

# MRI or MSK Ultrasound: Which Do I Choose?



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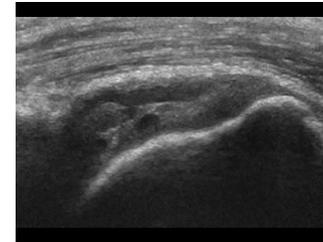
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# Introduction

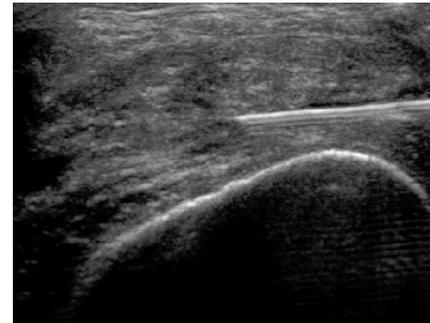


- What is ultrasound?
  - Use of high frequency sound waves (3-17 M Hz) to image soft tissues and bony structures in the body for the purposes of diagnosing pathology or guiding interventional procedures
- Interventional US usage
  - Injections,
  - tenotomy
  - aspiration / lavage
  - Biopsy
- Diagnostic US usage
  - Tendon (tendinopathy, tears)
  - Muscle (Strains / contusions)
  - Nerve (entrapment)
  - Ligament (sprains)
  - Joint (effusions)
  - Dynamic testing



# Benefits

- Ability to image in real-time
  - Dynamic Testing
- Interactive and allows patient feedback
- Not very affected by metal artifacts
- Safe with pacemaker
- No radiation
- Opposite limb can serve as a control for comparison
- High resolution
- Real-time guidance for procedures
- Portable
- Relatively inexpensive



# Limitations

- Limited field of view
- Limited penetration
  - Obese patients
- Inability to penetrate bone
- Operator dependent
  - Anatomical knowledge, scanning skills, interpretation
- Equipment
  - Cost and quality variable

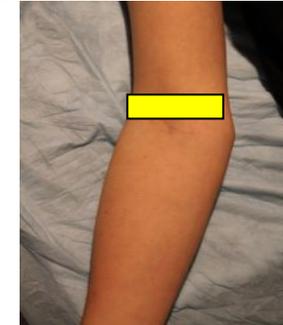
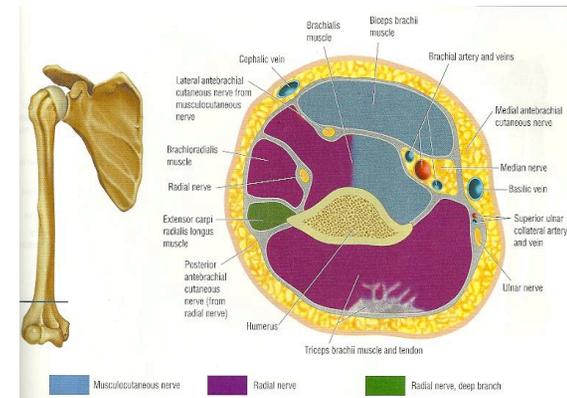


# MSK US vs MRI

- MSK US can provide results that are comparable or at times superior to those of MRI for MSK symptoms
- MRI generally favored over MSK US in USA
- Underused in the USA despite diagnostic accuracy and cost advantages



# Home Base Anterior Elbow



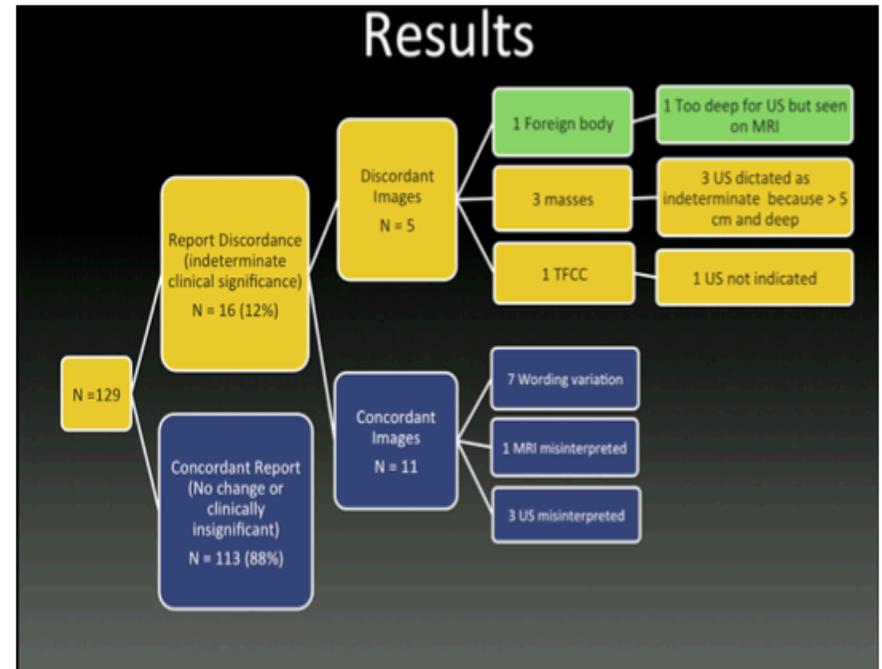
# Comparison of MRI Findings After Musculoskeletal Ultrasound: An Opportunity to Reduce Redundant Imaging

Lulu He, DO, Patricia Delzell, MD, Jean Schils, MD

Table 1. Concordant and discordant categorization of ultrasound and MRI reports by each radiologist

|               | Concordant | Discordant | Total Reports Reviewed |
|---------------|------------|------------|------------------------|
| Radiologist 1 | 113        | 16         | 129                    |
| Radiologist 2 | 115        | 14         | 129                    |

“In light of these results, we suggest that an appropriately ordered MSK US can serve as a definitive advanced imaging modality, limiting the need for additional MRI.”



# Musculoskeletal Imaging: Medicare Use, Costs, and Potential for Cost Substitution

Laurence Parker, PhD<sup>a</sup>, Levon N. Nazarian, MD<sup>a</sup>, John A. Carrino, MD, MPH<sup>b</sup>,  
William B. Morrison, MD<sup>a</sup>, Gregory Grimaldi, MD<sup>c</sup>, Andrea J. Frangos, MS<sup>a</sup>,  
David C. Levin, MD<sup>a</sup>, Vijay M. Rao, MD<sup>a</sup>

- 3,621 MRI for MSK symptoms reviewed
- 45.4% of primary diagnoses could have been made with MSK US
- Extrapolated savings of \$6.9 billion from 2006-2020
- Appropriate use of MSK US in place of MRI does not compromise diagnostic accuracy and can lead to huge cost savings



# Why is MSK US Not More Widely Used?

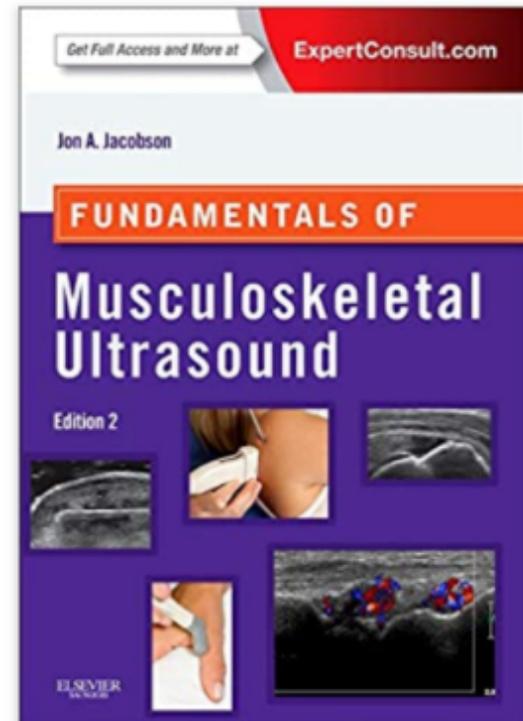
- Operator dependent
- Larger learning curve
- MRI is better “shotgun” approach with non specific symptoms
- Prescribing physicians habits and unfamiliarity with MSK US
- US brings in less revenue than MRI
  - reimbursements
  - physician time to scan and interpret



# Musculoskeletal Ultrasound and MRI: Which Do I Choose?

**Jon A. Jacobson, M.D.<sup>1</sup>**

SEMINARS IN MUSCULOSKELETAL RADIOLOGY/VOLUME 9, NUMBER 2 2005



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# From Jacobson 2005

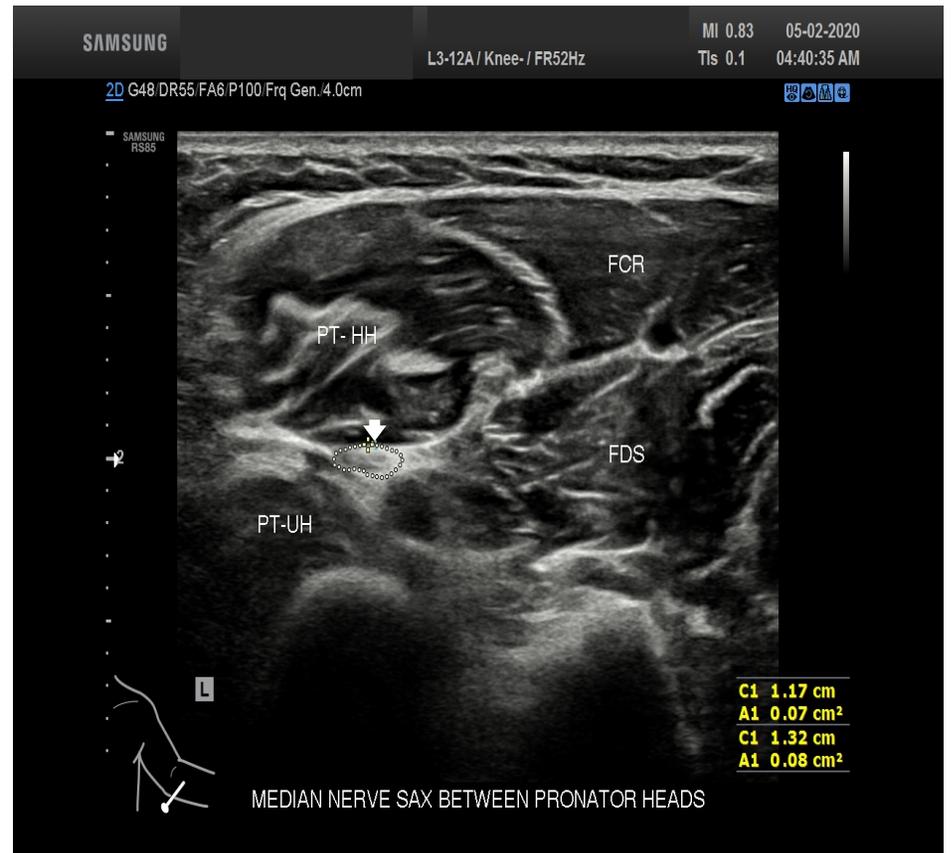
- **MSK US is the test of choice for:**
  - Soft Tissue Foreign Bodies
  - Peripheral Nerves/Nerve Entrapments
  - Dynamic Imaging: Tendon or Nerve Subluxation/Dislocation, Muscle Hernia, Partial vs Full Thickness Tendon or Ligament Tear (eg Achilles)
  - Evaluation of Soft Tissues Adjacent to Hardware
  - Transection Neuromas
  - Peripheral Nerve Sheath Tumors



# Absolute Advantages

- Resolution
- Ability to quickly image over an entire extremity (nerve tracking)
- Image around hardware without artifact
- Dynamic imaging







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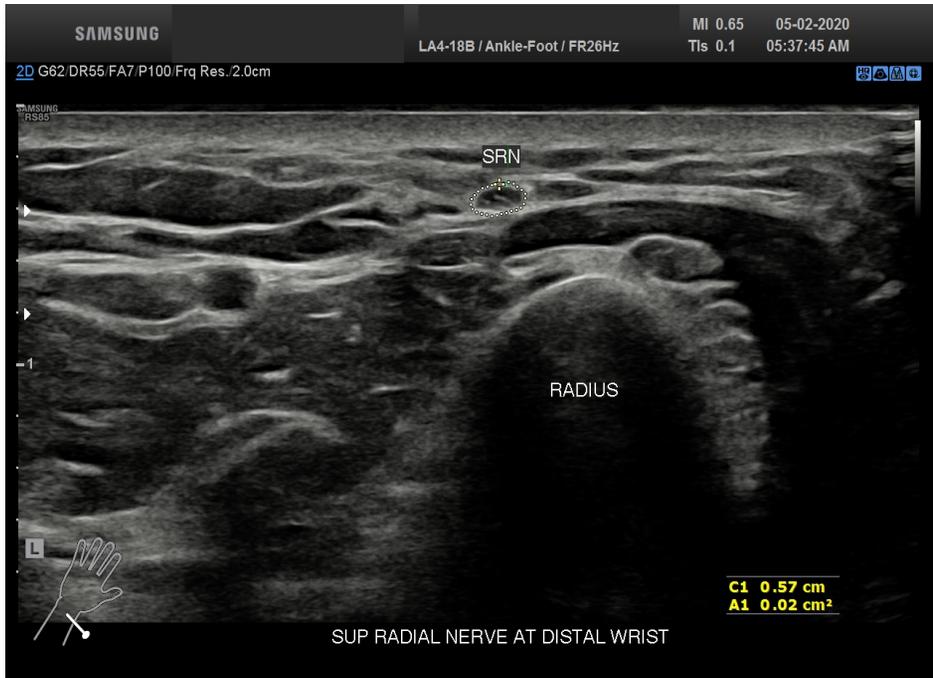
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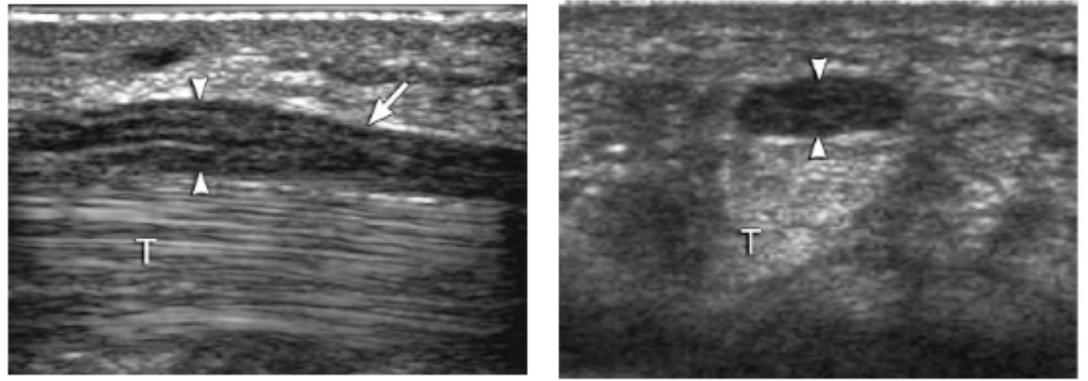
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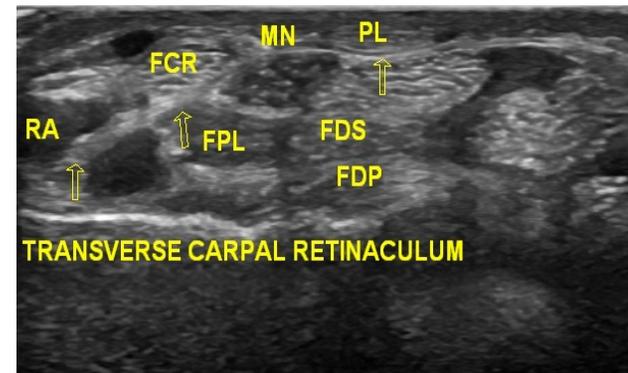


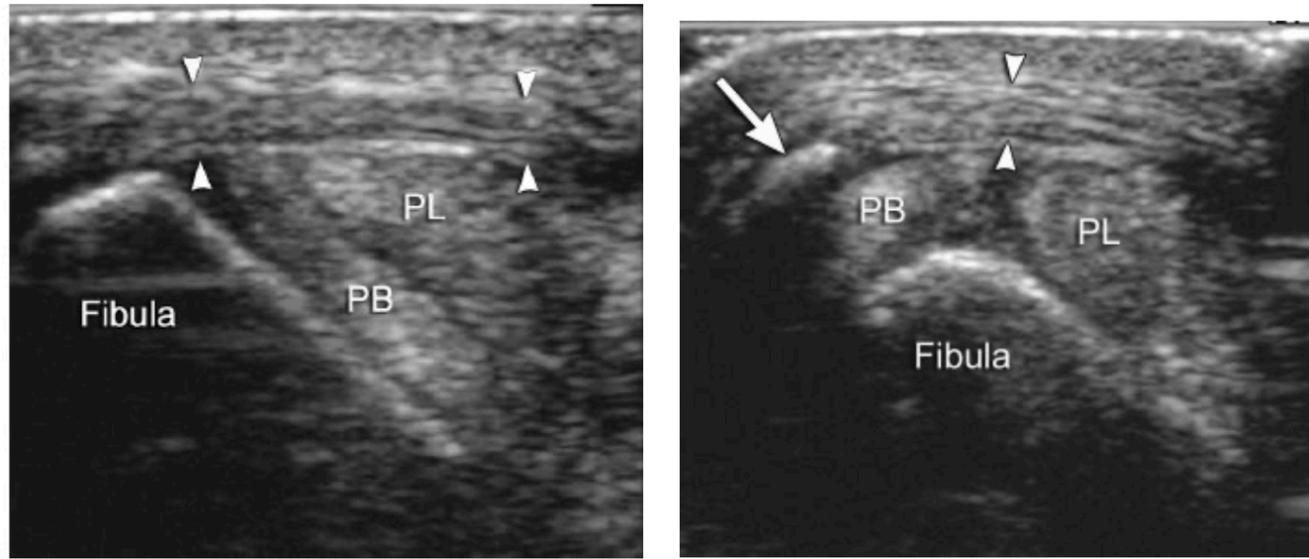


**Figure 2** Carpal tunnel syndrome. Sonograms longitudinal (A) and transverse (B) to the median nerve at the wrist shows hypoechoic swelling of the median nerve (arrowheads) just proximal to the carpal tunnel and flattening more distally (arrow). Note hyperechoic and fibrillar echotexture of normal flexor tendon (T).

## Median Nerve At Wrist

- Median Nerve at Lunate
- Probe place SA over distal wrist crease
- MN enters carpal tunnel with 9 tendons, FPL, FDS and FDP
- Palmaris Longus if present is superficial to MN and FCR lies outside of CT just radial to MN



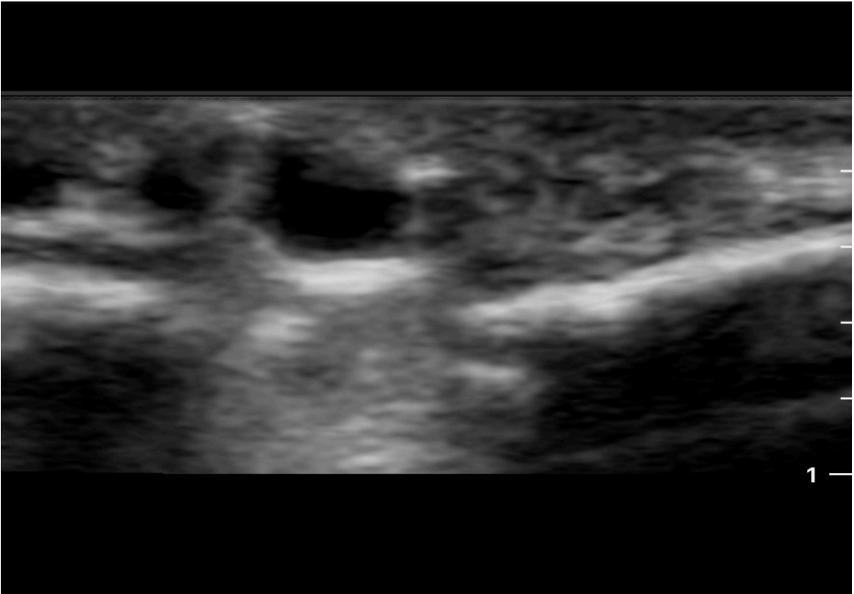
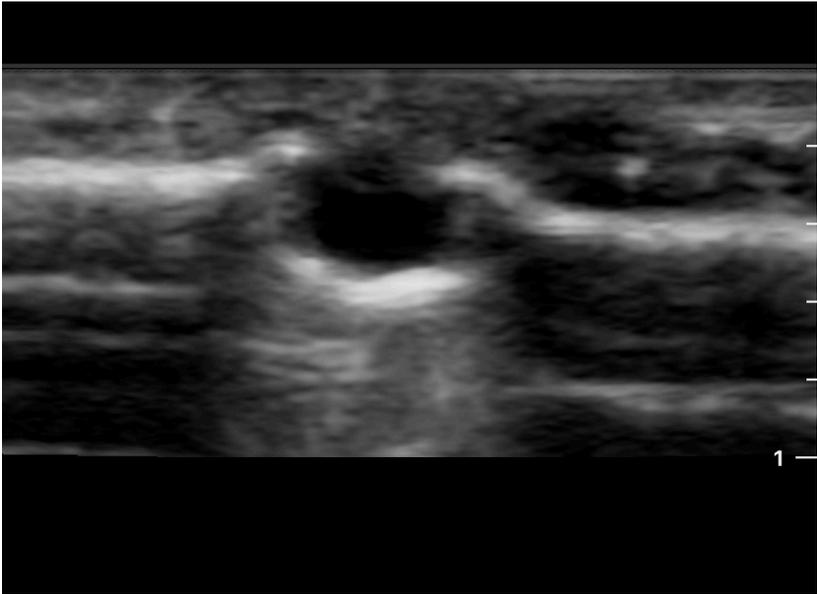


**Figure 6** Peroneus brevis tendon dislocation and superior peroneal retinaculum avulsion. Sonogram transverse to the distal peroneal tendons with the ankle in neutral position (A) shows normal location of the peroneus brevis (PB) and peroneus longus (PL) tendons. Note thickened superior peroneal retinaculum at the fibula (arrowheads). In ankle dorsiflexion and eversion (B), the peroneus brevis tendon dislocates anteriorly and laterally between the fibula and avulsion fragment (arrow) at the superior peroneal retinaculum attachment.

# Peroneus Brevis Tear with Snapping tendon



# Distal Fibula Hardware



# From Jacobson 2005

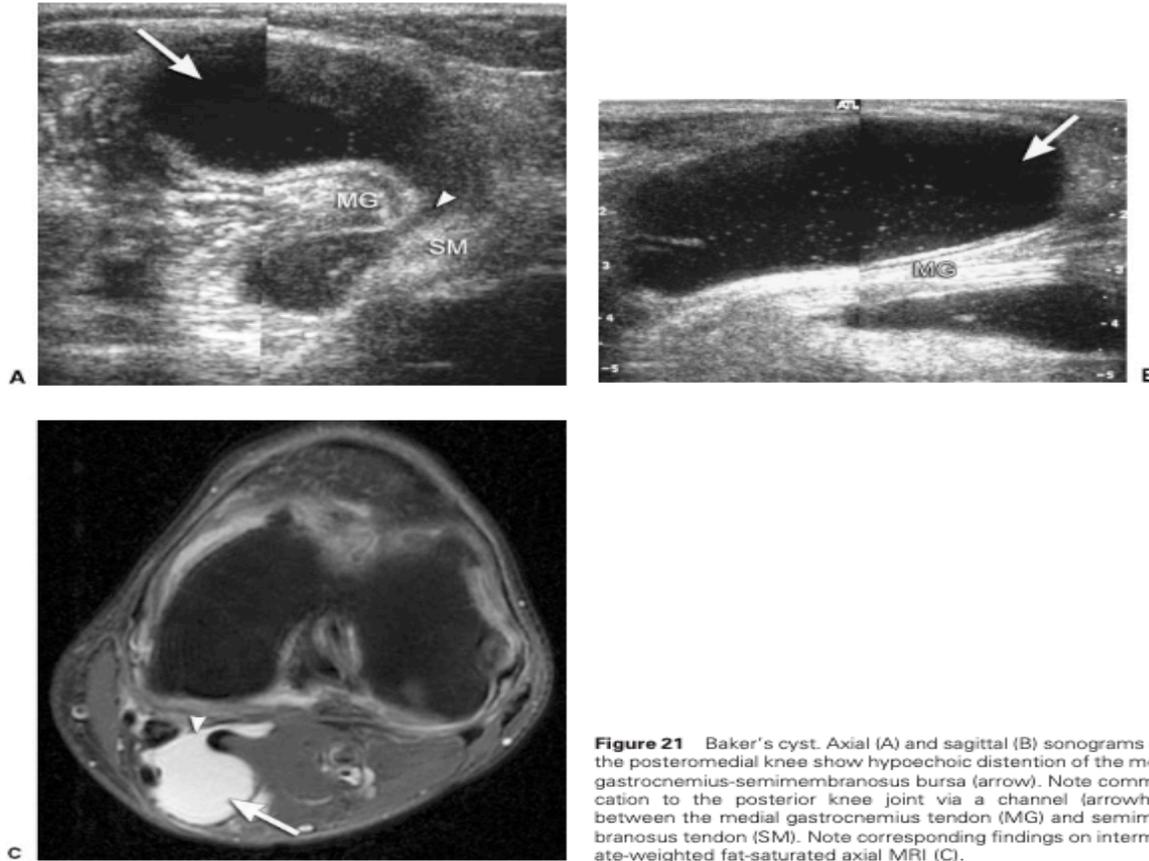
- **US and MRI both viable alternatives:**
  - Tendon Abnormality
  - Ligament Abnormality
  - Soft Tissue Fluid Collection
  - Probable Benign Cyst: Baker's Cyst, Wrist Ganglion Cyst (US preferred)
  
- **\*Make these decisions based on individual circumstances:**
  - Availability of US or MRI, availability of trained sonographer
  - Cost
  - Patient goals



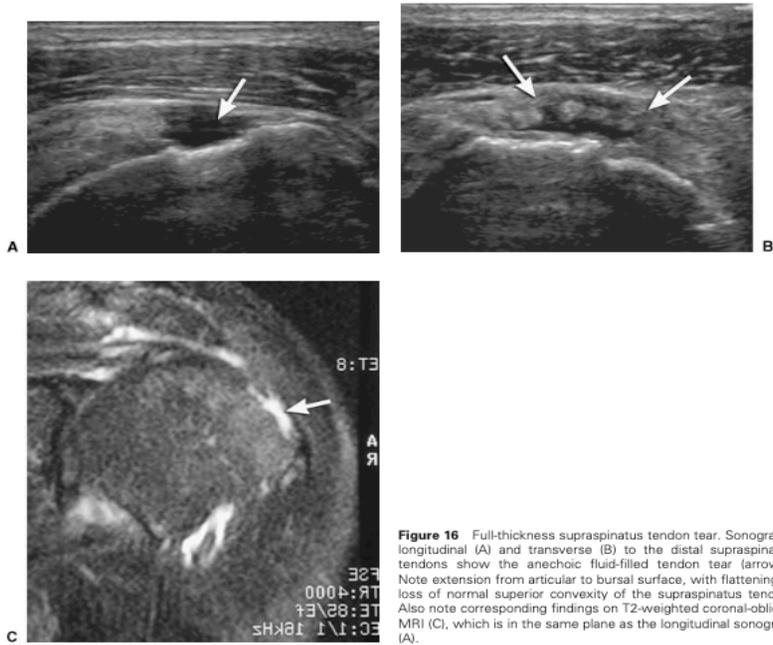
# Advantages to MRI

- Can globally assess a joint
- Seeing tendon, ligament, cartilage, bone
- Better if suspecting more than a specific focal problem
- Intra-articular pathology
- Deep structures
- Infection (osteomyelitis)
- Concern for malignant mass

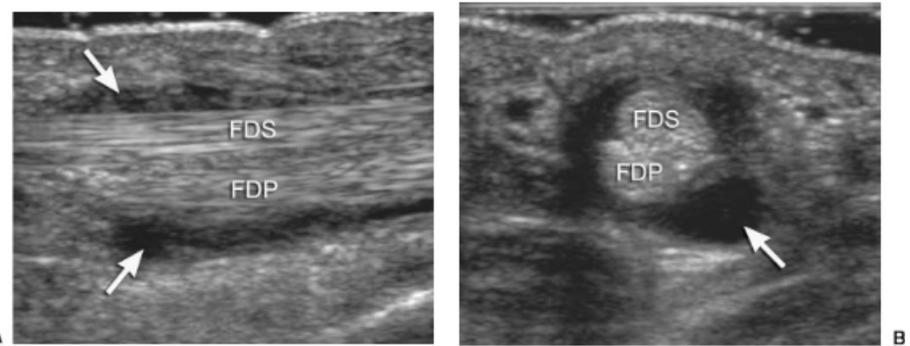




**Figure 21** Baker's cyst. Axial (A) and sagittal (B) sonograms over the posteromedial knee show hypoechoic distention of the medial gastrocnemius-semimembranosus bursa (arrow). Note communication to the posterior knee joint via a channel (arrowhead) between the medial gastrocnemius tendon (MG) and semimembranosus tendon (SM). Note corresponding findings on intermediate-weighted fat-saturated axial MRI (C).



**Figure 16** Full-thickness supraspinatus tendon tear. Sonograms longitudinal (A) and transverse (B) to the distal supraspinatus tendons show the anechoic fluid-filled tendon tear (arrows). Note extension from articular to bursal surface, with flattening or loss of normal superior convexity of the supraspinatus tendon. Also note corresponding findings on T2-weighted coronal-oblique MRI (C), which is in the same plane as the longitudinal sonogram (A).



**Figure 12** Tenosynovitis of flexor digitorum superficialis and profundus tendons. Sonograms longitudinal (A) and transverse (B) to flexor digitorum superficialis (FDS) and flexor digitorum profundus (FDP) tendons show surrounding anechoic fluid (arrows).



## Musculoskeletal Ultrasound: Focused Impact on MRI

Jon A. Jacobson<sup>1</sup>

- **MRI Favored:**
  - Intra-articular structures
  - Articular cartilage
  - Bone beyond the cortex

**TABLE 1: Accuracy of Ultrasound Versus MRI**

| Imaging Diagnosis                  | Accuracy (%) [reference no.] |            |
|------------------------------------|------------------------------|------------|
|                                    | Ultrasound                   | MRI        |
| Rotator cuff tears                 |                              |            |
| Full thickness                     | 96 [10]                      | 92–97 [12] |
| Partial thickness                  | 94 [11]                      | 92 [13]    |
| Ankle tendon tears                 | 94 [15]                      |            |
| Peroneal tendon                    | 90 [16]                      |            |
| Achilles tendon                    | 92 [17]                      |            |
| Tibialis posterior tendon          |                              | 96 [18]    |
| Anterior talofibular ligament tear | 100 [20]                     | 94 [21]    |



## Why is it difficult to compare accuracy of MSK US vs MRI?

- Individual experience/training
- Variable equipment
- Variable gold standard
- Variable scanning protocols



REVIEW

Open Access



# The accuracy of diagnostic ultrasound imaging for musculoskeletal soft tissue pathology of the extremities: a comprehensive review of the literature

Rogan E A Henderson<sup>1,4\*</sup>, Bruce F. Walker<sup>2</sup> and Kenneth J. Young<sup>3</sup>

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**Table 5** Accuracy Summary – Musculoskeletal Clinical Indications for the use of Diagnostic Ultrasound for the Shoulder Region

| Target Condition                     | Recommendation |
|--------------------------------------|----------------|
| Tendons and soft tissue              | Grade          |
| Calcific Tendinitis                  | 3              |
| Full thickness rotator cuff tears    | 3              |
| LHB: dislocation                     | 3              |
| LHB: full thickness tears            | 3              |
| LHB: tendinitis                      | 3              |
| Rotator cuff tendinopathy            | 3              |
| Subacromial bursitis                 | 3              |
| Partial thickness rotator cuff tears | 2              |
| Rotator cuff atrophy                 | 2              |
| Subacromial Impingement              | 2              |
| Adhesive capsulitis                  | Unknown        |
| Deltoid tears                        | Unknown        |
| LHB: partial thickness tears         | Unknown        |
| Pectoralis tears                     | Unknown        |

LHB long head of biceps

Unknown: No diagnostic accuracy studies found

Grade 0: Not indicated

Grade 1: Conflicting evidence (test results should be interpreted with caution)

Grade 2: Equivalent to other imaging techniques (other techniques might provide significant information)

Grade 3: First choice technique (other techniques rarely provide more information)

**Table 9** Accuracy Summary – Musculoskeletal Clinical Indications for the use of Diagnostic Ultrasound for the Elbow Region

| Target Condition             | Recommendation |
|------------------------------|----------------|
| Tendons and soft tissue      |                |
| Medial epicondylalgia        | 3              |
| Lateral epicondylalgia       | 3              |
| BTI: full thickness tears    | 2              |
| BTI: partial thickness tears | Unknown        |
| Bursitis                     | Unknown        |
| LCL and MCL injury           | Unknown        |
| Triceps tendon injury        | Unknown        |
| Nerves                       |                |
| Cubital tunnel syndrome      | 2              |
| Median nerve entrapment      | Unknown        |
| Radial nerve compression     | Unknown        |
| Ulnar nerve subluxation      | Unknown        |

BTI biceps tendon injury; LCL lateral collateral ligament; MCL medial collateral ligament

Unknown: No diagnostic accuracy studies found

Grade 0: Not indicated

Grade 1: Conflicting evidence (test results should be interpreted with caution)

Grade 2: Equivalent to other imaging techniques (other techniques might provide significant information)

Grade 3: First choice technique (other techniques rarely provide more information)

**Table 13** Accuracy Summary – Musculoskeletal Clinical Indications for the use of Diagnostic Ultrasound for the Wrist/Hand Region

| Target Condition                          | Recommendation |
|---|----------------|
| Tendons and soft tissue                   | Grade          |
| de Quervains                              | 3              |
| Ganglion cyst                             | 3              |
| Lunotriquetral ligament injury            | 2              |
| Ulnar collateral ligament (displaced)     | 2              |
| Ulnar collateral ligament (non-displaced) | 2              |
| Scapholunate ligament injury              | 1              |
| TFCC injury                               | 1              |
| Intersection syndrome                     | Unknown        |
| Rugby/jersey finger                       | Unknown        |
| Trigger finger                            | Unknown        |
| Other tendinopathy                        | Unknown        |
| Nerves                                    |                |
| Carpal tunnel syndrome                    | 2              |
| Guyons canal neuropathy                   | Unknown        |
| Wartenberg syndrome                       | Unknown        |

TFCC triangular fibrocartilage complex

Unknown: No diagnostic accuracy studies found

Grade 0: Not indicated

Grade 1: Conflicting evidence (test results should be interpreted with caution)

Grade 2: Equivalent to other imaging techniques (other techniques might provide significant information)

Grade 3: First choice technique (other techniques rarely provide more information)

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**Table 17** Accuracy Summary – Musculoskeletal Clinical Indications for the use of Diagnostic Ultrasound for the Hip Region

| Target Condition                        | Recommendation |
|---|----------------|
| Tendons and soft tissue                 | Grade          |
| Gluteal tendon tears                    | 3              |
| Trochanteric bursitis                   | 2              |
| Iliopsoas bursitis                      | Unknown        |
| Psoas/hamstring/quadiceps injury        | Unknown        |
| Snapping hip syndrome (extra-articular) | Unknown        |
| Nerves                                  |                |
| Meralgia paresthetica                   | 3              |
| Femoral nerve injury                    | Unknown        |
| Sciatica (causes)                       | Unknown        |

Unknown: No diagnostic accuracy studies found

Grade 0: Not indicated

Grade 1: Conflicting evidence (test results should be interpreted with caution)

Grade 2: Equivalent to other imaging techniques (other techniques might provide significant information)

Grade 3: First choice technique (other techniques rarely provide more information)

**Table 21** Accuracy Summary – Musculoskeletal Clinical Indication for Diagnostic Ultrasound of the Knee Region

| Target Condition                                | Recommendation |
|---|----------------|
| Tendons and soft tissue                         | Grade          |
| Full thickness quadriceps tendon tears          | 3              |
| Patella tendinopathy                            | 3              |
| Baker's Cyst                                    | 2              |
| Medial patella plica syndrome                   | 2              |
| Meniscal cyst                                   | 2              |
| Ganglion cyst                                   | Unknown        |
| Hamstring/ITB/gastrocnemius injury              | Unknown        |
| Hoffa's fat pad syndrome                        | Unknown        |
| Pes anserinus tendinobursitis                   | Unknown        |
| Internal knee derangement and associated injury |                |
| Full ACL tears                                  | 0 <sup>a</sup> |
| Partial ACL tears                               | 0              |
| Medial meniscus tears                           | 0 <sup>a</sup> |
| Lateral meniscus tears                          | 0 <sup>a</sup> |
| LCL injury                                      | 0 <sup>a</sup> |
| Popliteal injury                                | 0 <sup>a</sup> |
| MCL injury                                      | Unknown        |
| PCL injury                                      | Unknown        |
| Nerves  |                |
| Common peroneal neuropathy                      | 2              |

ACL anterior cruciate ligament; PCL posterior cruciate ligament; LCL lateral collateral ligament; MCL medial collateral ligament; ITB iliotibial band  
Unknown: No diagnostic accuracy studies found

Grade 0<sup>a</sup>: Not indicated as a definitive diagnostic tool for ligamentous and meniscal tears of the knee, however may have a role as an on field, point-of-care screening tool

Grade 0: Not indicated

Grade 1: Conflicting evidence (test results should be interpreted with caution)

Grade 2: Equivalent to other imaging techniques (other techniques might provide significant information)

Grade 3: First choice technique (other techniques rarely provide more information)

**Table 25** Accuracy Summary - Musculoskeletal Clinical Indications for Diagnostic Ultrasound Imaging in the Ankle/Foot Region

| Target Condition                      | Recommendation |
|---------------------------------------|----------------|
| Tendons and soft tissue               | Grade          |
| Anterior talofibular ligament injury  | 3              |
| Calcaneofibular ligament injury       | 3              |
| Peroneal tendon tears                 | 3              |
| Peroneal subluxation                  | 3              |
| Posterior tibial tendinopathy         | 3              |
| Plantaris Tendon tears                | 3              |
| Plantar fasciitis                     | 3              |
| Achilles tendinopathy                 | 2              |
| Deltoid ligament injury               | 2              |
| Plantar plate tears                   | 2              |
| Syndesmotic Injury                    | 2              |
| Anterolateral ankle impingement       | 0              |
| Posterior talofibular ligament injury | 0              |
| Bursitis                              | Unknown        |
| Ganglion cyst                         | Unknown        |
| Retinaculum pathology                 | Unknown        |
| Tibialis anterior tendinopathy        | Unknown        |
| Nerves                                |                |
| Morton's neuroma                      | 2              |
| Tarsal tunnel syndrome                | Unknown        |

Unknown: No diagnostic accuracy studies found

Grade 0: Not indicated

Grade 1: Conflicting evidence (test results should be interpreted with caution)

Grade 2: Equivalent to other imaging techniques (other techniques might provide significant information)

Grade 3: First choice technique (other techniques rarely provide more information)

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# Conclusions

- Reviewed applications for MSK US vs MRI
- US great asset to have at bedside
- Benefits vs limitations for use of US
- Surgeons often prefer MRI
- Can't review US images
- Have to build skills, trust and relationships
- When compared to MRI, MSK US has similar accuracies for many applications with proper training, adequate experience, and good equipment



# Questions???

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