MSK Ultrasound Certification and Fellowship Program

Introduction

Musculoskeletal (MSK) ultrasound is a safe, cost effective, and efficient manner of imaging soft-tissue structures. With the advent of the latest handheld ultrasound transducers which meet the necessary criteria sufficient for MSK sonography (≥12 MHz and ≥192 elements) for less than $5,000 USD it is very affordable as well. While ultrasound imaging can rival even MRI, it requires specialized training which has not been available to many healthcare practitioners. Getting started can be intimidating.

The educational program was created by Dr. Brandon Ramakko who has a Bachelor of Science (BS) in Applied Physics, a BS in Human Biology, a Master of Science (MS) in Physics, and a Doctorate of Chiropractic (DC) degree from University of Western States. Dr. Ramakko is Board Certified in Neuromusculoskeletal Medicine (IANM) and has been certified nationally in Musculoskeletal Sonography (RMSK). Dr. Ramakko also holds a teaching certificate in higher education from Harvard University.

In a point-of-care setting you can begin using ultrasound in practice with mere hours of training as you can learn to assess one structure at a time as you build your expertise: you don't need to know how to scan the hip to evaluate the median nerve at the wrist. This certification program is designed to get people started and, should they complete it, provides 60 hours of education and requires 150 scans to be interpreted (20 hours).

Completion of the core program and the certification exam entitles the practitioner to the subspecialty under the IANM: Certified in Neuromusculoskeletal Sonography (CNMS®). This subspecialty is open to doctoral level health professionals: MD, ND, DO, DPT, and DC. Also open to nurse practitioners.

There is an associated Fellowship Program which can be done concurrently with the CNMS program. For the fellowship, you partner with an IANM approved expert. The program lasts approximately one year. Throughout the program 150 performed patient exams must be submitted and discussed with the expert. The common regional exams will be practiced and/or discussed, focusing on ergonomics, completeness, proper image production, etc…

The program is Point-of-Care ultrasound (POCUS) focused. It is understood that not all practitioners will operate with the same scope of practice. Understanding this, some modules are optional, although highly recommended if they are relevant to your practice or needs such as interventional procedures, non-MSK trauma, and in-depth instrumentation. In part, these modules are also to ensure this program meets or exceeds common recommendations. The Alliance of Physician Certification and Advancement (APCA) recommends only 30+ hours of education and experience interpreting/performing 150 ultrasound scans for their competing certification (RMSK); the RMSK test includes interventional procedures which might not be relevant to most chiropractors for example.[1] The program (with additional modules) meets the American Medical

[1] https://www.apca.org/wp-content/uploads/pdf/RMSK-Prerequisites.pdf

Society for Sports Medicine sports ultrasound curriculum's educational requirements[2] and the individual would be well prepared for the APCA RMSK exam. The fellowship criteria was also heavily inspired by the AMSSM recommendations.

The program, including the fellowship, can be done entirely online. In a recent cohort study, online or in-person guidance didn't affect learning outcomes.[3] The program, including the fellowship, can be completed through Dr. Ramakko's website.[4] There are accommodations for those taking other educational programs and/or who have obtained competing certifications. (see advanced standing details and Fellowship details for more information).

The program does have a recommended textbook: Fundamentals of Musculoskeletal Ultrasound (3rd edition) by Jon A. Jacobson M.D. Most of the content of the program can be found in this book.

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[2] Hall MM, Bernhardt D, Finnoff JT, et al. American Medical Society for Sports Medicine sports ultrasound curriculum for sports medicine fellowships, *British Journal of Sports Medicine* 2022;56:127-137.
[3] Lake, S., Brydges, R., Penney, C. et al. Online vs in-person musculoskeletal ultrasound course: a cohort comparison study. *Ultrasound* J 16, 30 (2024). https://doi.org/10.1186/s13089-024-00375-4
[4] https://msk-pocus-training.trainercentralsite.com

Program Goals and Learning Outcomes

Since this specialty is a subspecialty under the IANM, the goals and outcomes are written as an addendum to the IANM Pillars of Practice.

PIllar II and V: Goal

- To perform and interpret ultrasound imaging studies relevant to neuromusculoskeletal pathologies.

  Task 1 Knowledge Outcomes:

- 1. Clinical indications for and relative value of ultrasound diagnostic studies.
- 2. Systemic diseases that may have ultrasound imaging manifestations.
- 3. The sonographic appearance of normal human anatomy
- 4. The terminology relevant to ultrasound imaging.
- 5. The principles, applications, technical and procedural elements employed in Ultrasound imaging.
- 6. The sonographic appearance of pathology.
- 7. Common ultrasound imaging artifacts.
- 8. The location of relevant anatomical structures

  Task 1 Skill Outcomes:

- 1. Ability to select which structures need to be imaged and the best way to image them.
- 2. Ability to correctly interpret and correlate findings with the physical examination and patient's complaints and history to inform the clinical impression.
- 3. Ability to choose appropriate settings and an appropriate probe.

Pillar VI: Goal

- To produce ultrasound imaging records consistent with acceptable standards

  Task 1 Knowledge Outcomes:

- 1) Best practices when creating ultrasound imaging reports: minimum required information and image annotation.
- 2) Minimum standards for insurance billing

  Task 1 Skill Outcomes:

- 1) Ability to create ultrasound imaging reports adhering to best practices

Certification Program Overview

The program is split into 4 parts:

Part 1: Roughly 10 hours of content. This part of the program is focused on preparing the student to start using ultrasound. These videos cover basic ultrasound physics and instrumentation, imaging artifacts and ultrasound settings, how to implement ultrasound in practice, and imaging characteristics of normal tissue and pathology. The online videos have formative assessments every 10-20 minutes for you to pause the video and assess your understanding. There are some sample ultrasound scanning videos that the student is expected to practice. There will be a summative evaluation in the form of a graded test at the end of part 1 (70% is required to pass).

Meeting with the Instructor: The student is expected to start using ultrasound in their practice after completing part one. To aid the implementation, the program cost includes a 1 hour virtual session with the instructor for the students to ask questions and receive guidance.

Part 2: Roughly 30 hours of content. This part of the program is to build expertise, region-by-region, in scanning the body with detailed anatomy and pathology reviews as well as details on how to best image each region. The student should pause the videos to reproduce/practice the scans. Other scans that are appropriate for a primary care practitioner are also covered here. There will be formative evaluations every 10-20 minutes of video. There will be a summative evaluation in the form of graded tests (70% is required to pass).

Practical Exam: There is a performance based assessment that can be performed any time after the completion of part 1. You must submit 2 scans/videos and submit two reports. A Grading rubric will be provided and 70% is required to pass.

Part 3: Roughly 20+ hours of content. 150 case studies where you will be asked to comment on cases or images. You may be asked to write a report or identify structures. Can be started after part 1.

After completing the first 3 parts and the practical exam, you will inform Dr. Ramakko, who will check your completion and inform the IANM of your eligibility for the exam, then you can book to take the CNMS exam with the IANM.

Part 4: Roughly 12 hours of optional content. This elective section here is a deep dive into more detailed instrumentation, ultrasound physics, non-msk trauma, and interventional ultrasound, useful for only some practitioners or for students who intend to challenge the APCA's RMSK exam. There will be formative evaluations every 10-20 minutes of video. There will be a summative evaluation in the form of graded tests (70% is required to pass).

	Name	Course Content	Video Length
Part 1	MSK ultrasound basics: physics and instrumentation	-elementary principles of ultrasound including definition of ultrasound, basic properties and units of measure. -Fundamental principles of sound and the propagation of sound in soft tissue. -components and terminology of ultrasound equipment and instrumentation. - Color Doppler, pulse wave, and Power doppler Imaging. - Differentiate imaging artifacts by their cause and characteristic appearance. - Outline safety and bioeffects -other optional ultrasound features or modes: elastography, compound imaging, THI, speckle reduction, panoramic, chroma, and split screen	2h
	MSK ultrasound basics: using MSK ultrasound in practice	-Standards of practice -Terminology conventions -How to scan for pathology -ultrasound machine settings -handheld vs cart-based ultrasound -Report writing basics -Billing codes	1h
	MSK ultrasound basics: normal sonoanatomy appearance and most common pathologies	-normal bone, muscle, nerve, ligament, tendon, and cartilage. -pathological appearance: fracture, hematoma, DOMS, atrophy, edema, tears, nerve impingement, tendinosis, gout, effusion - focused scans of the most common locations of pathology are demonstrated. -Chiropractors should be able to scan for, and identify, the most common pathologies that are easily identified on ultrasound following this course.	5h
Part 2	Shoulder	-anatomy review -scanning protocol -pathology	2h
	elbow	-anatomy review -scanning protocol -pathology	2h
	wrist/hand	-anatomy review -scanning protocol -pathology	4h
	hip	-anatomy review -scanning protocol -pathology	5h
	knee	-anatomy review -scanning protocol -pathology	3h

	ankle/foot	-anatomy review -scanning protocol -pathology	4h
	Fractures	-a review of fracture signs and an overview of the most common fracture locations.	1h
	Other Scans relevant for DDx and/or as a primary care physician	-hernias, thyroid, AAA, DVT, lymph nodes, etc…	5h
	Spine and jaw	-TMJ, brachial plexus, multifidus evaluation, facet joints, SI joints, etc…	2h
Part 4 (optional)	Ultrasound physics and Instrumentation	More in depth review of ultrasound physics in preparation for the RMSK or SPI exam	6h
	Trauma Ultrasound	Ultrasound protocols for emergencies, may be useful for sideline doctors. Includes the eFAST and RUSH protocols	3h
	Interventional Ultrasound	More in depth look at upper and lower limb interventional ultrasound procedures in preparation for the RMSK exam	2h

Fellowship Details

Fellows must be diplomates of the IANM. The CNMS program is quite robust. I would argue equivalent to other advertised fellowships (see the appendix for program comparison). The CNMS program was created as a type of virtual fellowship, hence the 150 sample cases. That being said, it lacks the human element that some would argue is essential in a fellowship. A fellowship requires performing with guidance and feedback. The core educational component is handled by the CNMS curriculum. The CNMS educational program is a requirement for completing the fellowship, they can be taken concurrently.

The fellowship requires partnering with a mentor. Dr. Ramakko offers mentoring sessions, subject to availability, but the mentor can be any approved individual. Approved individuals would meet one of the qualifications in the following list:

- PgCert (1 year Post grad) + 1 year experience, PGDip (2 years post grad), or MSc (3 years post grad) in MSK Ultrasound in the UK/european system, or
- Board certified radiologist with 2+ years of MSK ultrasound experience, or
- RMSK holder with 2+ years of ultrasound experience, or
- CNMS holder with 2+ years ultrasound experience or who has completed the fellowship, or
- Someone approved by the IANM subspecialty board/chair

The mentee must perform 150 patient exams and the mentor must comment and give feedback. It is advised to keep a log of scans, see the appendix. Comments can be given through the shared log spreadsheet or verbally in video or in-person meetings. There must be discussions of key regions so that the mentor can provide guidance or feedback. The regions are: non-msk pocus, shoulder, elbow, wrist, hand+fingers, hip/thigh, knee, leg+ankle, and foot. Interventional procedures and Acute Trauma should also be included if relevant. Progress can be assessed on a rubric out of 5. Level 3 is basic competency. Level 4 is expert level. Level 5 is being a leader in the field. The mentee should complete level 3 at a minimum for each region. The goal is to have the mentee complete at least some goals from levels 4 and 5. At least one goal from level 4 (such as incorporating the latest research into practice) for each region and at least one goal in level 5 (such as publishing a peer reviewed paper involving diagnostic ultrasound) should be completed. The Rubrics is reproduced from the AMSSM guidelines on sports ultrasound fellowships and can be found in the appendix.

I recommend printing them out or copying the rubric into a file and circle or highlight/bold goals that have been obtained.

The IANM recommends mentors have a minimum of 16 contact hours with mentees. Dr. Ramakko's mentorship package contains 20 contact hours for example…There should be documented evidence of meetings and discussed content. For example, the IANM recommends discussing at least 4 research papers.

Maintenance of Credentials

The IANM must maintain certain standards to maintain its high level of credibility, thus maintenance of credentials is required. Fellows must be diplomates and must maintain membership and pay their diplomate dues and complete the MOC for the DIANM credential.

To maintain the CNMS credential, a yearly fee must be paid to the IANM (no additional fee for diplomates), plus submission of evidence of completing at least 4 hours of ultrasound imaging educational activities (which can include the fellowship), or the specific MOC activities that will be offered via Dr. Ramakko. Those with similar credentials (like the RMSK) with MOC requirements that exceed these requirements may just submit proof of maintenance of that credential. The MOC yearly activities by Dr. Ramakko will be a mixture of case studies to analyze, research papers to read, and/or a lecture, roughly equivalent to 2 hours of content, suitable for experts in diagnostic ultrasound.

Education Module Content Breakdown

ONLINE MODULE 1: Point-of-Care MSK Ultrasound Fundamentals
- 12 hours including the expected practice and self-reflection

1. Ultrasound Physics and Instrumentation
    a. elementary principles of ultrasound including definition of ultrasound, basic properties and units of measure.
    b. Fundamental principles of sound and the propagation of sound in soft tissue.
    c. components and terminology of ultrasound equipment and instrumentation.
        i. Hall MM, Allen GM, Allison S, et al. Recommended musculoskeletal and sports ultrasound terminology: a Delphi-based consensus statement *British Journal of Sports Medicine* 2022;56:310-319.
    d. Color Doppler, pulse wave, and Power doppler Imaging.
    e. Differentiate imaging artifacts by their cause and characteristic appearance.
        i. Anisotropy
        ii. Posterior enhancement
        iii. Shadowing
        iv. Edge artifacts
        v. reverberations/Comet tail
        vi. Mirror imaging
        vii. Ring down
        viii. Lobe artifacts
        ix. Refraction artifacts
    f. Outline safety and bioeffects
    g. other optional ultrasound features or modes:
        i. elastography,
        ii. compound imaging,
        iii. THI, speckle reduction,
        iv. panoramic,
        v. chroma,
        vi. split screen
2. Implementation into Practice
    a. Standards of practice: POCUS vs Radiologist
    b. Terminology conventions
    c. How to scan for pathology
    d. ultrasound machine settings
    e. handheld vs cart-based ultrasound
    f. Report writing basics
    g. Billing codes
3. Muscles normal and pathologic appearance
    a. Normal appearance
    b. Terminology: muscle strain vs muscle tear
    c. Pathology:

        i. Muscle tear
        ii. Hematoma
        iii. Myofascial trigger point (MFTP)
        iv. Contusion
        v. Myositis ossificans
        vi. Myositis
        vii. Pyomyositis
        viii. Fatty infiltration
        ix. Atrophy
        x. Morel-Lavallée Lesion
        xi. Muscle herniations
        xii. Delayed onset muscle soreness (DOMS)
4. Tendons normal and pathologic appearance
    a. Normal appearance
    b. How to scan
    c. Terminology:
        i. Hyperemia
        ii. Dislocation vs subluxation
    d. Pathology:
        i. Tendinosis
        ii. Tendinitis
        iii. Calcific tendinopathy
        iv. Gout
        v. Tenosynovitis
        vi. Stenosing tenosynovitis
        vii. Paratenonitis
        viii. Tendon tear
        ix. Avulsion
    e. Fascia pathology
        i. Scar tissue/fascial adhesion
        ii. Fasal tear/herniation
    f. Sample scanning video
        i. Sample “normal” and “abnormal” reports
        ii. Achilles
        iii. Tibialis posterior
        iv. Plantar fascia
        v. Patellar
        vi. Common extensor
        vii. Supraspinatus
5. Ligaments, Joints, and Bones
    a. Sample “normal” and “abnormal” reports
    b. How to scan Ligaments
    c. Ligament Pathology:
        i. Tears
        ii. avulsions
    d. How to scan Joints
    e. Joint Pathology:
        i. Effusion
        ii. Synovial proliferation
        iii. Synovial hypertrophy
        iv. Synovitis
        v. Ganglion cysts
        vi. Bursitis
    f. How to scan Bones

    g. Bone pathology:
        i. Fracture
        ii. Osteophytes
        iii. Enthesophytes
        iv. Osteoarthritis
        v. Erosions
    h. Sample scans:
        i. Tibiofibular Ligament
        ii. Anterior Talofibular Ligament
        iii. Ulnar collateral Ligament
        iv. Radial collateral Ligament
        v. Knee, for arthritis and effusion
6. Nerves
    a. How to scan nerves
    b. Nerve Pathology
        i. Compression neuropathy
        ii. Transection
        iii. Neruroma
        iv. Neuritis
        v. Subluxation/Dislocation
        vi. Nerve Tumours: Neurofibroma/schwannoma
    c. Nerve sample scan
        i. Sample “normal” and “abnormal” reports
        ii. Median nerve scan

ONLINE MODULE 2: MSK Ultrasound: Shoulder
4 HOURS

1. Shoulder Anatomy
    a. Detailed review of anatomy, in particular highlighting:
        i. Rotator cuff tendons
        ii. Posterior labrum
        iii. Suprascapular nerve
        iv. Subscapularis recess
        v. Coracohumeral ligament
        vi. Coracoclavicular ligament
        vii. Subacromial/subdeltoid bursa
        viii. The shifted position of tendons in the modified crass position
    b. Scanning protocol as discussed in Fundamentals of Musculoskeletal Ultrasound (3rd edition) by Jon A. Jacobson M.D.. The scanning checklist contains:
        i. Long head biceps brachii
        ii. Subscapularis, biceps tendon dislocation
        iii. Supraspinatus, infraspinatus
        iv. Acromioclavicular joint, subacromial-subdeltoid bursa, dynamic evaluation
        v. Posterior glenohumeral joint, labrum, teres minor, infraspinatus, atrophy
    c. Additional structures:
        i. Superior Labrum and Supraspinatus Muscle
        ii. Coracohumeral Ligament
        iii. Rotator Cable
        iv. Coracoclavicular Ligaments
2. Shoulder Pathology
    a. Biceps Tendon
        i. Glenohumeral Joint effusion
        ii. dislocation/subluxation
        iii. tear
    b. Rotator Cuff
        i. Tears
        ii. Tendinosis
        iii. Muscle atrophy
        iv. Calcific tendinopathies
        v. Myofascial trigger points
        vi. Fibrous adhesions
        vii. Frozen shoulder
            1. Stella SM, Gualtierotti R, Ciampi B, et al. Ultrasound Features of Adhesive Capsulitis. *Rheumatol Ther.* 2022;9(2):481-495. doi:10.1007/s40744-021-00413-w
            2. Tandon A, Dewan S, Bhatt S, Jain AK, Kumari R. Sonography in diagnosis of adhesive capsulitis of the shoulder: a case-control study. *J Ultrasound.* 2017;20(3):227-236. Published 2017 Aug 21. doi:10.1007/s40477-017-0262-5
    c. Subacromial-subdeltoid bursa
        i. Impingement syndrome
            1. Read, J.W. and Perko, M. (2010), Ultrasound diagnosis of subacromial impingement for lesions of the rotator cuff. *Australasian Journal of Ultrasound in Medicine*, 13: 11-15. https://doi.org/10.1002/j.2205-0140.2010.tb00151.x
    d. Labrum

    i. Tear
    ii. Paralabral cyst
e. AC joint
    i. AC joint separation
        1. Faruch-Bilfeld, Marie and Lapegue, Franck and Chiavassa-Gandois, Hélène and Bayol, Marie - Aurélie and Bonnevialle, Nicolas and Sans, Nicolas Ultrasound of the coracoclavicular ligaments in the acute phase of an acromioclavicular disjunction: Comparison of radiographic, ultrasound and MRI findings. *European Radiology*, 2017, vol. 27 (n°2). pp. 483-490. ISSN 0938- 7994
    ii. Osteoarthritis
    iii. osteolysis
f. Greater tuberosity
    i. Hill sachs defect
    ii. Fracture
g. SC joint
    i. Infection
    ii. Dislocation
h. Pitfalls and errors
i. Post-surgical
    i. Yoo HJ, Choi JY, Hong SH, et al: Assessment of the postoperative appearance of the rotator cuff tendon using serial sonography after arthroscopic repair of a rotator cuff tear. J Ultrasound Med 34(7):1183–1190, 2015.
    ii. García, J.S., Vila, R., Martínez, M.V., Graells, M., & García-Ferrer, L. (2018). Subacromial “Biodegradable Spacer” in the Management Irreparable Rotator Cuff Tears: Radiological Findings.
    iii. Easton James Bents, Robert Thurston Bents, Ultrasound-Guided Deflation and Arthroscopic Removal of a Migrated Subacromial Balloon Spacer, Arthroscopy Techniques, Volume 12, Issue 9, 2023, Pages e1601-e1606, ISSN 2212-6287, https://doi.org/10.1016/j.eats.2023.05.003.

ONLINE MODULE 3: MSK Ultrasound: Elbow
3 HOURS

1. Elbow Anatomy and Scanning Protocol
    a. Anterior
        i. Brachialis
        ii. Biceps brachii
        iii. Median nerve
            1. Ng, A.J.T., Chandrasekaran, R., Prakash, A. et al. A systematic review: normative reference values of the median nerve cross-sectional area using ultrasonography in healthy individuals. *Sci Rep* 12, 9217 (2022). https://doi.org/10.1038/s41598-022-13058-8
        iv. Radial nerve
        v. Anterior joint recess
        vi. Pronator teres
        vii. Cartilage
    b. Medial
        i. Ulnar collateral ligament
        ii. Common flexor tendon
        iii. Ulnar nerve
            1. Letissier H, Dardenne G, Saraux A, Le Nen D, Borotikar B, Jousse-Joulin S. Ultrasound Ulnar Nerve Measurement in a Healthy Population [published correction appears in Rheumatol Ther. 2021 Jun;8(2):1049]. *Rheumatol Ther.* 2021;8(1):457-466. doi:10.1007/s40744-021-00283-2
    c. Lateral
        i. Common extensor tendon
        ii. Lateral collateral ligament complex
        iii. Radial head and annular recess
    d. Posterior
        i. Posterior joint recess
        ii. Triceps brachii
        iii. Olecranon bursa
2. Elbow Pathology
    a. Bartonella henselae infection
    b. Joint effusion and synovial hypertrophy
    c. Bursitis
    d. Synovial Fold syndrome
    e. Medial and lateral epicondylitis/epicondylitis
        i. Connell D, Burke F, Coombes P, et al. Sonographic examination of lateral epicondylitis. *AJR Am J Roentgenol.* 2001;176(3):777-782. doi:10.2214/ajr.176.3.1760777
        ii. Han SH, An HJ, Song JY, et al. Effects of corticosteroid on the expressions of neuropeptide and cytokine mRNA and on tenocyte viability in lateral epicondylitis. *J Inflamm (Lond)*. 2012;9(1):40. Published 2012 Oct 30. doi:10.1186/1476-9255-9-40
    f. Collateral ligament tear
        i. Sutterer BJ, Boettcher BJ, Payne JM, Camp CL, Sellon JL. The Role of Ultrasound in the Evaluation of Elbow Medial Ulnar Collateral Ligament

Injuries in Throwing Athletes. *Curr Rev Musculoskelet Med.* 2022;15(6):535-546. doi:10.1007/s12178-022-09793-0

g. Cubital tunnel syndrome
    i. Letissier H, Dardenne G, Saraux A, Le Nen D, Borotikar B, Jousse-Joulin S. Ultrasound Ulnar Nerve Measurement in a Healthy Population [published correction appears in Rheumatol Ther. 2021 Jun;8(2):1049]. *Rheumatol Ther.* 2021;8(1):457-466. doi:10.1007/s40744-021-00283-2
    ii. Yoon JS, Walker FO, Cartwright MS. Ultrasonographic swelling ratio in the diagnosis of ulnar neuropathy at the elbow. *Muscle Nerve.* 2008;38(4):1231-1235. doi:10.1002/mus.21094
    iii. Wiesler ER, Chloros GD, Cartwright MS, Shin HW, Walker FO. Ultrasound in the diagnosis of ulnar neuropathy at the cubital tunnel. *J Hand Surg Am.* 2006;31(7):1088-1093. doi:10.1016/j.jhsa.2006.06.007
    iv. Thoirs K, Williams MA, Phillips M. Ultrasonographic measurements of the ulnar nerve at the elbow: role of confounders. J Ultrasound Med. 2008;27(5):737-743. doi:10.7863/jum.2008.27.5.737
h. Biceps tendon ruptures/tears
i. Triceps tendon ruptures/tears
j. Median nerve pathology
    i. Pronator teres syndrome
        1. Balcerzak AA, Ruzik K, Tubbs RS, Konschake M, Podgórski M, Borowski A, Drobniewski M, Olewnik Ł. How to Differentiate Pronator Syndrome from Carpal Tunnel Syndrome: A Comprehensive Clinical Comparison. *Diagnostics.* 2022; 12(10):2433. https://doi.org/10.3390/diagnostics12102433
    ii. Struthers ligament
        1. Löppönen P, Hulkkonen S, Ryhänen J. Proximal Median Nerve Compression in the Differential Diagnosis of Carpal Tunnel Syndrome. *Journal of Clinical Medicine*. 2022; 11(14):3988. https://doi.org/10.3390/jcm11143988
        2. Caetano EB, Sabongi JJ Neto, Vieira LA, Caetano MF, de Bona JE, Simonatto TM. Struthers' ligament and supracondylar humeral process: an anatomical study and clinical implications. *Acta Ortop Bras.* 2017;25(4):137-142. doi:10.1590/1413-785220172504168330
k. Radial nerve pathology

ONLINE MODULE 4: MSK Ultrasound: Wrist and Hand
6 HOURS

1. Wrist and Hand Anatomy and Scanning Protocol
    a. Scanning protocol as discussed in “European Society of MusculoSkeletal Radiology: Musculoskeletal Ultrasound Technical Guidelines III. Wrist” and “Fundamentals of Musculoskeletal Ultrasound (3rd edition) by Jon A. Jacobson M.D.”
    b. Volar Wrist
        i. Median nerve
        ii. Palmar cutaneous branch of the median nerve
            1. Tagliafico A, Pugliese F, Bianchi S, et al. High-resolution sonography of the palmar cutaneous branch of the median nerve. *AJR Am J Roentgenol.* 2008;191(1):107-114. doi:10.2214/AJR.07.3383
        iii. Flexor tendons
        iv. Volar joint recesses
        v. Scaphoid
        vi. Flexor carpi radialis
        vii. Radial artery
        viii. Ulnar nerve
        ix. Dorsal Cutaneous Branch of the Ulnar Nerve
        x. Ulnar artery
    c. Dorsal Wrist
        i. Extensor tendons
            1. Choi SJ, Ahn JH, Lee YJ, et al. de Quervain disease: US identification of anatomic variations in the first extensor compartment with an emphasis on subcompartmentalization. *Radiology.* 2011;260(2):480-486. doi:10.1148/radiol.11102458
        ii. Dorsal joint recesses
        iii. Scapholunate ligament
        iv. Triangular fibrocartilage complex
            1. Semisch M, Hagert E, Garcia-Elias M, Lluch A, Rein S. Histological assessment of the triangular fibrocartilage complex. *J Hand Surg Eur* Vol. 2016 Jun;41(5):527-33.
    d. Hand Anatomy and Scanning Protocols
        i. Flexor tendons
        ii. Pulleys
        iii. Volar plate
        iv. Palmar muscles
            1. Lee, Justin & Healy, Jeremiah. (2005). Normal Sonographic Anatomy of the Wrist and Hand1. *Radiographics : a review publication of the Radiological Society of North America*, Inc. 25. 1577-90. 10.1148/rg.256055028.
            2. Bianchi, S., Beaulieu, JY. & Poletti, PA. Ultrasound of the ulnar–palmar region of the wrist: normal anatomy and anatomic variations. *J Ultrasound* 23, 365–378 (2020). https://doi.org/10.1007/s40477-020-00468-5
        v. Joint recesses
        vi. Extensor tendon
        vii. Extensor hood - sagittal bands
        viii. Joint recesses
        ix. Collateral ligaments

2. Wrist and Hand Pathology
    a. Joint Effusion and Synovitis
        i. Athan Baillet, Cécile Gaujoux-Viala, Gaël Mouterde, Thao Pham, Jacques Tebib, Alain Saraux, Bruno Fautrel, Alain Cantagrel, Xavier Le Loët, Philippe Gaudin, Comparison of the efficacy of sonography, magnetic resonance imaging and conventional radiography for the detection of bone erosions in rheumatoid arthritis patients: a systematic review and meta-analysis, *Rheumatology*, Volume 50, Issue 6, June 2011, Pages 1137–1147, https://doi.org/10.1093/rheumatology/keq437
        ii. Pseudoerosions vs erosions
        iii. Gout
    b. Tenosynovitis
    c. Dequervain's tenosynovitis
    d. Tendon tears and avulsions
    e. Sesamoid fractures and volar plate injuries
        i. Becciolini M, Bonacchi G. Fracture of the sesamoid bones of the thumb associated with volar plate injury: ultrasound diagnosis. J Ultrasound. 2015;18(4):395-398. Published 2015 Mar 24. doi:10.1007/s40477-015-0166-1
    f. Tendon dislocations
    g. Trigger finger
        i. Pathak SK, Salunke AA, Menon PH, Thivari P, Nandy K, Yongsheng C. Corticosteroid Injection for the Treatment of Trigger Finger: A Meta-Analysis of Randomised Control Trials. J Hand Surg Asian Pac Vol. 2022;27(1):89-97. doi:10.1142/S242483552250014X
    h. Intersection syndrome
    i. Carpal tunnel syndrome
    j. Ulnar tunnel syndrome
    k. Superficial radial nerve pathology
    l. neuromas
    m. Gamekeeper's/skier's thumb and other collateral ligament injuries
        i. Draghi F, Gitto S, Bianchi S. Injuries to the Collateral Ligaments of the Metacarpophalangeal and Interphalangeal Joints: Sonographic Appearance. J Ultrasound Med. 2018;37(9):2117-2133. doi:10.1002/jum.14575
    n. Stener lesion
    o. TFC tear
    p. Osteoarthritis
    q. Enthesopathy
    r. Fractures
        i. Endara-Mina J, Kumar H, Ghosh B, et al. Comparative use of ultrasound and radiography for the detection of fractures: a systematic review and narrative synthesis. Ann Med Surg (Lond). 2023;85(10):5085-5095. Published 2023 Sep 5. doi:10.1097/MS9.0000000000001229
        ii. Kwee RM, Kwee TC. Ultrasound for diagnosing radiographically occult scaphoid fracture. Skeletal Radiol. 2018;47(9):1205-1212. doi:10.1007/s00256-018-2931-7
        iii. Meyer, Philippe & Lintingre, Pierre-Francois & Pesquer, Lionel & Poussange, Nicolas & Silvestre, Alain & Dallaudiere, Benjamin. (2018).

Imaging of Wrist Injuries: A Standardized US Examination in Daily Practice. Journal of the Belgian Society of Radiology. 102. 10.5334/jbr-btr.1319.

s. Ganglion Cyst
    i. Joshua T. Bram, David P. Falk, Benjamin Chang, Jennifer M. Ty, Ines C. Lin, Faris Z. Fazal, Apurva S. Shah, Clinical Presentation and Characteristics of Hand and Wrist Ganglion Cysts in Children, *The Journal of Hand Surgery*, Volume 46, Issue 12, 2021, Pages 1122.e1-1122.e9, ISSN 363-5023, https://doi.org/10.1016/j.jhsa.2021.02.026.
t. Digital Mucous Cysts
u. Giant Cell Tumour of the Tendon Sheath
v. Dupuytren Contracture and knuckle pads
w. Glomus Tumour
x. Foreign bodies

ONLINE MODULE 5: MSK Ultrasound: Hip/Pelvis
8 HOURS

1. Hip/Pelvis Anatomy and Scanning Protocol
    a. Hip: anterior
        i. Hip joint,
        ii. Iliopsoas,
            1. Lungu, Eugen & Michaud, Johan & Bureau, Nathalie. (2018). US Assessment of Sports-related Hip Injuries. *RadioGraphics*. 38. 867-889. 10.1148/rg.2018170104.
        iii. rectus femoris,
        iv. Sartorius,
        v. Lateral femoral cutaneous nerve
            1. Rudin D, Manestar M, Ullrich O, Erhardt J, Grob K. The Anatomical Course of the Lateral Femoral Cutaneous Nerve with Special Attention to the Anterior Approach to the Hip Joint. *J Bone Joint Surg Am.* 2016;98(7):561-567. doi:10.2106/JBJS.15.01022
        vi. pubic symphysis
    b. Hip: lateral
        i. Greater trochanter,
        ii. gluteal tendons,
            1. Domb, Benjamin & Nasser, Rima & Botser, Itamar. (2010). Partial-Thickness Tears of the Gluteus Medius: Rationale and Technique for Trans-Tendinous Endoscopic Repair. *Arthroscopy : the journal of arthroscopic & related surgery* 26. 1697-705. 10.1016/j.arthro.2010.06.002.
        iii. bursae,
        iv. iliotibial tract,
        v. tensor fascia latae
    c. Hip: posterior
        i. Sacroiliac joint and ligaments
        ii. Piriformis
        iii. other external rotators of the hip
    d. Inguinal region
        i. Deep inguinal ring,
        ii. Hesselbach triangle,
        iii. femoral artery region
    e. Thigh: anterior
        i. Rectus femoris,
            1. Lungu, Eugen & Michaud, Johan & Bureau, Nathalie. (2018). US Assessment of Sports-related Hip Injuries. *RadioGraphics*. 38. 867-889. 10.1148/rg.2018170104.
        ii. vastus medialis,
        iii. vastus intermedius,
        iv. vastus lateralis
    f. Thigh: medial
        i. Femoral artery and nerve,
        ii. sartorius,
        iii. gracilis,
        iv. adductors
    g. Thigh: posterior
        i. Semimembranosus,

ii. semitendinosus,
iii. biceps femoris,
iv. sciatic nerve

2. Hip/Pelvis Pathology
    a. Joint effusion
    b. Osteoarthritis
    c. Labral tears
        i. Gao G, Fu Q, Cui L, Xu Y. The Diagnostic Value of Ultrasound in Anterosuperior Acetabular Labral Tear. *Arthroscopy.* 2019;35(9):2591-2597. doi:10.1016/j.arthro.2019.02.052
        ii. Jin, W.; Kim, K.I.; Rhyu, K.H.; Park, S.Y.; Kim, H.C.; Yang, D.M.; Park, J.S.; Park, S.J.; Ryu, K.N. Sonographic evaluation of anterosuperior hip labral tears with magnetic resonance arthrographic and surgical correlation. *J. Ultrasound Med.* 2012, 31, 439–447
    d. Trochanteric Pain Syndrome (trochanteric “bursitis”)
        i. Mallow M, Nazarian LN: Greater trochanteric pain syndrome diagnosis and treatment. Phys Med Rehabil Clin N Am 25(2):279–289, 2014.
        ii. Long SS, Surrey DE, Nazarian LN: Sonography of greater trochanteric pain syndrome and the rarity of primary bursitis. AJR Am J Roentgenol 201(5):1083–1086, 2013.
        iii. Silva F, Adams T, Feinstein J, et al: Trochanteric bursitis: refuting the myth of inflammation. J Clin Rheumatol 14(2):82–86, 2008.
        iv. Ruta S, Quiroz C, Marin J, et al: Ultrasound evaluation of the greater trochanter pain syndrome: bursitis or tendinopathy? J Clin Rheumatol 21(2):99–101, 2015.
        v. Kong A, Van der Vliet A, Zadow S: MRI and US of gluteal tendinopathy in greater trochanteric pain syndrome. Eur Radiol 17(7):1772–1783, 2007.
        vi. Fearon AM, Scarvell JM, Cook JL, et al: Does ultrasound correlate with surgical or histologic findings in greater trochanteric pain syndrome? A pilot study. Clin Orthop Relat Res 468(7):1838– 1844, 2010.
    e. Tendinosis and tears
        i. Westacott DJ, , Minns JI, , Foguet P. and The diagnostic accuracy of magnetic resonance imaging and ultrasonography in gluteal tendon tears - a systematic review. Hip Int. 2011; 21: 637– 645.
        ii. Ladurner A, Fitzpatrick J, O'Donnell JM. Treatment of Gluteal Tendinopathy: A Systematic Review and Stage-Adjusted Treatment Recommendation. Orthop J Sports Med. 2021;9(7):23259671211016850. Published 2021 Jul 29. doi:10.1177/23259671211016850
    f. Snapping hip
        i. Levine BD, Kwong S, Motamedi K. VIDEO: Dynamic Ultrasound for Snapping Hip Syndrome. AJR Am J Roentgenol. 2021;216(2):446. doi:10.2214/AJR.20.22865
        ii. Storgaard Jensen S, Lund K, Lange J. The effect of iliotibial band surgery at the hip: a systematic review. BMC Musculoskelet Disord. 2023;24(1):75. Published 2023 Jan 28. doi:10.1186/s12891-023-06169-4
        iii. Walker P, Ellis E, Scofield J, Kongchum T, Sherman WF, Kaye AD. Snapping Hip Syndrome: A Comprehensive Update. Orthop Rev (Pavia). 2021;13(2):25088. Published 2021 Jun 22. doi:10.52965/001c.25088
    g. Sportsman's hernia
    h. Morel-Lavalee Lesion
    i. Piriformis Syndrome
        i. Siahaan, Yusak & Tiffani, Pamela & Tanasia, Amanda. (2021). Ultrasound-Guided Measurement of Piriformis Muscle Thickness to

Diagnose Piriformis Syndrome. Frontiers in Neurology. 12. 10.3389/fneur.2021.721966.

j. Sacroiliac joint pathology
    i. Gutierrez, M., Pineda, C. Ultrasound in sacroiliitis: the picture is shaping up. Rheumatol Int 37, 1943–1945 (2017). https://doi.org/10.1007/s00296-017-3863-6
    ii. Mondal, Sumantro & Sinha, Debanjali & Ete, Tony & Goswami, Rudra & Bardhan, Jayati & Ghosh, Alakendu. (2016). A Foe Incognito: Paraneoplastic Sacroilitis. Journal of medical cases. 7. 10.14740/jmc2540e.
    iii. Todorov, P., Mekenjan, L., Nestorova, R., & Batalov, A. (2022). An ultrasound study of the long posterior sacroiliac ligament in healthy volunteers and in patients with noninflammatory sacroiliac joint pain. Medical Ultrasonography, 24(1), 44-51. doi:http://dx.doi.org/10.11152/mu-3162
    iv. Saunders J, Cusi M, Hackett L, Van der Wall H. An exploration of ultrasound-guided therapeutic injection of the dorsal interosseous ligaments of the sacroiliac joint for mechanical dysfunction of the joint. JSM Pain Manag 2016;1:1003-1007
    v. Tsoi C, Griffith JF, Lee RKL, Wong PCH, Tam LS. Imaging of sacroiliitis: Current status, limitations and pitfalls. Quant Imaging Med Surg. 2019;9(2):318-335. doi:10.21037/qims.2018.11.10
k. Peripheral neuropathies
l. Indirect/direct Hernias
m. Abdominal Aortic Aneurysms (AAA)
    i. Isselbacher E.M. Preventza O. Hamilton Black 3rd, J. et al. 2022 ACC/AHA guideline for the diagnosis and management of aortic disease: a report of the American heart association/American college of cardiology joint committee on clinical practice guidelines. Circulation. 2022; 146: e334-e482
n. Deep VeinThrombosus (DVT) in the thigh
    i. Stubbs MJ, Mouyis M, Thomas M. Deep vein thrombosis. BMJ. 2018 Feb 22;360:k351.
    ii. Waheed SM, Kudaravalli P, Hotwagner DT. Deep Vein Thrombosis. [Updated 2023 Jan 19]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK507708/
    iii. Pedraza García J, Valle Alonso J, Ceballos García P, Rico Rodríguez F, Aguayo López MÁ, Muñoz-Villanueva MDC. Comparison of the Accuracy of Emergency Department-Performed Point-of-Care-Ultrasound (POCUS) in the Diagnosis of Lower-Extremity Deep Vein Thrombosis. J Emerg Med. 2018;54(5):656-664. doi:10.1016/j.jemermed.2017.12.020
o. Diabetic Muscle Infarction

ONLINE MODULE 6: MSK Ultrasound: Knee
6 HOURS

1. Knee Anatomy
    a. Anterior
        i. Quadriceps tendon
            1. Waligora AC, Johanson NA, Hirsch BE. Clinical anatomy of the quadriceps femoris and extensor apparatus of the knee. Clin Orthop Relat Res. 2009;467(12):3297-3306. doi:10.1007/s11999-009-1052-y
        ii. Patella
        iii. Patellar tendon
        iv. Patellar retinaculum
        v. Suprapatellar recess
        vi. Medial and lateral recesses
        vii. Anterior knee bursae
        viii. Femoral articular cartilage
        ix. Distal ACL
            1. Wei-Ting Wu, Tsung-Min Lee, Kamal Mezian, Ondřej Naňka, Ke-Vin Chang, Levent Özçakar, Ultrasound Imaging of the Anterior Cruciate Ligament: A Pictorial Essay and Narrative Review, Ultrasound in Medicine & Biology, Volume 48, Issue 3, 2022, Pages 377-396, ISSN 0301-5629, https://doi.org/10.1016/j.ultrasmedbio.2021.11.004.
    b. Medial
        i. Medial collateral ligament
            1. Jacob, George & N., Sukesh & Kumar, Gautam & Varughese, Jacob. (2020). Percutaneous Arthroscopic Assisted Knee Medial Collateral Ligament Repair. Arthroscopy techniques. 9. 10.1016/j.eats.2020.06.014.
        ii. Medial meniscus: body and anterior horn
        iii. Pes anserinus
    c. Lateral
        i. Iliotibial tract
        ii. Lateral collateral ligament
        iii. Biceps femoris
        iv. Common peroneal nerve
        v. Anterolateral ligament
        vi. Popliteus
        vii. Lateral meniscus: body and anterior horn
    d. Posterior
        i. Baker cyst
        ii. Menisci: posterior horns
        iii. Posterior cruciate ligament
        iv. Anterior cruciate ligament
        v. Meniscofemoral Ligaments
            1. David G. Deckey, Sailesh Tummala, Jens T. Verhey, Jeffrey D. Hassebrock, Donald Dulle, Mark D. Miller, Anikar Chhabra, Prevalence, Biomechanics, and Pathologies of the Meniscofemoral Ligaments: A Systematic Review, Arthroscopy, Sports Medicine, and Rehabilitation, Volume 3, Issue 6, 2021, Pages e2093-e2101, ISSN 2666-061X, https://doi.org/10.1016/j.asmr.2021.09.006.

vi. Neurovascular structures
    1. Baker M, Anjum F, dela Cruz J. Deep Venous Thrombosis Ultrasound Evaluation. [Updated 2023 Aug 8]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK470453/

2. Knee Pathology
    a. Joint effusion
    b. Meniscus tear
        i. Dong F, Zhang L, Wang S, et al. The diagnostic accuracy of B-mode ultrasound in detecting meniscal tears: a systematic review and pooled meta-analysis. Med Ultrason. 2018;20(2):164-169. doi:10.11152/mu-1252
    c. ITband syndrome
    d. Collateral ligament tear
        i. Jacob, George & N., Sukesh & Kumar, Gautam & Varughese, Jacob. (2020). Percutaneous Arthroscopic Assisted Knee Medial Collateral Ligament Repair. Arthroscopy techniques. 9. 10.1016/j.eats.2020.06.014.
        ii. DeGrace D., Gill T.I.V., Gill T., III Analysis of medial collateral ligament injuries of the knee. Harvard Orthop J. 2013;15:13–24.
    e. Gout
    f. Osteoarthritis
        i. Podlipská, J., Koski, J., Kaukinen, P. et al. Structure-symptom relationship with wide-area ultrasound scanning of knee osteoarthritis. Sci Rep 7, 44470 (2017). https://doi.org/10.1038/srep44470
    g. Knee bursal distension (Baker Cyst, pes anserine bursitis, etc.)
    h. Knee tendon tendinosis and tears (jumper's knee, pes anserinus tendinitis bursitis syndrome, calcific tendinitis, etc.)
        i. Manske RC, Page P, Voight M, Wolfe C. Musculoskeletal Ultrasound: An Essential Tool in Diagnosing Patellar Tendon Injuries. IJSPT. 2023;18(4). doi:10.26603/001c.84448
        ii. Toktas, Hasan & Dundar, Umit & Adar, Sevda & Solak, Ozlem & Ulaşlı, Alper. (2014). Ultrasonographic assessment of pes anserinus tendon and pes anserinus tendinitis bursitis syndrome in patients with knee osteoarthritis. Modern rheumatology / the Japan Rheumatism Association. 25. 1-6. 10.3109/14397595.2014.931909.
        iii. Atici A, Bahadir Ulger FE, Akpinar P, et al. Poor Accuracy of Clinical Diagnosis in Pes Anserine Tendinitis Bursitis Syndrome. Indian J Orthop. 2021;56(1):116-124. Published 2021 May 21. doi:10.1007/s43465-021-00424-3
        iv. Barnes CL, Scott RD. Popliteus tendon dysfunction following total knee arthroplasty. J Arthroplasty 1995; 10:543–545.
        v. Garrick J, Webb D. Sports Injuries: Diagnosis and Management. Philadelphia, PA: WB Saunders Co; 1990.
        vi. Cooper DE. Snapping popliteus tendon syndrome: a cause of mechanical knee popping in athletes. Am J Sports Med 1999; 27:671–674.
        vii. Smith, Jay, et al. "Sonographically guided popliteus tendon sheath injection: techniques and accuracy." Journal of Ultrasound in Medicine 29.5 (2010): 775-782

viii. Lavigne A, Boudier-Revéret M. Ultrasound-Guided Lavage of a Popliteus Tendon Calcification. Pain Med. 2022;23(7):1333-1334. doi:10.1093/pm/pnac005

i. ACL and PCL tears
    i. Ptasznik R, Feller J, Bartlett J, Fitt G, Mitchell A, Hennessy O. The value of sonography in the diagnosis of traumatic rupture of the anterior cruciate ligament of the knee. AJR Am J Roentgenol. 1995;164(6):1461-1463. doi:10.2214/ajr.164.6.7754893
    ii. Sokal, P.A., Norris, R., Maddox, T.W. et al. The diagnostic accuracy of clinical tests for anterior cruciate ligament tears are comparable but the Lachman test has been previously overestimated: a systematic review and meta-analysis. Knee Surg Sports Traumatol Arthrosc 30, 3287–3303 (2022). https://doi.org/10.1007/s00167-022-06898-4
j. Patella (Patellofemoral pain syndrome, fracture, etc.…)
    i. Zhang DH, Wu ZQ, Zuo XC, Li JW, Huang CL. Diagnosis and treatment of excessive lateral pressure syndrome of the patellofemoral joint caused by military training. Orthop Surg. 2011;3(1):35-39. doi:10.1111/j.1757-7861.2010.00116.x
    ii. Fischhoff, Cyril & Goorah, Teejas & Dowlut, Sharoona. (2015). Ultrasound measurements for patellofemoral pain syndrome: An inter-operator reliability study. International Musculoskeletal Medicine. 37. 150514053812001. 10.1179/1753614615Z.000000000100.
    iii. Fischhoff, Cyril. (2015). Patellofemoral pain syndrome: Ultrasound measurements for diagnosis. International Musculoskeletal Medicine. 37. 150514063810005. 10.1179/1753614615Z.00000000099.
    iv. Lapègue F, Ponsot A, Barcelo C, Fourati M, Labarre D, Vial J, et al. Approche échographique du syndrome femoro-patellaire. Actualités en Echographie de l'appareil locomoteur 2011;8: 219–34
k. Common peroneal neuropathy
    i. Spinner, Robert J. et al. "Peroneal intraneural ganglia. Part I. Techniques for successful diagnosis and treatment." Neurosurgical focus 22 6 (2007): E16
    ii. Visser LH: High-resolution sonography of the common peroneal nerve: detection of intraneural ganglia. Neurology 67(8):1473–1475, 2006
l. DVT at the popliteal vein
    i. Amini, Richard & Panchal, Ashish & Bahner, David & Adhikari, Srikar. (2015). Half-dose Alteplase for Sub-massive Pulmonary Embolism Directed by Emergency Department Point-of-care Ultrasound. The western journal of emergency medicine. 16. 181-3. 10.5811/westjem.2014.12.24130.
m. Synovial hemangioma

ONLINE MODULE 7: MSK Ultrasound: Ankle and Foot
8 HOURS

1. Ankle Anatomy and Scanning Protocol
    a. Ankle: anterior
        i. Anterior tibiotalar joint recess
        ii. Tibialis anterior
        iii. Extensor hallucis longus
        iv. Dorsal pedis artery
        v. Superficial peroneal nerve
        vi. Extensor digitorum longus
    b. Ankle: medial
        i. Tibialis posterior
        ii. Flexor digitorum longus
        iii. Tibial nerve
        iv. Flexor hallucis longus
        v. Deltoid ligament
            1. Milner CE, Soames RW. The medial collateral ligaments of the human ankle joint: anatomical variations. Foot Ankle Int. 1998 May ;19 (5):289-92
            2. Hintermann B, Knupp M, Pagenstert GI. Deltoid ligament injuries: diagnosis and management. Foot Ankle Clin 2006;11(3):625-637.
            3. Hintermann B. Biomechanics of the unstable ankle joint and clinical implications. Med Sci Sports Exerc 1999;31(Suppl 7):459-69.
            4. Stadnick, M. Deltoid Ligament Injuries. MRI Web Clinic - January 2013. https://radsource.us/deltoid-ligament-injuries/
            5. Paterson RS, Brown JN, Roberts SNJ. The Posteromedial Impingement Lesion of the Ankle. AJSM 2001;29(5):550-557.
        vi. Spring Ligament
            1. Mansour, R., Teh, J., Sharp, R.J. et al. Ultrasound assessment of the spring ligament complex. Eur Radiol 18, 2670–2675 (2008). https://doi.org/10.1007/s00330-008-1047-1
            2. Harish, S., Jan, E., Finlay, K. et al. Sonography of the superomedial part of the spring ligament complex of the foot: a study of cadavers and asymptomatic volunteers. Skeletal Radiol 36, 221–228 (2007). https://doi.org/10.1007/s00256-006-0229-7
    c. Ankle: lateral
        i. Peroneus longus and brevis
        ii. Anterior talofibular ligament
        iii. Calcaneofibular ligament
        iv. Anterior tibiofibular ligament
        v. Posterolateral Ligaments
            1. Stella SM, Ciampi B, Del Chiaro A, et al. Sonographic visibility of the main posterior ankle ligaments and para-ligamentous structures in 15 healthy subjects. J Ultrasound. 2021;24(1):23-33. doi:10.1007/s40477-019-00420-2
    d. Ankle: posterior
        i. Achilles tendon
        ii. Posterior bursae
        iii. Plantar fascia
        iv. Accessory Soleus Muscle
            1. Al-Himdani, S., Talbot, C.L., Kurdy, N., & Pillai, A. (2013). Accessory

muscles around the foot and ankle presenting as chronic undiagnosed pain. An illustrative case report and review of the literature. Foot, 23 4, 154-61 .

e. Calf
    i. Soleus
    ii. Medial and lateral heads of gastrocnemius
    iii. Plantaris
    iv. Achilles tendon
f. Foot Anatomy
    i. Joint recesses
    ii. Tendons and plantar plate
    iii. Plantar fascia

2. Ankle Pathology
    a. Tibialis posterior tendon dysfunction
        i. Ramakko B. Point-of-Care Musculoskeletal Ultrasound in the Diagnosis of Tibialis Posterior Partial Tendon Tear: A Case Report. JIANM. 2022;19(2):2-6
    b. Tarsal tunnel syndrome
    c. Shin splints
        i. Rao A, Pimpalwar Y, Sahdev R, Sinha S, Yadu N. Diagnostic Ultrasound: An Effective Tool for Early Detection of Stress Fractures of Tibia. J Arch Mil Med. 2017;5(2):e57343. https://doi.org/10.5812/jamm.57343.
    d. Compartment syndrome
        i. American Academy of Orthopaedic Surgeons/Major Extremity Trauma and Rehabilitation Consortium Management of Acute Compartment Syndrome Clinical Practice Guideline. https://www.aaos.org/acscpg Published December 7, 2018.
        ii. Wassermann, D, & Oschman, Z. (2011). Role of ultrasound as a non-invasive method of diagnosis of chronic exertional compartment syndrome. SA Orthopaedic Journal, 10(4), 59-65.
        iii. Long N, Ahn JS, Kim DJ. Adjunctive Use of Point of Care Ultrasound to Diagnose Compartment Syndrome of the Thigh. POCUS J. 2021;6(2):64-66. Published 2021 Nov 23. doi:10.24908/pocus.v6i2.15185
        iv. Mühlbacher, J., Pauzenberger, R., Asenbaum, U. et al. Feasibility of ultrasound measurement in a human model of acute compartment syndrome. World J Emerg Surg 14, 4 (2019). https://doi.org/10.1186/s13017-019-0222-9
    e. Muscle herniation
        i. Artul, Suheil & Habib, George. (2014). The importance of dynamic ultrasound in the diagnosis of tibialis anterior muscle herniation. Critical ultrasound journal. 6. 14. 10.1186/s13089-014-0014-0.
    f. Muscle tear
    g. Muscle atrophy
        i. Albayda, J., van Alfen, N. Diagnostic Value of Muscle Ultrasound for Myopathies and Myositis. Curr Rheumatol Rep 22, 82 (2020). https://doi.org/10.1007/s11926-020-00947-y
    h. Ankle sprain
        i. Shiwaku, K., Teramoto, A., Iba, K. et al. The prevalence of posterior inferior tibiofibular ligament and inferior tibiofibular transverse ligament injuries in syndesmosis-injured ankles evaluated by oblique axial magnetic resonance

imaging: a retrospective study. BMC Musculoskelet Disord 23, 264 (2022). https://doi.org/10.1186/s12891-022-05220-0

ii. Mei-Dan, Omer & Kots, Eugene & Barchilon, Vidal & Massarwe, Sabri & Nyska, Meir & Mann, Gideon. (2009). A Dynamic Ultrasound Examination for the Diagnosis of Ankle Syndesmotic Injury in Professional Athletes: A Preliminary Study. The American journal of sports medicine. 37. 1009-16. 10.1177/0363546508331202.

iii. Durkee NJ, Jacobson JA, Jamadar DA, Femino JE, Karunakar MA, Hayes CW. Sonographic evaluation of lower extremity interosseous membrane injuries: retrospective review in 3 patients. J Ultrasound Med. 2003;22(12):1369-1375. doi:10.7863/jum.2003.22.12.1369

iv. Baltes, Thomas & Arnaiz, Javier & Al-Naimi, Maryam & Al-Sayrafi, Omar & Geertsema, Celeste & Geertsema, Liesel & Evans, Toni & Hooghe, Pieter & Kerkhoffs, Gino & Tol, Johannes. (2020). Limited intrarater and interrater reliability of acute ligamentous ankle injuries on 3 T MRI. Journal of ISAKOS Joint Disorders & Orthopaedic Sports Medicine. 1-8. 10.1136/jisakos-2020-000503.

v. Ferran, Nicholas & Oliva, Francesco & Maffulli, Nicola. (2009). Ankle Instability. Sports medicine and arthroscopy review. 17. 139-45. 10.1097/JSA.0b013e3181a3d790.

vi. Ribbans, William Or Bill & Garde, Ajit. (2013). Tibialis Posterior Tendon and Deltoid and Spring Ligament Injuries in the Elite Athlete. Foot and ankle clinics. 18. 255-291. 10.1016/j.fcl.2013.02.006.

vii. Cai Y, Li S, Chen S, Hua Y, Shan J. An Ultrasound Classification of Anterior Talofibular Ligament (ATFL) Injury. Open Orthop J. 2017;11:610-616. Published 2017 Jul 31. doi:10.2174/1874325001711010610

i. Joint effusion

j. Tendinopathies

i. Dombek MF, Lamm BM, Saltrick K, Mendicino RW, Catanzariti AR. Peroneal tendon tears: a retrospective review. J Foot Ankle Surg. 2003 Sep-Oct;42(5):250-8.

ii. Grant TH, Kelikian AS, Jereb SE, et al: Ultrasound diagnosis of peroneal tendon tears. A surgical correlation. J Bone Joint Surg Am 87(8):1788-1794, 2005.

k. Peroneus quadratus and tertius

i. Chepuri NB, Jacobson JA, Fessell DP, et al: Sonographic appearance of the peroneus quartus muscle: correlation with MR imaging appearance in seven patients. Radiology 218(2):415–419, 2001

ii. Athavale, S.A., Gupta, V., Kotgirwar, S. et al. The peroneus quartus muscle: clinical correlation with evolutionary importance. Anat Sci Int 87, 106–110 (2012). https://doi.org/10.1007/s12565-011-0129-3

iii. Sirasanagandla SR, Al Balushi AW. Variations of Peroneus Tertius Muscle in Omani Population: A Surface Anatomical Study. Ethiop J Health Sci. 2021;31(5):1061-1068. doi:10.4314/ejhs.v31i5.19

iv. Bilgili, Mustafa & Kaynak, Gokhan & Botanlıoğlu, Hüseyin & Basaran, Serdar & Ercin, Ersin & Baca, Emre & Uzün, Ibrahim. (2014). Peroneus quartus: Prevalance and clinical importance. Archives of orthopaedic and trauma surgery. 134. 10.1007/s00402-014-1937-4.

l. Plantar plate injury

m. Accessory soleus muscle
    i. Al-Himdani, S., Talbot, C.L., Kurdy, N., & Pillai, A. (2013). Accessory muscles around the foot and ankle presenting as chronic undiagnosed pain. An illustrative case report and review of the literature. Foot, 23 4, 154-61.
n. Bassett Ligament impingement
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v. Rheumatoid nodules
    1. Tamborrini, Giorgio & Gengenbacher, Michael & Bianchi, Stefano. (2015). Knuckle pads - a rare finding. Journal of ultrasonography. 12. 493-8. 10.15557/JoU.2012.0037.
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ONLINE MODULE 8: MSK Ultrasound: Jaw and Spine
3 HOURS

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    a. Maranini B, Ciancio G, Mandrioli S, Galiè M, Govoni M. The Role of Ultrasound in Temporomandibular Joint Disorders: An Update and Future Perspectives. Front Med (Lausanne). 2022;9:926573. Published 2022 Jun 20. doi:10.3389/fmed.2022.926573
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    i. Bodor M, Murthy N, Uribe Y. Ultrasound-guided cervical facet joint injections. Spine J. 2022;22(6):983-992. doi:10.1016/j.spinee.2022.01.011
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4. Lumbar Region
   a. https://www.nysora.com/techniques/lumbar-paravertebral-sonography-considerations-ultrasound-guided-lumbar-plexus-block/
   b. https://www.nysora.com/pain-management/ultrasound-guided-lumbar-facet-nerve-block-and-intra-articular-injection/
   c. Luo X, Zhao Y. Ultrasound-Guided Superior Cluneal Nerve Block: A Narrative Review. J Pain Res. 2024;17:1829-1836 https://doi.org/10.2147/JPR.S462166
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5. Sacro-iliac joint
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ONLINE MODULE 9: Fractures - 2 HOURS

- Many practitioners won't see a trauma case but sometimes you'll have people visit your clinic before the hospital and sometimes radiographs miss fractures that ultrasound may catch.
- The American Medical Society for Sports Medicine has a consensus sports ultrasound curriculum for sports medicine fellowships.Even though some of the fractures are covered in previous lectures they recommend this review in their curriculum.

1. Review of how to identify fractures
    i. Ramakko B. The Role of Handheld Point-of-Care Musculoskeletal Ultrasound in Identifying Bone Injury: A Multi-Case Report. JIANM. 2024;21(1):2-9.
    ii. Fodar D, et al. The EFSUMB Guidelines and Recommendations for Musculoskeletal Ultrasound – Part I: Extraarticular Pathologies. Ultraschall Med. 2022; 43(01): 34-57. doi:10.1055/a-1562-1455
    iii. Champagne N, Eadie L, Regan L, et al. The effectiveness of ultrasound in the detection of fractures in adults with suspected upper or lower limb injury: a systematic review and subgroup meta-analysis. BMC Emerg Med 2019;19, 17. https://doi.org/10.1186/s12873-019-0226-5
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2. Common fracture sites
    a. Proximal Humerus
        i. Jacob Triplet, Proximal Humerus Fractures, OrthoBullets, Sep 20 2024. https://www.orthobullets.com/trauma/1015/proximal-humerus-fractures
        ii. Blankstein A. Ultrasound in the diagnosis of clinical orthopedics: The orthopedic stethoscope. World J Orthop. 2011;2(2):13-24. doi:10.5312/wjo.v2.i2.13
        iii. Rutten, M.J.C.M., Jager, G.J., de Waal malefijt, M.C. et al. Double line sign: a helpful sonographic sign to detect occult fractures of the proximal humerus. Eur Radiol 17, 762–767 (2007). https://doi.org/10.1007/s00330-006-0331-1
    b. Hip
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        ii. Safran O, Goldman V, Applbaum Y, Milgrom C, Bloom R, Peyser A, et al. Posttraumatic painful hip: sonography as a screening test for occult hip fractures. J Ultrasound Med. 2009;28(11):1447–1452. doi: 10.7863/jum.2009.28.11.1447.
        iii. Medero Colon R, Chilstrom ML. Diagnosis of an Occult Hip Fracture by Point-of-Care Ultrasound. J Emerg Med. 2015;49(6):916-919. doi:10.1016/j.jemermed.2015.06.077
    c. Rib.
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doi:10.1016/j.cjtee.2016.04.010
iii. Napier, Donna. (2019). Ultrasound in the diagnosis of rib fracture following blunt chest trauma: a case study. Sonography. 6. 10.1002/sono.12176.
iv. Murata, Hiroaki & Salviz, E. & Chen, Stephanie & Vandepitte, Catherine & Hadzic, Admir. (2013). Ultrasound-Guided Continuous Thoracic Paravertebral Block for Outpatient Acute Pain Management of Multilevel Unilateral Rib Fractures. Survey of Anesthesiology. 57. 318-319. 10.1097/01.sa.0000435471.90739.48.
d. Clavicle.
i. Daniel Tarazona, Leah Ahn, Ujash Sheth, Clavicle Fractures - Midshaft, OrthoBullets, Jul 5 2024
ii. Leah Ahn, Evan Watts, Clavicle Fractures -Distal, OrthoBullets, Aug 25 2024
iii. Cross, K.P., Warkentine, F.H., Kim, I.K., Gracely, E.J., & Paul, R.I. (2010). Bedside ultrasound diagnosis of clavicle fractures in the pediatric emergency department. Academic emergency medicine : official journal of the Society for Academic Emergency Medicine, 17 7, 687-93 .
e. Radius/ulna.
i. Deborah Allen, Mark Cohen, Coronoid Fractures, OrthoBullets, Sep 24 2024
ii. Mark Karadsheh, Joaquin Sanchez-Sotelo, Olecranon Fractures, OrthoBullets, Feb 14 2024
iii. Joaquin Sanchez-Sotelo, Joseph Abboud, Devon Myers, Radial Head Fractures, OrthoBullets, Aug 13 2024
iv. Rachel Frank, Mark Cohen, Elbow Dislocation, OrthoBullets, Feb 16 2024
v. Cocco, G., Ricci, V., Villani, M. et al. Ultrasound imaging of bone fractures. Insights Imaging 13, 189 (2022). https://doi.org/10.1186/s13244-022-01335-z
vi. Tyler Paras, Radius and Ulnar Shaft Fractures, OrthoBullets, Oct 3 2024
vii. Ben Sharareh, John R. Riehl, Isolated Ulnar Shaft Fractures, OrthoBullets, May 24 2024
viii. Wood, D., Reddy, M., Postma, I. et al. Ultrasound in forearm fractures: a pragmatic study assessing the utility of Point of Care Ultrasound (PoCUS) in identifying and managing distal radius fractures. Emerg Radiol 28, 1107–1112 (2021). https://doi.org/10.1007/s10140-021-01957-8
ix. Leah Ahn, Mark Vitale, Orrin Franko, Distal Radius Fractures, Orthobullets, Mar 12 2024
f. Scaphoid.
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vi. Matthew J. Steffes, Scaphoid Fracture, Orthobullets, May 8, 2024

g. Metacarpal.
i. Aksay, Ersin & Yesilaras, Murat & Kilic, Turgay & Çalışkan, Feriyde & Sever, Mustafa & Kaya, Ahmet. (2013). Sensitivity and specificity of bedside ultrasonography in the diagnosis of fractures of the fifth metacarpal. Emergency medicine journal : EMJ. 32. 10.1136/emermed-2013-202971.
ii. Hoffman DF, Adams E, Bianchi SUltrasonography of fractures in sports medicineBritish Journal of Sports Medicine 2015;49:152-160.

h. Ankle Fractures (fibula/malleoli)
i. Shibuya N, Davis ML, Jupiter DC. Epidemiology of foot and ankle fractures in the United States: an analysis of the National Trauma Data Bank (2007 to 2011). J Foot Ankle Surg. 2014;53(5):606-608. doi:10.1053/J.JFAS.2014.03.011
ii. Jacob Triplet, Femoral Neck Fractures, OrthoBullets, Sep 20 2024. https://www.orthobullets.com/trauma/1015/proximal-humerus-fractures
iii. FeizDisfani, H., Bolvardi, E., Shourabi, M., Sharifi, M., Mousavi, S., & Farzaneh, R. (2020). Comparison of ultrasonography and X-ray test for lateral malleolar fracture in ankle sprain. Biomedical Research and Therapy, 7(8), 3939-3943. https://doi.org/10.15419/bmrat.v7i8.624
iv. Crombach, Aniek & Azizi, Nasim & Lameijer, Heleen & El Moumni, Mostafa & Maaten, Jan. (2020). Point-of-care bedside ultrasound examination for the exclusion of clinically significant ankle and fifth metatarsal bone fractures; a single blinded prospective diagnostic cohort study. Journal of Foot and Ankle Research. 13. 10.1186/s13047-020-00387-y.
v. Daniels, Clinton & Welk, Aaron & Enix, Dennis. (2015). Evaluation by diagnostic ultrasound of an ankle fracture undetectable by conventional radiography: A case report. Journal of chiropractic medicine. accepted for publication. 10.1016/j.jcm.2016.02.005.

i. Metatarsal.
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ii. Matthew J. Steffes, Brian Weatherford, 5th Metatarsal Base Fracture, OrthoBullets, Dec 20 2023
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iv. Boggs RG, Nitz AJ. Musculoskeletal Ultrasonography to Detect a Displaced Fracture of the Fifth Metatarsal. J Orthop Sports Phys Ther. 2018;48(11):903. doi:10.2519/jospt.2018.7884
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al. Sensitivity and specificity of ultrasonography in early diagnosis of metatarsal bone stress fractures: a pilot study of 37 patients. J Rheumatol. 2009;36(8):1715–9.

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        i. Ramakko B. The Role of Handheld Point-of-Care Musculoskeletal Ultrasound in Identifying Bone Injury: A Multi-Case Report. JIANM. 2024;21(1):2-9.
        ii. Vopat ML, Peebles BA, et al. Accuracy and Reliability of Imaging Modalities for the Diagnosis and Quantification of Hill-Sachs Lesions: A Systematic Review. Arthroscopy. 2021; 37, 1, P391-401. https://doi.org/10.1016/j.arthro.2020.08.005
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        iv. Abrams R, Akbarnia H. Shoulder Dislocations Overview. [Updated 2023 Aug 8]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK459125/
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    b. Phalanx
        i. Cheung, Jason & Tse, Wing & Ho, Pak. (2015). Irreducible volar subluxation of the proximal interphalangeal joint due to radial collateral ligament interposition: case report and review of literature. Hand Surgery. 20. 153-7. 10.1142/S0218810415720053.
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        ii. Matthew H. Zimny, Bradford L. Walters, Amit Bahl, Bedside Ultrasound for Hip Dislocations, The Journal of Emergency Medicine, Volume 43, Issue 6, 2012, Pages 1063-1065, ISSN 0736-4679, https://doi.org/10.1016/j.jemermed.2012.02.015
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        iv. Jacobino BCP, Galvão MD, da Silva AF, de Castro CC. Using the Graf method of ultrasound examination to classify hip dysplasia in neonates. Autops Case Rep. 2012;2(2):5-10. Published 2012 Jun 30. doi:10.4322/acr.2012.018

ONLINE MODULE 10: MSK Ultrasound: Relevant POCUS scans
7 HOURS

1. Eye
    a. www.pocus101.com/ocular-ultrasound-made-easy-step-by-step-guide/
    b. Jianu, Dragos & Jianu, Silviana & Munteanu, Mihnea & Vlad, Daliborca & Rosca, Cosmin & Petrica, Ligia. (2015). Color Dopper imaging features in patients presenting central retinal artery occlusion with and without giant cell arteritis. Vojnosanitetski pregled. 73. 87-87. 10.2298/VSP140814087C.
    c. Saucedo, Pablo & Redondo, Olga & Mateu, Angel & Huertas-Arroyo, Rafael & García Ruiz, Rafael & Paniagua, Enrique. (2015). Sonographic assessment of the optic nerve sheath diameter in the diagnosis of idiopathic intracranial hypertension. Journal of the Neurological Sciences. 361. 10.1016/j.jns.2015.12.032.
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    f. Bates A, Goett HJ. Ocular Ultrasound. [Updated 2023 Jul 24]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK459120/
    g. Hideaki L. Tanaka, Daniel Popa, Stephen R. Hayden, Diagnosing Central Retinal Artery Occlusion via Point-of-Care Ultrasound in the Emergency Department, The Journal of Emergency Medicine, Volume 60, Issue 5, 2021, Pages 655-658, ISSN 0736-4679, https://doi.org/10.1016/j.jemermed.2020.12.003.
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2. Thyroid
    a. Hamill C, Ellis PK, Johnston PC. Point of Care Thyroid Ultrasound (POCUS) in Endocrine Outpatients: A Pilot Study. Ulster Med J. 2020;89(1):21-24.
    b. Tessler F.N. Middleton W.D. Grant E.G. et al. ACR Thyroid Imaging, Reporting and Data System (TI-RADS): white paper of the ACR TI-RADS Committee. J Am Coll Radiol. 2017; 14: 587-595
3. Carotid Artery
    a. Chang WL, Chen PY, Hsu PJ, Lin SK. Validity and Reliability of Point-of-Care Ultrasound for Detecting Moderate- or High-Grade Carotid Atherosclerosis in an Outpatient Department. Diagnostics (Basel). 2023;13(11):1952. Published 2023 Jun 2. doi:10.3390/diagnostics13111952
    b. Hsiao C.L., Chen P.Y., Hsu P.J., Lin S.K. Nomogram and Carotid Risk Score for Predicting Moderate or High Carotid Atherosclerosis among Asymptomatic Elderly Recycling Volunteers. Diagnostics. 2022;12:1407. doi: 10.3390/diagnostics12061407.
    c. Lee W. General principles of carotid Doppler ultrasonography. Ultrasonography. 2014;33(1):11-17. doi:10.14366/usg.13018
    d. Benninger DH, Baumgartner RW. Ultrasound diagnosis of cervical artery dissection. Front Neurol Neurosci. 2006;21:70-84. doi:10.1159/000092386
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vertebral artery dissection: Two case reports. Medicine (Baltimore). 2017;96(12):e6379. doi:10.1097/MD.0000000000006379
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c. Lichtenstein, Daniel. (2017). Lung Ultrasound (in the Critically Ill) Superior to CT: the Example of Lung Sliding. The Korean Journal of Critical Care Medicine. 32. 10.4266/kjccm.2016.00955.
5. Abdominal Aortic Aneurysms (AAA)
a. US Preventive Services Task Force. Screening for Abdominal Aortic Aneurysm: US Preventive Services Task Force Recommendation Statement. JAMA. 2019;322(22):2211–2218. doi:10.1001/jama.2019.18928
b. https://www.gov.uk/guidance/abdominal-aortic-aneurysm-screening-programme-overview
c. Altobelli E, Rapacchietta L, Profeta VF, Fagnano R. Risk Factors for Abdominal Aortic Aneurysm in Population-Based Studies: A Systematic Review and Meta-Analysis. Int J Environ Res Public Health. 2018;15(12):2805. Published 2018 Dec 10. doi:10.3390/ijerph15122805
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k. The Society for Vascular Surgery practice guidelines on the care of patients with an abdominal aortic aneurysm, Chaikof, Elliot L. et al., Journal of Vascular Surgery, Volume 67, Issue 1, 2 - 77.e2
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aneurysm - a validation study from the randomized DANCAVAS study. BMC Med Imaging. 2017;17(1):14. Published 2017 Feb 14. doi:10.1186/s12880-017-0186-8
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   a. https://www.cdc.gov/blood-clots/data-research/facts-stats/index.html
   b. Kearon C, Julian JA, Math M, et al. Noninvasive diagnosis of deep vein thrombosis. McMaster Diagnostic Imaging Practice Guidelines Initiative. Ann Intern Med. 1998; 128: 663–677.
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   k. Sheiman RG, Weintraub JL, McArdle CR: Bilateral lower extremity US in the patient with bilateral symptoms of deep vein thrombosis: assessment of need, Radiology 196:379-381, 1995.
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   n. Yao, Y., Yang, X., Dai, X., Xu, X., Rong, Z., Song, K., Shi, D., Zhihong, Xu, Chen, D., Dai, J., & Jiang, Q. (2016). Why are there so few cases of anterior tibial vein thrombosis ? A case report after total joint arthroplasty and literature review.
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   p. Yang, WT., Jin, ZY., Li, CM. et al. Recurrence in isolated distal DVT after anticoagulation: a systematic review and meta-analysis of axial and muscular venous thrombosis. Thrombosis J 22, 57 (2024). https://doi.org/10.1186/s12959-024-00623-6
   q. Ro A, Kageyama N. Clinical Significance of the Soleal Vein and Related Drainage Veins, in Calf Vein Thrombosis in Autopsy Cases with Massive Pulmonary Thromboembolism. Ann Vasc Dis. 2016;9(1):15-21. doi:10.3400/avd.oa.15-00088
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& Bonnin, Philippe. (2021). Pathophysiological Processes Underlying the High Prevalence of Deep Vein Thrombosis in Critically Ill COVID-19 Patients. Frontiers in Physiology. 11. 10.3389/fphys.2020.608788.
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7. Lymph nodes (axilla, epitrochlear at the elbow, inguinal crease)
    a. Maini R, Nagalli S. Lymphadenopathy. [Updated 2023 Aug 8]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK558918/
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    c. Esen G, Gurses B, Yilmaz MH, et al: Gray scale and power Doppler US in the preoperative evaluation of axillary metastases in breast cancer patients with no palpable lymph nodes. *Eur Radiol* 15(6):1215–1223, 2005
8. Pilonidal cyst
9. Lipoma
    a. Kuwano Y, Ishizaki K, Watanabe R, et al: Efficacy of diagnostic ultrasonography of lipomas, epidermal cysts, and ganglions. *Arch Dermatol* 145(7):761–764, 2009.
10. Angiolipoma
    a. Howard WR, Helwig EB. Angiolipoma. Arch Dermatol. 1960;82:924–931. doi: 10.1001/archderm.1960.01580060078011.
    b. Lin JJ, Lin F. Two entities in angiolipoma: a study of 459 cases of lipoma with review of literature on infiltrating angiolipoma. Cancer. 1974;34:720–727. doi: 10.1002/1097-0142(197409)34:3<720::AID-CNCR2820340331>3.0.CO;2-K.
11. Myxoma
    a. Jonelle M. Petscavage-Thomas, Eric A. Walker, Chika I. Logie, Loren E. Clarke, Dennis M. Duryea, Mark D. Murphey. Soft-Tissue Myxomatous Lesions: Review of Salient Imaging Features with Pathologic Comparison. (2014) RadioGraphics. 34 (4): 964-80. doi:10.1148/rg.344130110
    b. Murphey M, McRae G, Fanburg-Smith J, Temple H, Levine A, Aboulafia A. Imaging of Soft-Tissue Myxoma with Emphasis on CT and MR and Comparison of Radiologic and Pathologic Findings. Radiology. 2002;225(1):215-24. doi:10.1148/radiol.2251011627
    c. Majoor B, van de Sande M, Appelman-Dijkstra N et al. Prevalence and Clinical Features of Mazabraud Syndrome: A Multicenter European Study. J Bone Joint Surg Am. 2019;101(2):160-8. doi:10.2106/JBJS.18.00062
12. Sarcoma
13. Cellulitis
14. Xanthoma
    a. Bureau NJ, Roederer G: Sonography of Achilles tendon xanthomas in patients with heterozygous familial hypercholesterolemia. AJR Am J Roentgenol 171(3):745–749, 1998
15. Fat necrosis
    a. Lee, S.A., Chung, H.W., Cho, K.J. et al. Encapsulated fat necrosis mimicking subcutaneous liposarcoma: radiologic findings on MR, PET-CT, and US imaging. Skeletal Radiol 42, 1465–1470 (2013). https://doi.org/10.1007/s00256-013-1647-y
    b. Restrepo, R., Inarejos Clemente, E.J., Corral, G. et al. Subcutaneous fat necrosis of the newborn: a pictorial essay of an under-recognized entity. Pediatr Radiol 53, 313–323 (2023). https://doi.org/10.1007/s00247-022-05509-1
16. Rheumatoid nodules

a. Tamborrini, Giorgio & Gengenbacher, Michael & Bianchi, Stefano. (2015). Knuckle pads - a rare finding. Journal of ultrasonography. 12. 493-8. 10.15557/JoU.2012.0037.
b. Rusinovich O, Morán LM, Botello LN, Andreu JL. Nódulo reumatoide benigno en sóleo. Reporte de un caso. Rev Colomb Reumatol. 2021;28:152–155.

17. osteomyelitis
18. Foreign bodies
19. Nerve Tumors: Neurofibroma/schwannoma
20. Osseous tumors
21. Giant Cell Arteritis

a. Dejaco C, Ramiro S, Duftner C, et al. EULAR recommendations for the use of imaging in large vessel vasculitis in clinical practice. Ann Rheum Dis. 2018;77(5):636 643. (10.1136/annrheumdis-2017-212649)
b. Estrada Alarcón PV, Moya Alvarado P, Sirvent Alierta EL. Ultrasound for the Diagnosis of Giant Cell Arteritis. Eur J Rheumatol. 2024 Jul 5;11(3):S283-S289. doi: 10.5152/eurjrheum.2024.20104. PMID: 39311386; PMCID: PMC11459609.
c. Aranda-Valera IC, García Carazo S, Monjo Henry I, De Miguel Mendieta E. Diagnostic validity of Doppler ultrasound in giant cell arteritis. Clin Exp Rheumatol. 2017;35(suppl 103):123 127. [PubMed] [Google Scholar]
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ONLINE MODULE 11: MSK Ultrasound: 150 scans interpreted
20 HOURS

- Based on patient scans and case reports
- Some image information will be removed
- Based on the case history and images students will have to do one or more of the following:
    - Identify structures
    - Propose a diagnosis or an appropriate ddx list
    - Write a report
    - Propose future management: referrals, further imaging, etc…
    - Critique the quality of the images/scan
- Once the student has submitted their answer, then relevant information about pathology, sonoanatomy, management, etc… will be provided for them to read.
- These are learning activities, not summative evaluations. Their answers will not be graded.

I suggest those planning to take this course not study the list of pathologies to not spoil the benefits of the educational experience.

Region	Pathology
1st mtp joint	gout
AC joint	capsule/acromioclavicular ligament partial tear and joint effusion
achilles	Large tendon tear, likely full rupture
achilles	tendinosis
achilles	tendinosis
achilles	haglund deformity -enthesitis,bursitis, tendinitis
achilles tendon	achilles full rupture/tear
achilles tendon	achilles paratendinitis
achilles tendon	tendinosis
ankle	normal achilles and tibialis posterior tendinosis
ankle and plantar foot	tib post tear and plantar fasciitis
ankle and plantar foot	tibialis posterior tendinosis and normal plantar fascia
anteromedial knee	medial plica syndrome
anterior and lateral hip	normal anatomy
anterior calf	tibialis anterior myositis ossificans
anterior hip	normal
anterior neck	intramuscular lipoma
anterior shoulder	subscapularis tendinosis and supraspinatus full tear.
anterior Shoulder	full supraspinatus tear and subscapularis tendinosis or tear
anterior shoulder	biceps and supraspinatus tendinosis. bicep tendon sheet effusion/tenosynovitis
calf	soleus muscle tear
costosternal region	fracture
dorsal foot	tenosynovitis

dorsal foot	intermetatarsal ligament tear
Elbow	effusion, infection
Elbow	Normal Anatomy
elbow	distal biceps tendon partial tear
elbow	normal anatomy
elbow	triceps enthesopathy
elbow	biceps tendon rupture
elbow	tennis elbow, lateral epicondylitis, extensor tendinosis
elbow	medial collateral ligament degenerative changes
elbow	olecranon bursitis
elbow	common extensor tendinosis and MFTP
elbow and hand	elbow and finger arthritis, ulnar nerve compression
finger	psoriatic arthritis
finger	normal anatomy
finger	gout
finger	erosions, RA
finger	boxer's knuckle
finger	avulsion fracture, mallet finger
finger	trigger finger
finger	ganglion cyst
finger	extensor tendon tear
foot	intermetatarsal bursitis
forearm	tenosynovitis
forehead	osteoma
glute region	sciatic nerve impingement/entrapment/neuropathy
glute region	ischiofemoral impingement
hamstrings	tear, tendinosis, fascial adhesions/scar tissue, and MFTPs
hamstrings	partial muscle tear
hamstrings	tear, fascial adhesions/scar tissue, and MFTPs
hand	inflammatory arthritis
hand	Dupuytren's Disease/contracture
heel	sever's disease, calcaneal apophysitis
heel and lateral ankle	peroneus brevis tear and achilles tendinosis and heel tissue injury (plantar fascia)
hip	gluteus minimus calcific tendinosis
inguinal region	lateral femoral cutaneous nerve impingement
ischial tuberosity	ischial bursitis
knee	baker's cyst and meniscus tear and MCL tear
knee	osteoarthritis, patellar and quadriceps tendinosis and joint effusion.
knee	patellar tendon tendinosis
knee	medial meniscus tear, spurring, normal anatomy

knee	joint effusion with synovial hypertrophy and an injection
knee	synovial hypertrophy, arthritis, adductor magnus tendon calcific tendinosis
knee	osteophyte, pes anserine tear
knee	CPPD
knee	patellar tendon tendinosis
knee	osteoarthritis, pes anserine and quadriceps tendinopathy
knee	MCL tear
knee	normal anatomy
knee	pes anserine tendinosis and minor MCL tear
knee	MCL and meniscus tear and joint effusion
knee	pes anserine bursitis and pes anserine tendinopathy
knee	joint effusion, pes anserine tendinosis or healing tendon tear.
Knee and achilles	osteoarthritis, tendinosis, and achilles insertional tendinosis
lateral ankle	ATFL avulsion
lateral ankle	ATFL grade 2 sprain/tear
lateral ankle	peroneus longus tendon tear
lateral ankle	intrasheath subluxation of the peroneal tendons
lateral ankle	normal anatomy
lateral ankle	ATFL tear
lateral elbow	blood vessel, DOMS, Scar tissue, MFTP
lateral foot	5th metatarsal base fracture
lateral hip	external snapping hip
lateral hip	glute medius calcific tendinitis, tendinosis, and partial tear
Lumbar musculature	small tear
medial ankle	accessory navicular bone
medial ankle	tibial nerve intraneural ganglion - tarsal tunnel syndrome
medial elbow	Ulnar collateral ligament full tear
medial hamstrings	distal tendon tear - full rupture or large tear
medial knee	medial meniscus tear and parameniscal cyst
medial knee	healing MCL tear
navicular	avascular necrosis, Kohler's disease
Neck	Cervical Rib
perianal	abscess
plantar foot	Morton's neuroma
plantar foot	plantar fascia partial tear
plantar foot	plantar plate fracture
plantar foot	abductor hallucis muscle tear
plantar foot	bipartite 1st MTP lateral sesamoiditis, sesamoid fracture
plantar foot	foreign body
plantar foot	adventitious bursa

plantar foot and ankle	normal plantar fascia, MFTP, achilles tendinosis, tibialis posterior tendinosis/tear
posterior heel	soft tissue injury, subcutaneous bursitis
posterior knee	ruptured Baker's cyst
posterior knee	Lateral Sural Cutaneous Nerve Entrapment
posterior shoulder	posterior dislocation and reverse hill sach's lesion
posterior shoulder	infraspinatus atrophy
posterior thigh	semitendinosus scar tissue and fascial adhesions
posterior wrist	normal anatomy
posteromedial knee	semimembranosus scar tissue and fascial adhesions
proximal radius	buckle fracture
rectus femoris	tendinosis, heterotopic ossification, scar tissue
rectus femoris	scar tissue
Ribs	Fracture
shoulder	old supraspinatus tear, coracoid process scar tissue, deltoid hypertrophy
shoulder	Normal Anatomy, proximal humeral head fracture
Shoulder	impingement, supraspinatus tendon tear, tendinosis
shoulder	normal AC, biceps tendinosis.
shoulder	hill sachs, supraspinatus tear, infraspinatus tendinosis
Shoulder	biceps tenosynovitis, odd supraspinatus images
shoulder	biceps tendinosis, osteoarthritis, impingement syndrome,deltoid atrophy
shoulder	normal anatomy, AC joint effusion
shoulder	supraspinatus partial tear
shoulder	supraspinatus full tear and muscle atrophy
shoulder	3 post operative supraspinatus tendons
shoulder	impingement syndrome
shoulder	bicep tendinosis
shoulder	supraspinatus tear and supraspinatus, subscapularis, and bicep tendinosis
shoulder	polymyalgia rheumatica
shoulder	bilateral frozen shoulder
shoulder	supraspinatus tear
shoulder	biceps tendon dislocation
shoulder	infraspinatus tendinosis, subscapularis and supraspinatus tears (partial)
shoulder	subscapularis tear, MFTP, AC joint osteoarthritis
shoulder	supraspinatus tear, deltoid fatty infiltration, bursal fluid distension
shoulder	supraspinatus full thickness tear
shoulder	calcific tendonitis
thoracic region	muscle tear (serratus posterior)
thumb	gamekeeper's thumb, stener lesion
tibia	stress fracture

tibialis anterior	tendinosis, subcutaneous gout, MTP effusion
Vastus Lateralis	vastus lateralis tear, possible heme arthrosis and/or synovial hypertrophy
vastus medialis	partial tendon tear
Volar Wrist and Hand	Normal Anatomy
wrist	carpal tunnel syndrome
wrist	De Quervain's tenosynovitis
wrist	distal intersection syndrome
wrist extensor tendons	tenosynovitis - infection

MSK Ultrasound: Practical Exam
1 HOURS

The student will submit two videos and two reports with images. These will be evaluated and feedback will be given. The exam will be considered complete once the submitted work is of sufficient quality. The video is designed to be educational, so the doctor will have to explain which pathology they are checking for and what structures are being imaged and also explain what is going on in the images. It is up to the doctor, whether they want to aim the explanations at the physician level or at the general public level. They could also do a voice over instead of having to explain during the scan. Videos should be roughly 2 -10 minutes. This is a formative evaluation, and as many attempts as necessary will be given to complete it.

IANM COMPENTENCY EXAMINATION

After the completion of modules 1-11 and the practical exam, the student will have to pass the IANM written exam. After which, they will be Certified in Neuromusculoskeletal Sonography (CNMS®) by the IANM.The exam will be 100 multiple choice questions.

(optional) ONLINE MODULE 12: MSK Ultrasound: Interventional Procedures
3 HOURS

I know most practitioners will be limited in what they can do, but this can act as a review of sonoanatomy and is a necessary component for the RMSK exam (aspirations and injections of the peripheral joints). The dry needling is not focused on in the RMSK exam but will be relevant to a larger number of practitioners.

1. Introduction to Ultrasound guided procedures
    a. AIUM, “Guidelines for Cleaning and Preparing External- and Internal-Use Ultrasound Transducers and Equipment Between Patients as Well as Safe Handling and Use of Ultrasound Coupling Gel”, Dec 2022
2. Dry needling - for tendinopathy and MFTPs
    a. Ang BFH, Mohan PC, Png MA, et al. Ultrasonic Percutaneous Tenotomy for Recalcitrant Lateral Elbow Tendinopathy: Clinical and Sonographic Results at 90 Months. Am J Sports Med. 2021;49(7):1854-1860. doi:10.1177/03635465211010158
    b. Stoychev V, Finestone AS, Kalichman L. Dry Needling as a Treatment Modality for Tendinopathy: a Narrative Review. Curr Rev Musculoskelet Med. 2020;13(1):133-140. doi:10.1007/s12178-020-09608-0
    c. Navarro-Santana MJ, Sanchez-Infante J, Fernández-de-las-Peñas C, Cleland JA, Martín-Casas P, Plaza-Manzano G. Effectiveness of Dry Needling for Myofascial Trigger Points Associated with Neck Pain Symptoms: An Updated Systematic Review and Meta-Analysis. Journal of Clinical Medicine. 2020; 9(10):3300. https://doi.org/10.3390/jcm9103300
3. Percutaneous electrolysis:
    a. Daniel Martínez-Silván, et. al. Clinical use of percutaneous needle electrolysis in musculoskeletal injuries: A critical and systematic review of the literature, Apunts Sports Medicine, Volume 57, Issue 216, 2022, 100396, ISSN 2666-5069, https://doi.org/10.1016/j.apunsm.2022.100396.
    b. Asensio-Olea L, Leirós-Rodríguez R, Marqués-Sánchez MP, de Carvalho FO, Maciel LYS. Efficacy of percutaneous electrolysis for the treatment of tendinopathies: A systematic review and meta-analysis. Clin Rehabil. 2023 Jun;37(6):747-759. doi: 10.1177/02692155221144272. Epub 2022 Dec 30. PMID: 36583575.
    c. Rodríguez-Sanz J, Rodríguez-Rodríguez S, López-de-Celis C, Malo-Urriés M, Pérez-Amodio S, Pérez-Antoñanzas R, Borrella-Andrés S, Albarova-Corral I, Mateos-Timoneda MÁ. Biological and Cellular Effects of Percutaneous Electrolysis: A Systematic Review. Biomedicines. 2024; 12(12):2818. https://doi.org/10.3390/biomedicines12122818
4. Interventional procedures:
    a. Cortisone
        i. Visser TSS, van Linschoten R, Vicenzino B, Weir A, de Vos RJ. Terminating Corticosteroid Injection in Tendinopathy? Hasta la Vista, Baby. J Orthop Sports Phys Ther. 2023;54(1):1-4. doi:10.2519/jospt.2023.11875
        ii. Deng, Xiaoyan MD; Zhu, Siyi MD; Li, Daishun MD; Luo, Yi MD; Zhang, Xin MD; Tan, Yanling MD; Li, Juan MD; He, Xia MD. Effectiveness of Ultrasound-Guided Versus Anatomic Landmark–Guided Corticosteroid Injection on Pain, Physical Function, and Safety in Patients With Subacromial Impingement Syndrome: A Systematic Review and Meta-analysis. American Journal of Physical Medicine & Rehabilitation

101(12):p 1087-1098, December 2022. | DOI: 10.1097/PHM.0000000000001940

b. PRP/Prolotherapy
c. Barbotage,
d. Aspiration

5. Interventional Ultrasound - Upper body
    a. Injections and/or aspiration strategies
        i. Cervical spine
            1. Zhang X, Shi H, Zhou J, et al. The effectiveness of ultrasound-guided cervical transforaminal epidural steroid injections in cervical radiculopathy: a prospective pilot study. J Pain Res. 2018;12:171-177. Published 2018 Dec 31. doi:10.2147/JPR.S181915
        ii. Brachial plexus
            1. Pester JM, Hendrix JM, Varacallo M. Brachial Plexus Block Techniques. [Updated 2023 Aug 4]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK470213/
        iii. Shoulder
        iv. Elbow
        v. Wrist
            1. Mardi Santoso, W. ., Sedar Wasis Sasono, I. ., Ari Setianto, C. ., & Hevy, N. . (2022). COMPARISON OF HYDRODISSECTION INJECTION THERAPY USING ULTRASONOGRAPHIC AS GUIDES BETWEEN TRIAMCINOLONE ACETONIDE AND 5% DEXTROSE IN CARPAL TUNNEL SYNDROME . Journal of Pain, Headache and Vertigo, 3(2), 50–58. https://doi.org/10.21776/ub.jphv.2022.003.02.5
            2. Lento, Paul & Ihm, Joseph & Kennedy, David & Visco, Christopher. (2011). Peripheral Joint and Soft Tissue Injection Techniques. 10.1016/B978-1-4377-0884-4.10024-2.
            3. Babaei-Ghazani, Arash & Forogh, Bijan & Raissi, Gholam & Ahadi, Tannaz & Eftekharsadat, Bina & Yousefi, Naseh & Rahimi-Dehgolan, Shahram & Moradi, Katayoun. (2020). Ultrasound-Guided Corticosteroid Injection in Carpal Tunnel Syndrome: Comparison Between Radial and Ulnar Approaches. Journal of Pain Research. 13. 1569-1578. 10.2147/JPR.S248600.
        vi. Hand
            1. Bodor M, Flossman T. Ultrasound-guided first annular pulley injection for trigger finger. J Ultrasound Med. 2009;28(6):737-743. doi:10.7863/jum.2009.28.6.737
6. Interventional Ultrasound - Lower body
    a. Injections and/or aspiration strategies
        i. Lumbar spine
            1. https://www.nysora.com/pain-management/ultrasound-guided-lumbar-nerve-root-periradicular-injections/
            2. Tay M, Sian SCSH, Eow CZ, Ho KLK, Ong JH, Sirisena D. Ultrasound-Guided Lumbar Spine Injection for Axial and Radicular Pain: A Single Institution Early Experience. Asian Spine J. 2021;15(2):216-223. doi:10.31616/asj.2019.0399
        ii. Hip
        iii. Knee
        iv. Ankle
        v. Foot

(optional) ONLINE MODULE 13: Extra ultrasound physics and instrumentation in preparation for RMSK exam - 6 HOURS

- Not all professionals need more ultrasound physics/instrumentation above what they are likely to encounter on a day-to-day basis. This information will be made optionally available.
- This module, combined with modules 1-7, 11, and 12, should adequately prepare someone for the RMSK exam with the APCA.
- Note that the 150 scans interpreted does not meet the RMSK exam prerequisites as those must be **performed** by the test candidate. (the fellowship does meet this requirement)
- Dr. Ramakko also offers his services as a third party to authenticate the completion of the 150 performed scans for a small fee. (authentication is included in the fellowship with him)

1. Ultrasound physics and instrumentation - Exam preparation
    a. elementary principles of ultrasound including definition of ultrasound, basic properties and units of measure.
    b. Fundamental principles of sound and the propagation of sound in soft tissue.
    c. components and terminology of ultrasound equipment and instrumentation.
    d. Color Doppler, pulse wave, and Power doppler Imaging.
    e. Differentiate imaging artifacts by their cause and characteristic appearance.
    f. Outline safety and bioeffects
    g. other optional ultrasound features or modes: elastography, compound imaging, THI, speckle reduction, panoramic, chroma, and split screen

(optional) ONLINE MODULE 14: Non-MSK Trauma - 3 HOURS

- Many practitioners won't see a trauma case. If you are a sideline doctor this is relevant.
- The American Medical Society for Sports Medicine has a consensus sports ultrasound curriculum for sports medicine fellowships. In addition to modules 1-11, this completes the recommended sports ultrasound curriculum by the American Medical Society for Sports Medicine.

4. eFAST protocol
5. RUSH protocol
6. Eye injuries
7. Pulmonary
8. CLUE protocol
9. DVT review

Appendix I: Recommended Log Format (required in fellowship and for RMSK exam)

Keeping a log will help keep track of scans. If done in a cloud spreadsheet, the mentor could include feedback in the spreadsheet. If feedback is given verbally, it is still a good way of keeping track of which scans received feedback. The RMSK exam requires you to keep track of the regions of each of the 150 scans. This spreadsheet can be useful to keep relevant ultrasound information handy like reference values and links.

Date	Patient initials	Region	Comments/findings	Feedback

Using a spreadsheet to keep track of meeting with the mentor and/or overall goals (using the rubrics in the next appendix). This is optional and the format is just a recommendation. By the end, patient scan # should be 150 and each of the regions should reach level 4 in the rubrics in the next appendix.

Date	What we did	Number of Patient scans	shoulder	Elbow	hand	hip	knee	foot

Appendix II: Fellowship Goals

These Goals/Grading rubrics are created based on the AMSSM recommendations.[5]

Non MSK POCUS scans (AAA (machine dependent), DVT, lung, giant cell arteritis) **and Acute Trauma** (only if mentee will reasonably encounter trauma cases and/or only to the capabilities of their ultrasound machine in completing trauma exam protocols), minimum protocols/regions: ocular for major trauma and/or increased intracranial pressure, Lung for hemothorax and pneumothorax, eFAST (if relevant and possible), AAA (or RUSH if relevant), 2-3 point DVT, and Giant Cell Arteritis screening.				
Level 1	Level 2	Level 3	Level 4	Level 5
Verbally describes rational for useful non-msk POCUS scans for an MSK professional.	Correctly acquires, labels, and saves images of all required protocols	Correctly identifies and labels essential pathology and generates an appropriate diagnostic report	Correctly identifies and labels desirable pathology and generates an appropriate diagnostic report	Consistently and independently performs and teaches the skills outlined in previous levels
Verbally describes the rationale for a diagnostic US assessment of an acutely injured athlete (optional)	Demonstrates appropriate patient positioning and physician ergonomics for essential pathology and protocols	Performs essential protocols, including appropriate image labeling, and generates an appropriate report	Performs desirable protocols, including appropriate image labeling, and generates an appropriate report	Correctly identifies and labels optional pathology and generates an appropriate diagnostic report
Verbally lists indications for repeat US examinations or complimentary advanced imaging	Verbally describes all essential pathology		Integrates current research and literature with guidelines to recommend management or guidelines relevant to the protocol	Performs optional protocols, including appropriate image labeling, and generates an appropriate report
				Publishes peer-reviewed work related to ultrasound evaluation of trauma and other acute conditions

[5] Hall MM, Bernhardt D, Finnoff JT, et al. American Medical Society for Sports Medicine sports ultrasound curriculum for sports medicine fellowships, *British Journal of Sports Medicine* 2022;56:127-137.

Shoulder (includes neck, chest, and upper arm)				
Level 1	Level 2	Level 3	Level 4	Level 5
Verbally describes the indications for a diagnostic US of the shoulder and lists the structures needed to be imaged during a complete examination	Correctly acquires, labels, and saves images of all required protocols	Correctly identifies and labels essential pathology and generates an appropriate diagnostic report	Correctly identifies and labels desirable pathology and generates an appropriate diagnostic report	Consistently and independently performs and teaches the skills outlined in previous levels
Verbally describes the indications, contraindications, risks and benefits of US-guided shoulder injections and/or procedures (only required if mentee can perform injections and/or procedures)	Demonstrates appropriate patient positioning and physician ergonomics for both diagnostic and procedural applications	If relevant, performs essential protocols, including appropriate image labeling, and generates an appropriate report	Performs desirable protocols, including appropriate image labeling, and generates an appropriate report	Correctly identifies and labels optional pathology and generates an appropriate diagnostic report
	Verbally describes all essential pathology		Integrates current research and literature with guidelines to recommend management or guidelines relevant to the protocol	If relevant, performs optional procedures, including appropriate image labeling, and generates an appropriate report
	If relevant, describe essential procedures			Publishes peer-reviewed work related to ultrasound of the shoulder

Elbow (anterior, medial, lateral, and posterior)				
Level 1	Level 2	Level 3	Level 4	Level 5
Verbally describes the indications for a diagnostic US of the elbow and lists the structures needed to be imaged during a complete examination	Correctly acquires, labels, and saves images of all required protocols	Correctly identifies and labels essential pathology and generates an appropriate diagnostic report	Correctly identifies and labels desirable pathology and generates an appropriate diagnostic report	Consistently and independently performs and teaches the skills outlined in previous levels
Verbally describes the indications, contraindications, risks and benefits of US-guided elbow injections and/or procedures (only required if mentee can perform injections and/or procedures)	Demonstrates appropriate patient positioning and physician ergonomics for both diagnostic and procedural applications	If relevant, performs essential protocols, including appropriate image labeling, and generates an appropriate report	Performs desirable protocols, including appropriate image labeling, and generates an appropriate report	Correctly identifies and labels optional pathology and generates an appropriate diagnostic report
	Verbally describes all essential pathology		Integrates current research and literature with guidelines to recommend management or guidelines relevant to the protocol	If relevant, performs optional procedures, including appropriate image labeling, and generates an appropriate report
	If relevant, describe essential procedures			Publishes peer-reviewed work related to ultrasound of the elbow

Wrist (Volar and Dorsal)				
Level 1	Level 2	Level 3	Level 4	Level 5
Verbally describes the indications for a diagnostic US of the wrist and lists the structures needed to be imaged during a complete examination	Correctly acquires, labels, and saves images of all required protocols	Correctly identifies and labels essential pathology and generates an appropriate diagnostic report	Correctly identifies and labels desirable pathology and generates an appropriate diagnostic report	Consistently and independently performs and teaches the skills outlined in previous levels
Verbally describes the indications, contraindications, risks and benefits of US-guided wrist injections and/or procedures (only required if mentee can perform injections and/or procedures)	Demonstrates appropriate patient positioning and physician ergonomics for both diagnostic and procedural applications	If relevant, performs essential protocols, including appropriate image labeling, and generates an appropriate report	Performs desirable protocols, including appropriate image labeling, and generates an appropriate report	Correctly identifies and labels optional pathology and generates an appropriate diagnostic report
	Verbally describes all essential pathology		Integrates current research and literature with guidelines to recommend management or guidelines relevant to the protocol	If relevant, performs optional procedures, including appropriate image labeling, and generates an appropriate report
	If relevant, describe essential procedures			Publishes peer-reviewed work related to ultrasound of the wrist

Hand and Fingers				
Level 1	Level 2	Level 3	Level 4	Level 5
Verbally describes the indications for a diagnostic US of the hand and finger and lists the structures needed to be imaged during a complete examination	Correctly acquires, labels, and saves images of all required protocols	Correctly identifies and labels essential pathology and generates an appropriate diagnostic report	Correctly identifies and labels desirable pathology and generates an appropriate diagnostic report	Consistently and independently performs and teaches the skills outlined in previous levels
Verbally describes the indications, contraindications, risks and benefits of US-guided hand and finger injections (only required if mentee can perform injections)	Demonstrates appropriate patient positioning and physician ergonomics for both diagnostic and procedural applications	If relevant, performs essential protocols, including appropriate image labeling, and generates an appropriate report	Performs desirable protocols, including appropriate image labeling, and generates an appropriate report	Correctly identifies and labels optional pathology and generates an appropriate diagnostic report
	Verbally describes all essential pathology		Integrates current research and literature with guidelines to recommend management or guidelines relevant to the protocol	If relevant, performs optional procedures, including appropriate image labeling, and generates an appropriate report
	If relevant, describe essential procedures			Publishes peer-reviewed work related to ultrasound of the hand and fingers

Hip (anterior, medial, lateral, and posterior), also includes thigh				
Level 1	Level 2	Level 3	Level 4	Level 5
Verbally describes the indications for a diagnostic US of the hip the structures needed to be imaged during a complete examination	Correctly acquires, labels, and saves images of all required protocols	Correctly identifies and labels essential pathology and generates an appropriate diagnostic report	Correctly identifies and labels desirable pathology and generates an appropriate diagnostic report	Consistently and independently performs and teaches the skills outlined in previous levels
Verbally describes the indications, contraindications, risks and benefits of US-guided hip injections (only required if mentee can perform injections)	Demonstrates appropriate patient positioning and physician ergonomics for both diagnostic and procedural applications	If relevant, performs essential protocols, including appropriate image labeling, and generates an appropriate report	Performs desirable protocols, including appropriate image labeling, and generates an appropriate report	Correctly identifies and labels optional pathology and generates an appropriate diagnostic report
	Verbally describes all essential pathology		Integrates current research and literature with guidelines to recommend management or guidelines relevant to the protocol	If relevant, performs optional procedures, including appropriate image labeling, and generates an appropriate report
	If relevant, describe essential procedures			Publishes peer-reviewed work related to ultrasound of the hip

Knee (anterior, medial, lateral, and posterior)				
Level 1	Level 2	Level 3	Level 4	Level 5
Verbally describes the indications for a diagnostic US of the knee the structures needed to be imaged during a complete examination	Correctly acquires, labels, and saves images of all required protocols	Correctly identifies and labels essential pathology and generates an appropriate diagnostic report	Correctly identifies and labels desirable pathology and generates an appropriate diagnostic report	Consistently and independently performs and teaches the skills outlined in previous levels
Verbally describes the indications, contraindications, risks and benefits of US-guided knee injections (only required if mentee can perform injections)	Demonstrates appropriate patient positioning and physician ergonomics for both diagnostic and procedural applications	If relevant, performs essential protocols, including appropriate image labeling, and generates an appropriate report	Performs desirable protocols, including appropriate image labeling, and generates an appropriate report	Correctly identifies and labels optional pathology and generates an appropriate diagnostic report
	Verbally describes all essential pathology		Integrates current research and literature with guidelines to recommend management or guidelines relevant to the protocol	If relevant, performs optional procedures, including appropriate image labeling, and generates an appropriate report
	If relevant, describe essential procedures			Publishes peer-reviewed work related to ultrasound of the knee

Calf and Ankle (anterior, medial, lateral, and posterior)				
Level 1	Level 2	Level 3	Level 4	Level 5
Verbally describes the indications for a diagnostic US of the leg and ankle the structures needed to be imaged during a complete examination	Correctly acquires, labels, and saves images of all required protocols	Correctly identifies and labels essential pathology and generates an appropriate diagnostic report	Correctly identifies and labels desirable pathology and generates an appropriate diagnostic report	Consistently and independently performs and teaches the skills outlined in previous levels
Verbally describes the indications, contraindications, risks and benefits of US-guided leg and ankle injections (only required if mentee can perform injections)	Demonstrates appropriate patient positioning and physician ergonomics for both diagnostic and procedural applications	If relevant, performs essential protocols, including appropriate image labeling, and generates an appropriate report	Performs desirable protocols, including appropriate image labeling, and generates an appropriate report	Correctly identifies and labels optional pathology and generates an appropriate diagnostic report
	Verbally describes all essential pathology		Integrates current research and literature with guidelines to recommend management or guidelines relevant to the protocol	If relevant, performs optional procedures, including appropriate image labeling, and generates an appropriate report
	If relevant, describe essential procedures			Publishes peer-reviewed work related to ultrasound of the leg and ankle

Foot				
Level 1	Level 2	Level 3	Level 4	Level 5
Verbally describes the indications for a diagnostic US of the foot the structures needed to be imaged during a complete examination	Correctly acquires, labels, and saves images of all required protocols	Correctly identifies and labels essential pathology and generates an appropriate diagnostic report	Correctly identifies and labels desirable pathology and generates an appropriate diagnostic report	Consistently and independently performs and teaches the skills outlined in previous levels
Verbally describes the indications, contraindications, risks and benefits of US-guided foot injections (only required if mentee can perform injections)	Demonstrates appropriate patient positioning and physician ergonomics for both diagnostic and procedural applications	If relevant, performs essential protocols, including appropriate image labeling, and generates an appropriate report	Performs desirable protocols, including appropriate image labeling, and generates an appropriate report	Correctly identifies and labels optional pathology and generates an appropriate diagnostic report
	Verbally describes all essential pathology		Integrates current research and literature with guidelines to recommend management or guidelines relevant to the protocol	If relevant, performs optional procedures, including appropriate image labeling, and generates an appropriate report
	If relevant, describe essential procedures			Publishes peer-reviewed work related to ultrasound of the foot

Appendix III: Comparison of this program with alternatives

Most information was collected in late 2022, some information may be out-of-date.

Fellowships or certifications for musculoskeletal ultrasound (physician level).

Registered in musculoskeletal ultrasound (RMSK) by the APCA

- Started in 2012. The current standard. The APCA is a sister organization to the ARDMS, responsible for the standard certifications for sonography.
- 150 patient exams required(no more than 8 may be therapeutic). 30 hours education recommended but not required. 1 written exam offered twice a year via exam proctoring center.
- Available to MD, DO, DPM, MBBS, DC, NP, PA, DPT, PT
- $600 USD cost.
- Pass rate of about 60-70%
- The complete program (including the optional modules) should well prepare you for this exam.
- Dr. Ramakko can fill the attestation form for a fee if you need it.

POCUS musculoskeletal ultrasound specialty certification by the POCUS certification academy

- Requires a “POCUS fundamentals” certification. $150 which includes a 1-2 hour online module and an exam.
- They do have some free case studies and learning resources/infographics
- Individual regions can be certified: upper extremity, soft tissue, or lower extremity. Each costs $150, requires an exam, 20 scans, 2 peer evaluations of competency.
- $625 for specialty certification. Requires an exam, 60 scans, 2 peer evaluations, and Six 5s-60s video submissions (3 showing normal anatomy and 3 showing pathology)

Certificate, Diplomate, or Fellowship in musculoskeletal ultrasound by the american academy of MSK ultrasound (AAMU)

- Certificate $3999, Diplomate $8,388, Fellowship $28,050
- All of them include online learning modules and 2 weekend live scanning events.
- Diplomate adds in 2 more days of live scanning and a report writing module
- Fellowship adds live-onsite mentorship and 150 individualized case reviews.
- Advertised as the only musculoskeletal ultrasound fellowship program

AIUM practice accreditation

- voluntary accreditation of a clinic
- sets standards for equipment and for practitioners.
- The standards for chiropractors are as follows:

  The supervision and/or performance, interpretation, and reporting of ~~150~~ 300 (as of April 2025) diagnostic MSK ultrasound examinations and 30 hours of AMA PRA Category 1 Credits™ or AOA Category 1-A Credits specific to MSK ultrasound within the previous 36 months, including at

least 1 MSK ultrasound course that provided hands-on training; and Certification in MSK ultrasound (active status) by the APCA-RMSK Or Diplomate status granted by the American Chiropractic Board of Radiology or the American Chiropractic Board of Sports Physicians.

If they have been in practice for more than 36 months, then evidence of 30 hours of credits and documentation of 150 exams or written attestation by department chief who meets criteria.

Some online educational programs

"musculoskeletal sonography for Advanced Practice" by the Michener Institute

- **(I did this and it was terrible - Dr.Ramakko)**
- Sonographer level program
- Amateurish: links to free youtube videos, missing examples of scanning important regions, (No example of posterior knee scan?!), errors in quizzes, etc…
- Region based, one module for each region: shoulder, wrist, hip, etc…
- - normal then common pathologies. Common format, easy to organize the curriculum and to teach.
- Officially 48 hours (4.8CEU) but less in practice, only temporary access to lectures.
- Approx $1000 USD

AIUM online continuing education

- 50 online seminars, webinars, lectures, and articles
- Ranging in length from 1 to 3.5 CE hours **(I've watched a few, they are excellent -Dr. Ramakko)**
- From **$0** to $60/hour - discount for members
- They partnered with the american physical therapy association to promote ultrasound use and the online lectures/seminars produced are **relevant for POCUS chiropractors and physical therapists.**
- You can watch just one lecture, specifically on how to use it to diagnose carpal tunnel (not a comprehensive lecture on all wrist sonoanatomy/pathology). After that one lecture the physician can start to use it for that purpose that day! They also have longer lectures, One on general msk ultrasound use (3.5 hours) and some on regions (1-2 hours).

MSKmasters

- educational materials produced by a chiropractor
- foundations course (18 hours), live scanning demo (6 hours), and RMSK review (20 hours).
- videos are 15-20 minutes long, easily digestible
- lifetime access, $1,795 USD for the whole program (as of April 2022)
- This program is similar to what we should want in terms of size of videos, foundations covering basics to get the chiropractor knowledgeable enough to get out there and start scanning and then the RMSK review course delves into the deep detail of an expert. Example: the foundations course covers scanning the posterior wrist for tenosynovitis or effusion in such a way to spot if something is wrong. The RMSK review goes into the specific compartments of the posterior wrist.

Gulfcoast ultrasound institute

- Online goal based courses from about $500 to $1,200 USD, one year access.

- All of them involve John Jacobson MD, RMSK (author of arguably the most well known book on msk ultrasound)
- Region based introduction (upper extremity or lower extremity), physics and sonography principles and instrumentation registry review, rmsk review, POCUS MSK certification review, peripheral nerves, advanced ultrasound uses.
- rmsk review is the longest course at approx 24 hours. **(I did this and it was excellent, equivalent to my program but more radiologist/MD focused - Dr. Ramakko)**

American Academy of Musculoskeletal Ultrasound (AAMU)
- Certificate, diploma, and fellowship program
- Live weekend courses mostly
- Top level includes a site visit and a 150 report writing/interpreting module
- Prices for the three levels are $3999, $8388, and $28,050 respectively.

American Academy of Manipulative therapy (AAMT)
- Live workshops costing about $1,300 a piece
- 60 hour diploma program, 4 courses in 8 days, cost of about $5,000
- 114 hour fellowship program, 6 courses over 14 days, cost of about $9,000

123sono / sonoskills
-15 hours, 170 short lectures, introduction to msk ultrasound
- 20 h shoulder-only course, 12 hour foot and ankle course
-courses are roughly $500 USD - one year access

MSK ultrasound mastermind
-taught by a RMSK/physiotherapist
-typical modules: intro, shoulder, elbow, wrist/hand, etc… Each module with anatomy, how to scan, then pathology.
-only program I've seen so far with a module on lumbar spine and SI joints.
-$1,500

Sonosim
- simulated scanning software and usb scanning device (fake ultrasound transducer and pad)
- only way to get a feel for scanning pathology before finding it in patients. I'd argue that scanning a live person is still better than using the simulated pad for normal anatomy.
- I like the idea of scan-along exercises and would like to incorporate that into our program except with the use of an actual transducer, on themselves or on a helper.
- modules are $400-$800 USD and the entire package for msk is $4500USD.
- Requires yearly membership to retain access to purchased modules.

Pocuspro
- Resource to have experts over-read and comment on your images and cases at $10/case. Resource of case studies to read and participate in discussions.

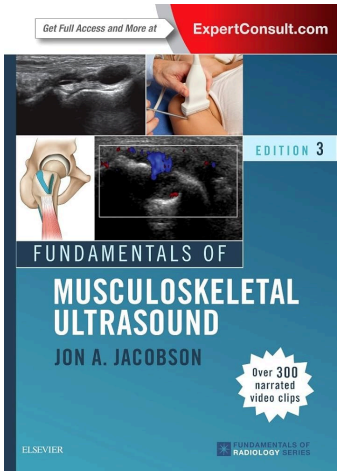
NHS/College of radiographers - clinical imaging
- $120 for a 45 module course involving MRI, radiographs, and sonography (half a dozen modules). Each module is roughly 2-3 hours.

Appendix IV: Useful Educational resources

AIUM online continuing education
- Some lectures are free

Free youtube videos
- SMUG ultrasound: 2 minutes quick scan protocols with normal anatomy - perfect for the POCUS practitioner either to learn or to get a refresher. Longer 8min to 20 min videos, often featuring Jon Jacobson.
- MSK Australia - 2-5 min scanning videos featuring normal anatomy - great for POCUS practitioners.

Jon Jacobson's book - Fundamentals of Musculoskeletal Ultrasound, third edition.



Radiopedia
- Resource for radiologists

European Society of Musculoskeletal Ultrasound scanning guides
- Guides for Ankle, Knee, Elbow, Shoulder, Hip, Wrist
- Shows normal anatomy with some standard positions and views.
- Good for practicing.
- I got into the trap of trying to get the pictures when I started scanning patients, the static picture is a starting point, you have to scan through the anatomy you are interested in. Ultrasound scanning is much more organic and dynamic, particularly in a pocus setting, than radiographs where the standard images are what you want.

The EFSUMB Guidelines and Recommendations for Musculoskeletal Ultrasound part I, part II

POCUS certification Academy
- Infographic and case studies

-

Appendix V: Ultrasound Machine Recommendations

An ultrasound transducer is necessary for this program. A high frequency linear array transducer with 196 elements or more is recommended with a maximum frequency of at least 12 MHz, but ideally a bit higher like 15-18MHz. Colour and/or power doppler are useful to detect hyperemia (increased blood flow) as can be found in inflammation, vascularity in soft tissue masses, or neovascularity in tendinosis. Other optional features like, compound imaging, elastography, and extended field of view may be useful. Split screen is also highly recommended.

I have the Clarius L15HD combined with the Samsung tabs6 lite and it is a reasonable option (I have no affiliation with either company). Order the optional fan attachment as you will need it for practicing. I have a Chinese suresult 196 element, 64 channel dual ended probe. It is usable for diagnostic purposes but the learning curve would be steeper if this was your unit to learn with, I feel I can only use it as well as I can because I already know what I'm looking for. If this is all you can afford then using it is better than no ultrasound. The GE and Philips handhelds are reported to be at the same level as the Clarius but may offer a better user experience, but maximum frequency may be lower:[6]

You get what you pay for. The more the better. A used cart or laptop model from within the past 10-15 years may give better images than any handheld.

A curvilinear transducer or sector probe may help image some msk structures on larger patients and would also give you the capability to do emergency protocols like the eFAST and screen for AAA.

[6] Perez-Sanchez, A., Johnson, G., Pucks, N. et al. Comparison of 6 handheld ultrasound devices by point-of-care ultrasound experts: a cross-sectional study. Ultrasound J 16, 45 (2024). https://doi.org/10.1186/s13089-024-00392-3

Appendix VI: Advanced Standing Details

Those with RMSK status can challenge the IANM CNMS exam directly if they have achieved 30 hours of education AND have 2+ years of experience using ultrasound on patients.

Board certified radiologists with 2+ years of MSK ultrasound experience and 30 hours of training can challenge the exam.

“Experts” in the field, teaching accredited courses with 2+ years of experience and 30 hours of training can challenge the exam.

Those with 5+ years of experience with MSK ultrasound can challenge the exam if they also have 30 hours of education.

Those who have earned a PgCert (1 year Post grad), PGDip (2 years post grad), MSc (3 years post grad) in MSK Ultrasound in the UK/European system can challenge the exam.

In addition to accepting hours from Dr. Ramakko’s 80 hour program, you can use other programs/workshops towards the 80 hours. It can’t replace the practical exam unless your training included a practical testing component or a letter of attestation to competence by an expert (anyone who meets the fellowship mentor requirements). Content of the alternative hours should include content similar to the program outlined in this document.

- Hours that are accredited by a university, or respected professional organization for CE credits and/or PRA category 1 credits will be accepted.
- Webinars by ultrasound manufacturers will be accepted, a supervisor must sign off that you completed the seminar if the seminar does not issue certificates of completion.
- In person training can be accepted, signed off by a supervisor and/or the individual running the workshop/training session if they meet the fellowship mentor requirements.
- Hours in any program (live or recorded) approved by subcommittee experts (fellowship mentor requirements).
- At this time, only the michener institute in canada is excluded.
- AIUM and the Gulfcoast Ultrasound Institute are both highly recommended alternatives.

Appendix VII: 2025 Specialty Subcommittee Members

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