US and US Elastography of the Musculoskeletal System

Upper and Lower Limb

Elena Drakonaki  MD, PhD, PostDoc
Consultant MSK Radiologist
Independent Practice Heraklion, Greece
Radcliff NHS Trust, Oxford, UK
MSK imaging

Xray-fluoroscopy
CT
MR

Ultrasonography

Advantages
Real time multiplanar imaging
Dynamic examination
Contralateral comparison
No radiation
Cheap, practical & widely available
Soft tissue & joint intervention

Limitations
Long learning curve
Bone marrow & Cartilage
Intraarticular structures
What makes US so special?

Allows clinical examination imaging & intervention
High Resolution US
A new generation of US scanners

Probes
- High resolution
- High frequency (10-18 MHz)
- Ergonomic probes
- 3D/4D probes

High spatial resolution
- Compounding
- Speckle reducing algorithms
- Harmonics
- Sensitive power/colour Doppler

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New techniques
Elastography

Clinical applications in MSK:
Achilles
Plantar fascia
Epicondylitis
Muscle
Small tendons
Rotator cuff

EFSUMB Guidelines and Recommendations on the Clinical Use of Ultrasound Elastography. Part 2: Clinical Applications
New techniques
Fusion imaging: a new dimension

St Lukes radiology team
Oxford UK
US-guided MSK intervention

Spine Intervention
Injection into SI Joint

Hard to visualise with US
High Resolution MSK US
Clinical Indications

Standard Radiographs + High resolution US

Bone and Joint Tendon, Nerve, Ligament, Synovium

First line imaging tool
Alternative or supplementary to MR

# High Resolution MSK US Accuracy

<table>
<thead>
<tr>
<th></th>
<th>US</th>
<th>Clinical opinion*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid masses</td>
<td>82.1%</td>
<td>64.2%</td>
</tr>
<tr>
<td>Cystic masses</td>
<td>100%</td>
<td>86.1%</td>
</tr>
<tr>
<td>Tendon disorders</td>
<td>86.5%</td>
<td>68.7%</td>
</tr>
<tr>
<td>Nerve disorders</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Synovitis</td>
<td>100%</td>
<td>25%</td>
</tr>
<tr>
<td>OA, Fractures</td>
<td>100%</td>
<td>33.3%</td>
</tr>
<tr>
<td>Foreign Body</td>
<td>100%</td>
<td>83.3%</td>
</tr>
<tr>
<td>No abnormality</td>
<td>84.6%</td>
<td>15.4%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>164/178 (92.1%)</strong></td>
<td><strong>126/178 (70.8%)</strong></td>
</tr>
</tbody>
</table>

*Reference centre for upper limb disorders

Allen GM, Drakonaki EE et al.  
## High Resolution MSK US

### Accuracy

<table>
<thead>
<tr>
<th>Condition</th>
<th>US</th>
<th>MR</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epicondylitis</td>
<td>67-100%</td>
<td>83-100%</td>
<td>Miller et al, J Clin Ultrasound 2002</td>
</tr>
<tr>
<td>Partial RC tears</td>
<td>90%</td>
<td>90%</td>
<td>Vlychou et al, Acta radiol 2009</td>
</tr>
<tr>
<td>*Partial RC tears</td>
<td>89%</td>
<td>67%</td>
<td>Rutten et al, Eur Radiol 2010</td>
</tr>
<tr>
<td>Full-thick RC tears</td>
<td>95%</td>
<td>100%</td>
<td>Rutten et al, Eur Radiol 2010</td>
</tr>
<tr>
<td>*Achilles tendinopathy</td>
<td>100%</td>
<td>62.5%</td>
<td>Kamel et al, J Rheumatol 2003</td>
</tr>
<tr>
<td>RA changes hand/wrist</td>
<td>80-96%</td>
<td>100%</td>
<td>Skladarek et al, Arthritis Rheum 2004</td>
</tr>
<tr>
<td>ATFL injury</td>
<td>91%</td>
<td>97%</td>
<td>Oae et al, Skeletal radiol 2010</td>
</tr>
<tr>
<td>ATFL injury</td>
<td>95.2%</td>
<td></td>
<td>Hua et al, Acta radiol 2012</td>
</tr>
</tbody>
</table>

“When an expert is available, US can be used; otherwise, MRI should be performed”

Chang et al, Clin Imaging 2002
US-guided MSK intervention

**Diagnostic Procedures**

- Contrast Media injection for MR/CT Arthrography
- Diagnostic Injections for Pain management
- Biopsy-Aspiration

**Therapeutic Procedures**

**TENDONS:**
- Prolotherapy, High volume injections, Debrisement of Achilles
- Dry needling for tendinosis (plantar fascia, lateral epicondylitis, patella)
- Barbotage-Lavage of calcium in rotator cuff
- Peritendinous Injection of substances *(hyaluronic, steroid, anesthetic, PRP, sclerosing factors)*

**JOINTS:**
- Intraarticular Injection of substances *(hyaluronic, steroid, anesthetic)*
- Hydrodilation for adhesive capsulitis
- Synovial Biopsy for inflammatory arthritis

**NERVES:**
- Peripheral Nerve Block

**MUSCLES:**
- Aspiration of Hematomas
- Intramuscular Injection of substances *(butilin toxin, PRP)*

**LIGAMENTS:**
- Injection of substance *(PRP, hyaluronic acid)*

**SOFT TISSUE:**
- Symplysiolisis at subacromial bursa
- FB removal
- Treatment of Mortons neuromas
- Trigger finger Percutaneous Release
- Treatment of ganglia/bursitis/Bakers cysts
US and US Elastography in MSK: 
Upper and Lower Limb

Common Indications: mainstream clinical practice

Diagnosis & Intervention
TENDONS
Achilles Tendinosis: Doppler
TENDONS
Achilles Tendinosis: Elastography

predict histopathologic degeneration more sensitively than US

Klauser et al, Radiology 2013

TENDONS
Achilles Tendinosis: Therapy

Dry needling
PRP-autologous blood injections
Sclerosing/dextrose injections
Paratendon stripping/Brisement

High volume Injections

20-40 mls saline
Anaesthetic
No steroid

OUTCOME (4w)
Reduce neovascularization
Reduce tendon thickness
Improve symptoms

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High Res US in MSK

Available online at www.sciencedirect.com

The short-term effects of high volume image guided injections in resistant non-insertional Achilles tendinopathy
Joel Humphrey, Otto Chan, Tom Crisp, Nat Padhiar, Dylan Morrissey, Richard Twycross-Lewis, John King, Nicola Mattuli
TENDONS
Patella Tendinosis: Doppler-Elastography

Distal tendinopathy

Proximal tendinopathy

4 w after treatment
TENDONS

Patella Tendinosis: Therapy

**Dry Needling**
(to stimulate healing response by platelet cascade)

+/- steroid, PRP, Tenocyte, sclerosing injections

Sclerosing injections: effective at 2/3 at 44w

Dry needling: effective for mid tendon but not for insertional tendinopathy

Testa V et al, Med Sci sports Exces 1999
Hoksrud et al, Am J Sport Med 2011
High Res US in MSK

TENDONS
Plantar Fasciitis: B-Mode, Elastography

Dry needling + steroid
Reduce pain and swelling 4 weeks

McNally et al, Semin MSK Radiol 2010

Elastography: increases diagnostic performance assists in cases of inconclusive US findings.

Sconfienza L et al, Radiology 2013
TENDONS
Epicondylitis: Doppler-Elastography

Better accuracy than US for tendinitis (94% vs 91%) and detection of ligament damage (26% vs 21%)

De Zordo et al, AJR 2009

Dry needling
+/-
Steroid or PRP

Stenhous et al, Skeletal Radiol 2013
TENDONS
Rotator Cuff lesions

- Rim rent tear
- Intrasubstance partial tear-cyst
- Full thickness tear supraspinatus
- Complete tear
High Res US in MSK

TENDONS
Rotator Cuff

impingement

bursitis

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Calcific tendinitis (HADD)

Type III eroding bone

Type I

Impingement under CAL

Impingement under Acromion
TENDONS
Rotator Cuff Barbotage

Double needle technique

Hydroxyapatite deposition disease (HADD)

TABLE 5
Comparative Mean SPADI Scores in 30 Symptomatic Shoulders

<table>
<thead>
<tr>
<th>Subcategory</th>
<th>Before</th>
<th>After</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>36.1</td>
<td>25.1</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Disability</td>
<td>42.2</td>
<td>32.1</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Total</td>
<td>39.2</td>
<td>28.6</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Note.—P value was determined by using the paired t test.

Sconfienza et al, Skeletal Radiol 2013

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High Res US in MSK

TENDONS

Small tendon disease

De Quervain’s disease

FCR tenosynovitis

Tendinopathy

Detachment of FDP-empty sheath- fracture
TENDONS
Diagnose and Treat small tendon degeneration

Steroid, hyalouronic
JOINTS

Diagnosis

Knee effusion & synovitis

2d MCP synovitis-Rheumatoid arthritis
JOINTS
Pediatric Joints

Periosteal sleeve avulsion, Tibia

5y old, JIA, ankle

5y old, JIA, knee

5y old, JIA, elbow
US-guided MSK intervention

LARGE JOINTS
Intraarticular Injections

Knee joint

Hip joint
US-guided MSK intervention

LARGE JOINTS

Hydrodilatation for Frozen Shoulder (capsulitis)

20-40 mls saline \(+/-\) steroid

Or

Hyaluronic acid

Break the adhesions and distend/break the capsule

Improvement in ROM, function, pain (2 y)

Park et al, Arch Phys Med Rehabil 2013
High Res US in MSK

SMALL JOINTS
Intraarticular injections

1st MCP
High Res US in MSK

NERVES

- Similar accuracy
- Pre-surgical planning (cause, anatomy)
- Patient friendly
- Follow up examinations
- Post surgical complications

Normal median nerve

CTS

Rheumatology 2004;43:887–895
Advance Access publication 20 April 2004

Ultrasonography versus nerve conduction study in patients with carpal tunnel syndrome: substantive or complementary tests?

Y. M. El Miedany, S. A. Aty¹ and S. Ashour²
The cause of CTS

**FT Tenosynovitis**

**Median Nerve Tumor**

**FT Tendinopathy**

**Thickened Retinaculum**
Sciatic nerve selective fascicular injury after THR

Posterior Interosseous Nerve injury caused by metal implants
NERVES
Peripheral Nerve Blocks

Carpal tunnel injection

Lateral Femoral Cutaneous nerve block

Tagliafico et al, JUM 2011
NERVES
Morton’s Neuromas

**Ultrasound-guided interdigital neuroma injections: short-term clinical outcomes after a single percutaneous injection—preliminary results.**

Sofka CM, Adler RS, Ciavarra GA, Pavlov H.

Department of Radiology and Imaging, Hospital for Special Surgery, New York, NY 10021, USA. sofka@hss.edu
MUSCLE Injury

First US

1 month later
MUSCLE Injury

- Myossitis ossificans
- Fibrosis
- Muscle hernia
**MUSCLE**

Myopathic/ Dystrophic Muscle

- Botox injection in spastic muscle
- Dry needling in trigger points
- Biopsy myopathic muscle

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LIGAMENTS
Ankle sprains

19y, Wimbledon tennis player, grade III ATFL injury
High Res US in MSK

SOFT TISSUE
Ganglia, Bursae

Greater trochanteric bursa injection

Tibiofibular joint ganglion aspiration

Semimembranosus bursitis
SOFT TISSUE
Ganglia, Bursae

Identify the subacromial bursa to inject

Retrocalcaneal bursa

Drakonaki et al, BJR 2012
Bone lesions
Fractures, periosteal reaction, erosions, sclerosis

Juxtracortical chondroma - phalanx

34y long distance runner, metatarsal pain, X-ray negative

Kienbock’s malacia
High Res US in MSK

Summary

- Diagnostic tool
- US guided intervention
- Follow up after treatment

Supervised Training & Experience
High Resolution Equipment
Clinical Correlation

Be enthusiastic about US
Thank you

Allen GM, Drakonaki EE, Maybury M, Wilson DJ.

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G. Bodner, Vienna Austria