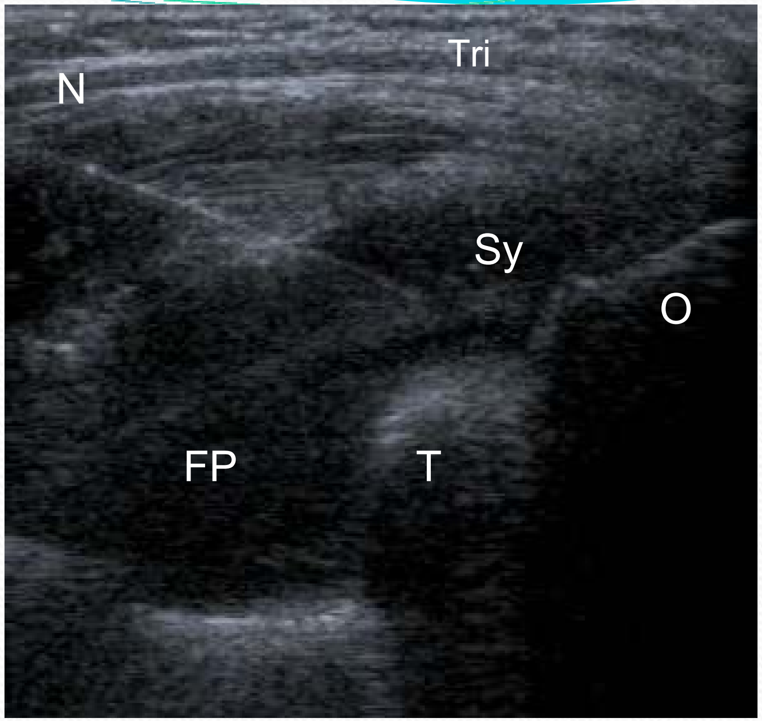




# Methods of guidance

- Direct method - elbow
  - US to locate area to be injected
  - Skin is marked and depth of field measured





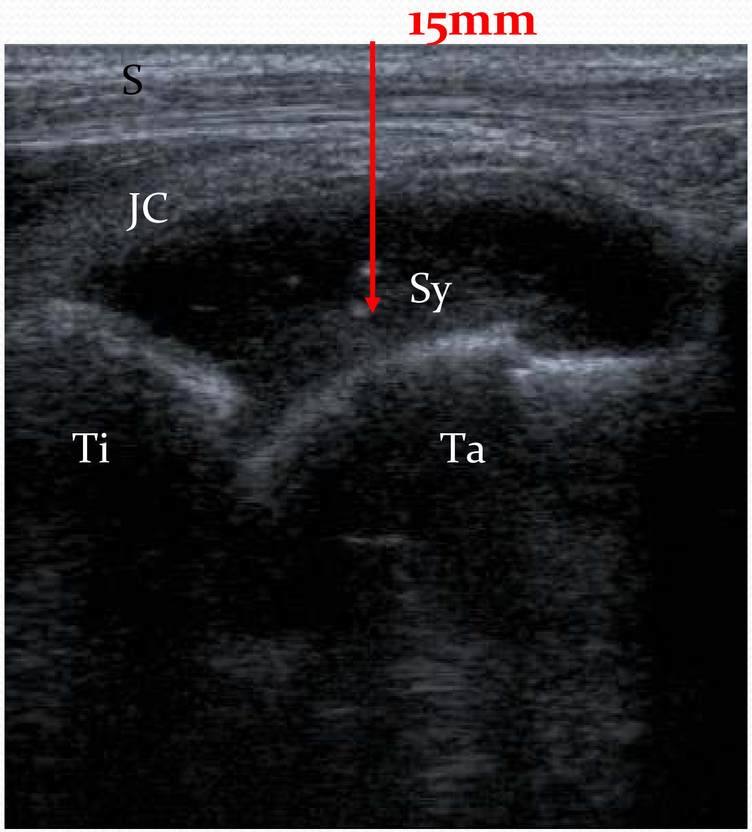

- Injection is done using direct visualisation in real time to ensure accurate placement

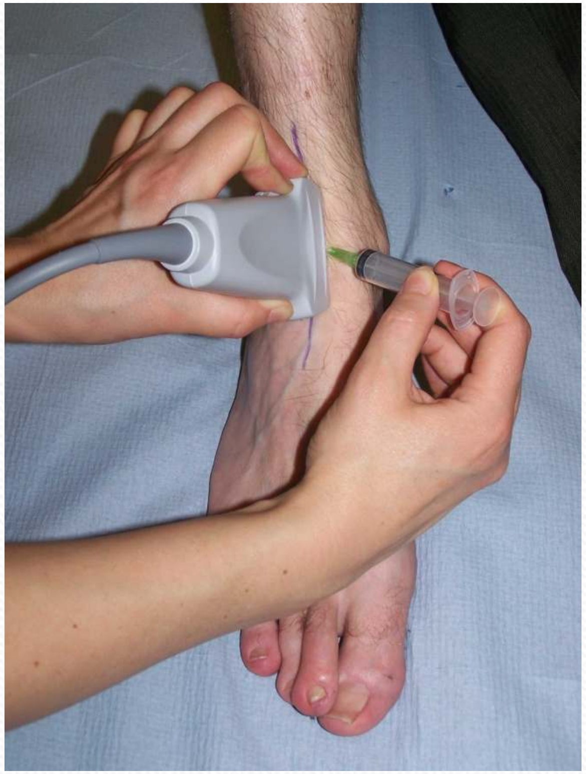
N = needle with tip in joint space, Tri = triceps muscle insertion, FP = olecranon fossa fat pad, T = trochlear, O = olecranon, Sy = synovitis

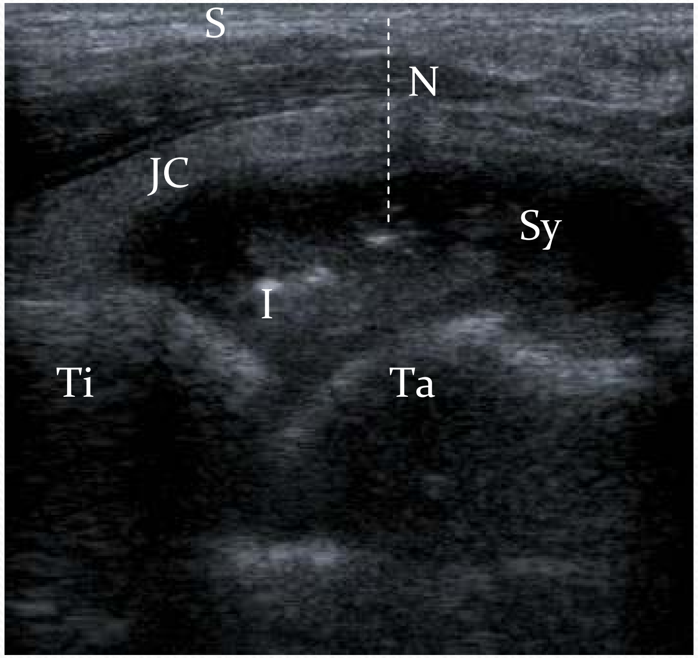
# Elbow injection

# Methods of guidance

- Indirect method - ankle
  - US to locate area to be injected
  - Skin is marked and depth of field measured







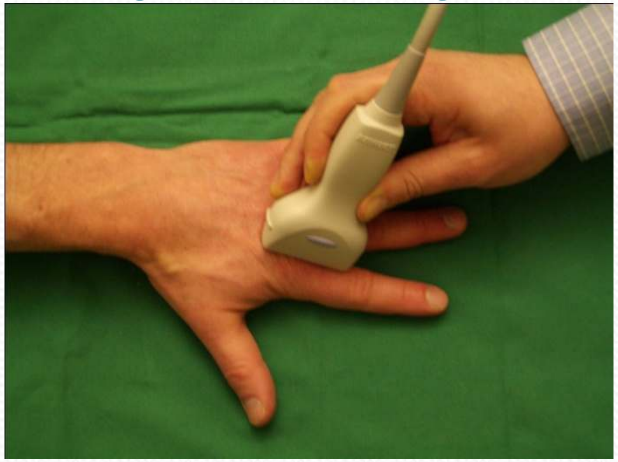

- Injection is the done using the markings for guidance (no direct visualisation)

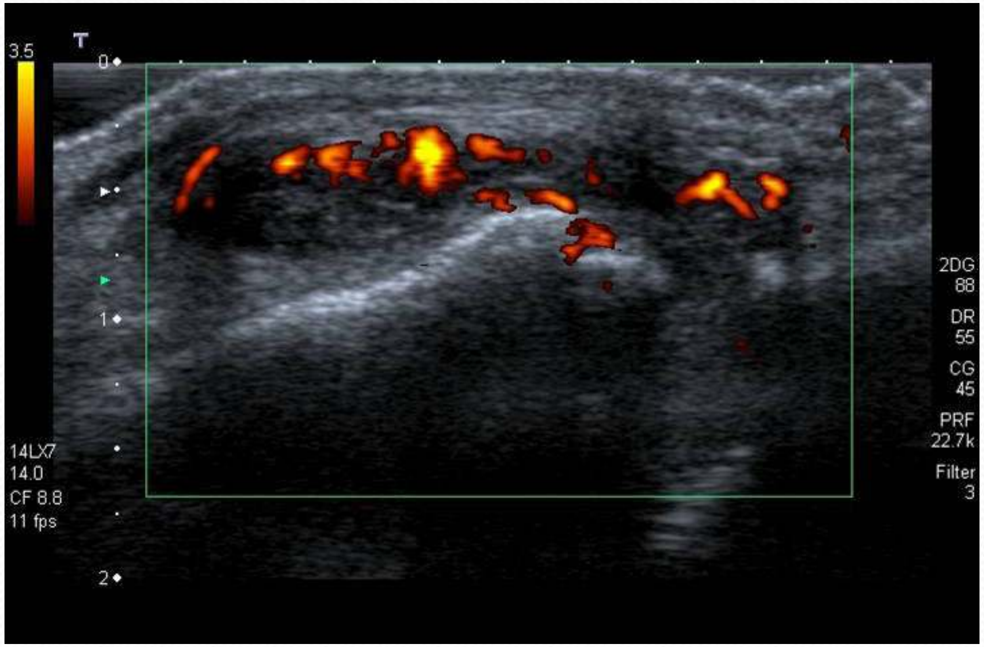
S = skin and subcutaneous fat, JC = thickened joint capsule, Sy = synovitis and effusion, I = injectate seen, Ti = tibia, Ta = talar, N = needle approach.

# Tibiotalar injection

- Both of these methods have been shown to be feasible and safe for all joint and soft tissue injections
  - Indirect – ankle, hip, small joints
  - Direct – all others depending on size of probe and area
- Inject air or an air/steroid/saline mix into the joint capsule - clearly visualised by US
  - Particularly useful for hip (Qvistgaard, Kristoffersen et al. 2001; Koski, Hermunen et al. 2006).

# MCP joint injection






# MCPj injection

# Subacromial space injection


# SAB injection

# Pre patella bursa

# Pre patella bursal injection

# Tendon sheath injection

# Acknowledgements

- Dr Phil Platt
- Dr David Kane