MUSCULOSKELETAL SYSTEM

CHAPTER 24

1

OBJECTIVES

Upon completion of this presentation, students will be able to:

- Identify the normal anatomic location and function of the tendons, ligaments, muscles, nerves, and bursa
- Describe sonographic artifacts in MSK imaging
- Identify basic anatomy, protocols, and patient positioning for MSK exams of the shoulder, wrist/hand, and ankle
- Recognize various types of MSK pathology

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ANATOMY OF THE MUSCULOSKELETAL SYSTEM

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MUSCLE

Skeletal Muscle

- contains long organized units called muscle fibers
- Long fibers under voluntary control: to contract muscle and move joints
- Groups of muscle fibers are encapsulated by a thin connective tissue layer called the **perimysium**
- The group of muscle fibers referred to as muscle bundles
- Blood vessels, lymphatics, and nerves follow fibrous partitions between bundles of muscle
- Muscles have fibers that run parallel to bone
  - fan shape, or pennate pattern
  - run oblique to long axis of the muscle and are unipennate, bipennate, multipennate, or circumpennate

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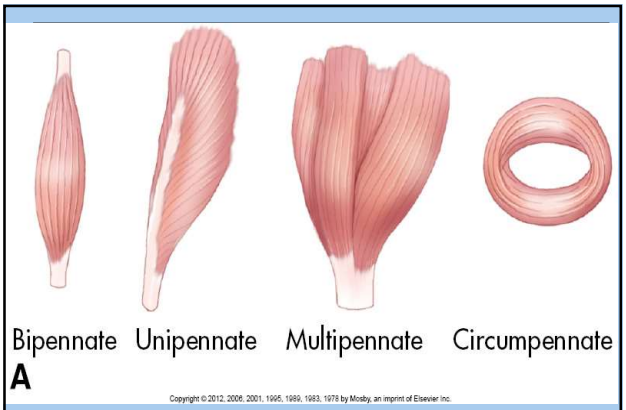

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MUSCLE (CONT'D)

- Proximal portion of muscle considered origin; insertion is distal end
- Muscle with two or more heads has origin in more than one place on bone

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MUSCLE (CONT'D)

- Muscle bundle contains nerves, fascia, tendons, fat, and the fibrous connective tissue surrounding muscle
- Epimysium continues into muscle developing into perimysium, which separates the bundles into muscle fibers
- Hypoechoic structures, when compared with muscle fibers, help differentiate muscles

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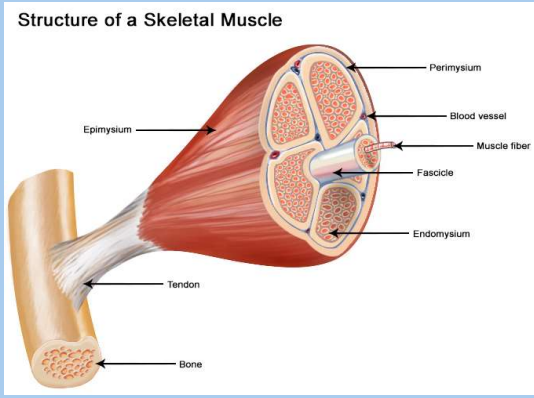

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MUSCLE (CONT'D)

- Sonographic appearance of muscle can be deceiving in some areas, such as hand, because of similarity of echo texture to mass or tenosynovitis
- Careful scanning and transducer rotation help image pinnate structure of muscle, aiding in identification of possible normal muscle variant

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MUSCLE (CONT'D)

- Normal dynamics of muscle image easily in real-time since contraction of muscle increases thickness and hypoechogenicity
- Echogenic connective tissue bands increase in obliquity
- Sustained contraction of muscle has same sonographic appearance as muscle bundles found in athletic patient.
- Decreased echogenic muscle, as result of hypertrophy, normal for this patient population.
- Compression of muscle with transducer condenses tissue, resulting in increase in echogenicity of muscle.

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MUSCLE

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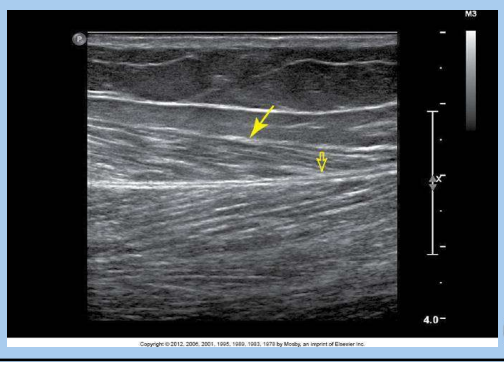
MUSCLE



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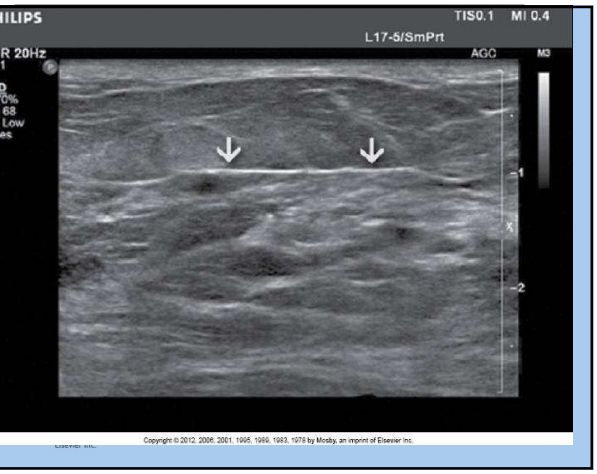

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TENDONS

- Attachment of muscle occurs at proximal and distal portions of bundle- collection of tough collagenous fibers called a tendon
- Attachments can be cordlike or flat sheets (aponeuroses) -occurs in flat muscles like the rectus abdominis in abdomen
- Tendons occur with or without synovial sheath
- Tubular sac surrounding tendon has two layers
- Fluid separates two layers of sheath and occurs in shoulder, hand, wrist, ankle

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TENDONS (CONT'D)

- Biceps tendon of shoulder is one example of tendon with synovial sheath
- Thickness of sheath only a few millimeters
  - ❖ appears as a hypoechoic halo surrounding tendon
- Inflammation of sheath and tendon aids in imaging and diagnosing problems with tendon
- Paratenon- loose areolar connective tissue that fills fascial compartment of tendon lacking synovial sheath
- Epitendineum- layer of connective tissue that closely adjoins tendon
  - ❖ images as echogenic layer adjacent to tendon

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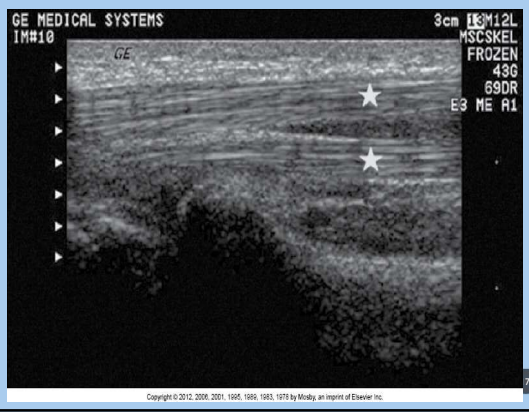
TENDONS



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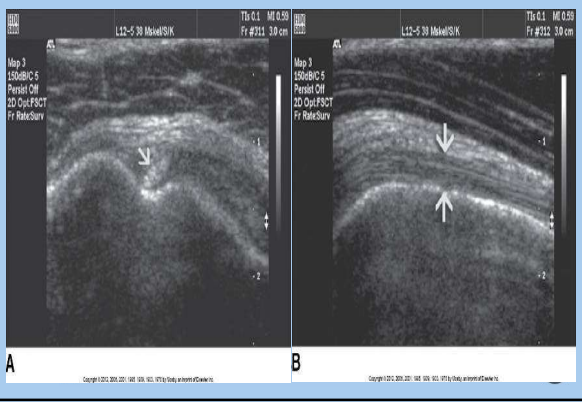
TENDONS



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TENDONS (CONT'D)

- Lack of density differences in interfaces makes tendon difficult to image.
- Examples: Achilles, patellar, proximal gastrocnemius, semimembranosus tendons
- Interwoven and interconnected collagen fibers found in tendon run in parallel path.
- Numerous interfaces of collagen fascicles provide strong linear reflector that images well.
- Linear array >7- to 10-MHz transducer

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TENDONS (CONT'D)

- Tendon insertion site has its own sonographic characteristics
- Joining of tendon to bone occurs (enthesis) with narrow band of fibrocartilage
  - Avascular structure- 1 cm long and images longitudinally as triangular hypoechoic area in distal tendon
- Familiarity with normal sonographic appearance important because injury to area of tendon results in thickening of insertion site

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LIGAMENTS

- Short bands of tough fibers connect bones to other bones
  - provides support and strength to joints
  - important in knees, ankles, and shoulders
- Thin, superficial structures; difficult to image
- Higher frequency transducer (>10 MHz), and possibly a standoff pad to aid in imaging ligaments outside joint

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LIGAMENTS (CONT'D)

- Critical to ligament identification—equipment parameter adjustment
  - Too much gain with either overall gain or time gain compensation (TGC) results in loss of detail
  - Longitudinal imaging of ligament only method used to image injuries
  - Transverse planes are of little help when imaging ligament

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LIGAMENTS (CONT'D)

- Ligaments in large joints of body image well as hyperechoic straplike structures
  - hip, shoulder, ankle, wrist, knee
- Exception- Cruciate ligament within knee joint, which appears hypoechoic
- Difficulty in imaging ligament: Lack of contiguous structure, such as muscle, to aid in location

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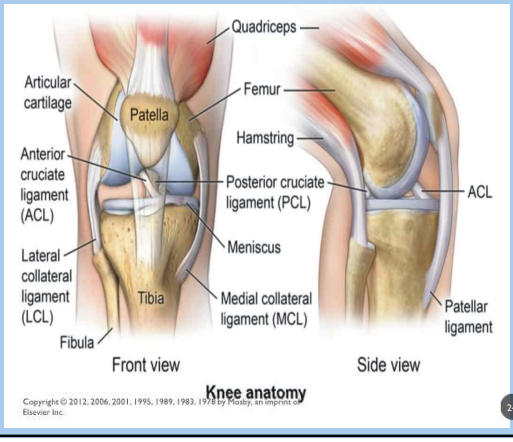

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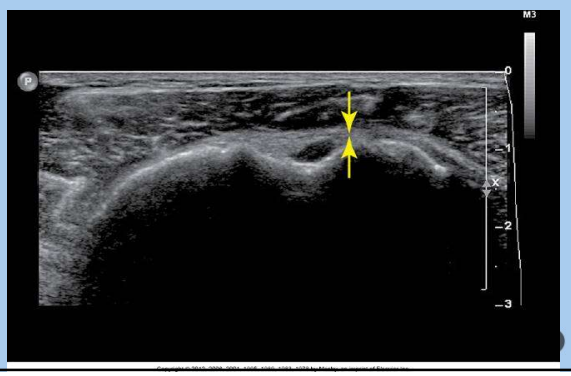
LIGAMENTS



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LIGAMENTS (CONT'D)

- Dense fibers have slightly less regular appearance and may help hold tendon in place
- Ligament measures 2 to 3 mm thick; images as hypoechoic band with homogeneous appearance
- Structures found close to both ends attaching to bony cortex

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LIGAMENTS (CONT'D)

- Median collateral ligament (MCL) or tibial collateral deviates from usual ligament appearance.
- Wide, smooth ligament: 9 cm long, deep and superficial portions
- External superficial portion: Connective tissue appearing as dense band that connects medial femoral condyle to proximal tibia
- Deep layer connects medial meniscus to femur and tibia

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LIGAMENTS (CONT'D)

- Sonographic imaging of MCL reveals three-layer structure
- Superficial and deep layers have a hypoechoic-separating layer
- Loose connective tissue forms this middle layer and is a potential space for bursa in some individuals

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BURSA

- Small sac between two moving surfaces, usually tendon and bone
- These fluid-filled cavities facilitate movement of tendons or muscles over bony projections
- Minute amount of viscous fluid within bursa helps reduce friction between moving parts of joint
- Major bursa of body is subacromial-subdeltoid bursa found in shoulder covering deep surface of deltoid muscle

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BURSA

- Types of bursa:
  1. communicating
  2. noncommunicating
- Categorization explains relationship of bursa to joint space
- Communicating bursa that sonographers see is called a Baker's cyst
  -located in medial popliteal fossa
  -located between semimembranosus and medial gastrocnemius tendons
  - has connecting neck to bursa contained within knee joint
- Superficial, noncommunicating type of bursa is prepatellar bursa

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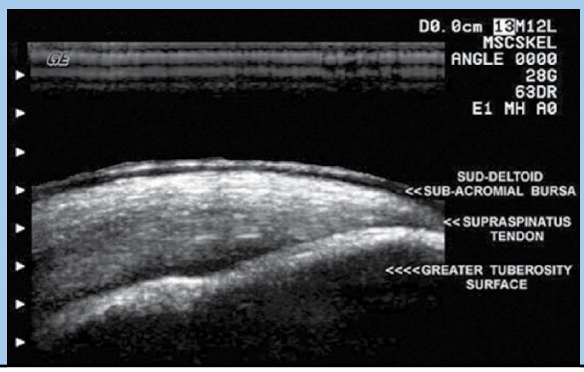
BURSA



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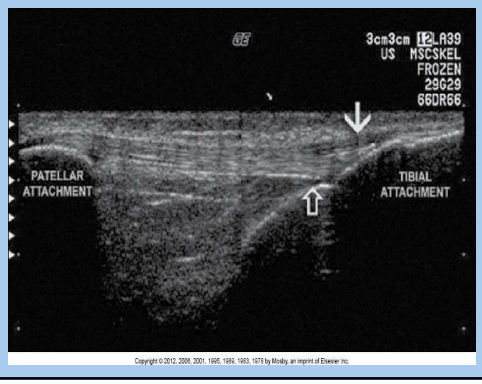
BURSA



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NERVES

- Conduit for impulses to and from muscles and central nervous system (CNS)
- Muscle action- under control of muscle system with nerves in contact with muscle through motor end plates
- Elements of nerves include nerve fibers, arranged into bundles (fasciculi) and surrounded by dense insulating sheaths of myelin (forms sheath of Schwann cells), and connective tissue
- In transverse views, nerve fibers appear hypoechoic, with hyperechoic perineurium surrounding each fiber
- Collagenous epineurium: Outer layer of nerve, appears as hyperechoic layer

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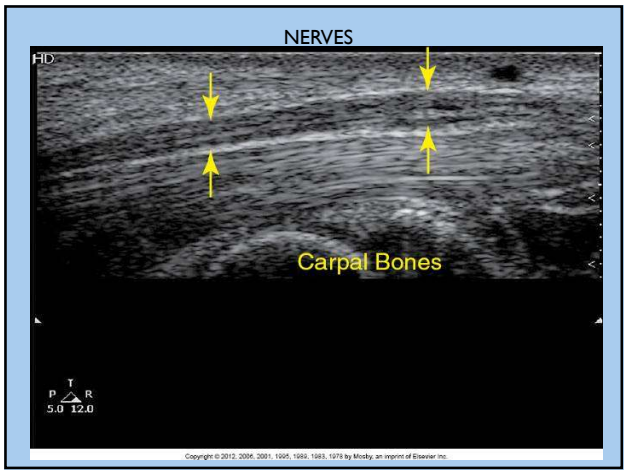
NERVES
Carpal Bones

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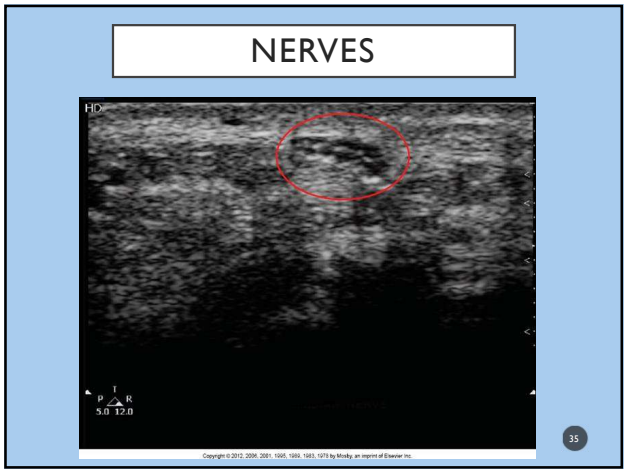
NERVES
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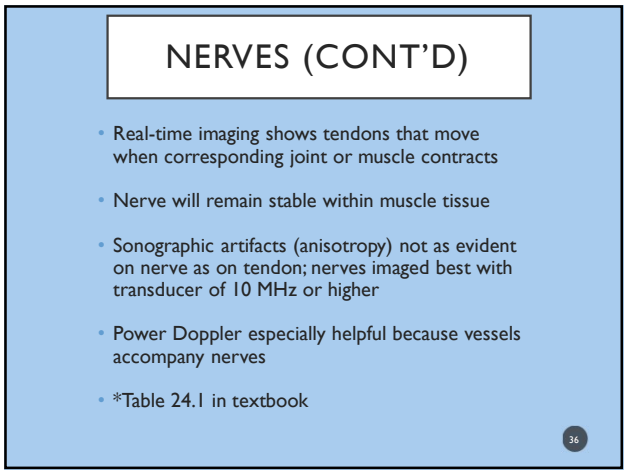
NERVES (CONT'D)
Real-time imaging shows tendons that move when corresponding joint or muscle contracts
Nerve will remain stable within muscle tissue
Sonographic artifacts (anisotropy) not as evident on nerve as on tendon; nerves imaged best with transducer of 10 MHz or higher
Power Doppler especially helpful because vessels accompany nerves
*Table 24.1 in textbook
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LIGAMENTS

- Thin, superficial structures- difficult to image
- Higher frequency transducer (>10 MHz), and possibly a standoff pad to aid in imaging ligaments outside joint
- Critical to ligament identification—equipment parameter adjustment
  - ✓ Too much gain with either overall gain or time gain compensation (TGC) results in loss of detail
  - ✓ Longitudinal imaging of ligament- only method used to image injuries
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LIGAMENTS (CONT'D)

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  *exception is the Cruciate ligament within knee joint which appears hypoechoic
- Large joints include hip, shoulder, ankle, wrist, knee
- Difficulty in imaging ligament due to lack of contiguous structure, such as muscle, to aid in location
- Dense fibers have slightly less regular appearance and may help hold tendon in place.
- Typically measures 2 to 3 mm thick; images as hypoechoic band with homogeneous appearance
- Found close to both ends attaching to joint

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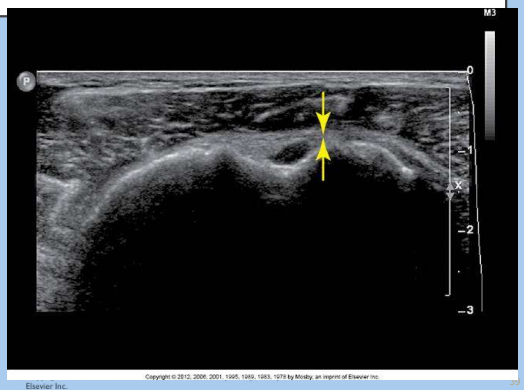
LIGAMENTS



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MEDIAN COLLATERAL LIGAMENT (MCL)

- Median collateral ligament (MCL) or tibial collateral deviates from usual ligament appearance
  - external, superficial portion connects medial femoral condyle to medial proximal tibia
  - deep layer connects medial meniscus to femur and tibia
- Wide, smooth ligament
- 9 cm long

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MCL (CONT'D)

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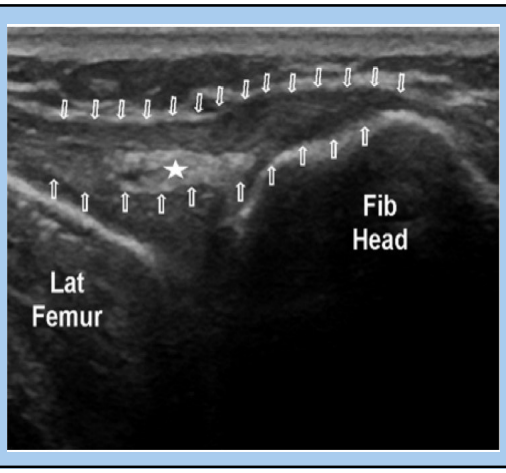

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ARTIFACTS

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TYPES OF ARTIFACTS:

- Aniostropy
- Reverberation
- Speed error
- Refractile shadowing

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ANISOTROPY

- Occurs when the angle of insonation is not perpendicular to the structure being imaged
- Angle and direction of the reflected soundwave depends on the angle of incidence, as well as the shape of the reflector
- Soundwaves reflect away from the transducer instead of directly back at 90 degrees

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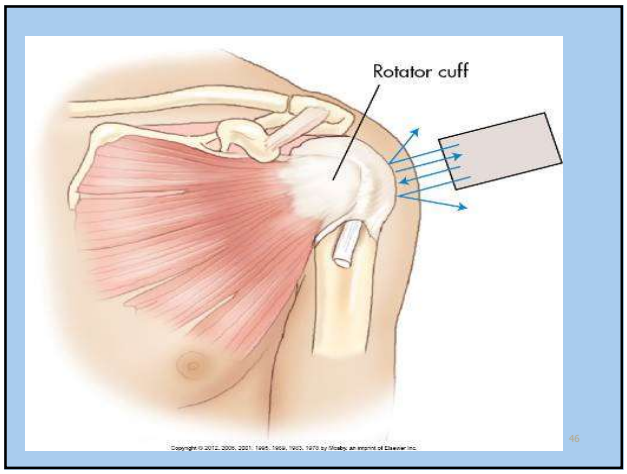
Rotator cuff

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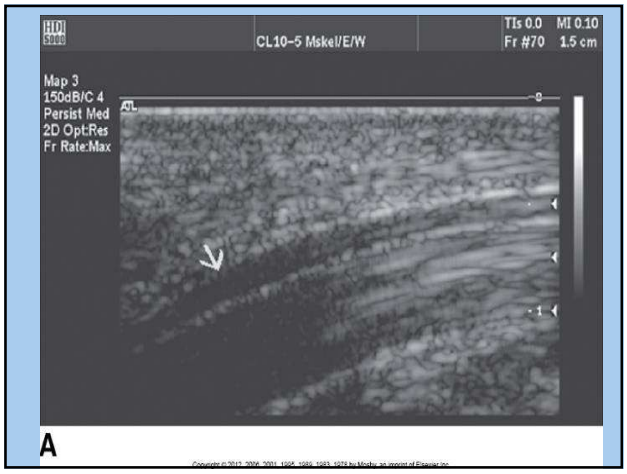
CL10-5 Mskel/E/W
TIs 0.0 MI 0.10
Fr #70 1.5 cm
Map 3
150dB/C 4
Persist Med
2D Opt:Res
Fr Rate:Max
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L12-5 38 Mskel/Hd/Ft
TIs 0.0 MI 0.3
Fr #83 2.4 cm
Map 3
150dB/C4
Persist Med
Fr Rate Med
2D Opt:Res

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REVERBERATION

- Initial sound beam transmits and returns
- Multiple delayed reflections from strong tissue boundaries, such as bone, result in linear artifact that *decreases* in intensity with depth.
- Reflected sound is superimposed over primary signal, adding distracting information to image

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REVERBERATION (CONT'D):

- Comet tail artifact- function of sound bouncing between two closely placed reflectors within imaged structure
- Pin surgically placed within bone- reflecting surfaces are anterior and posterior borders of hardware
- Ringing occurs within metal object; each time sound returns to anterior border some sound escapes
- Resultant artifact resembles comet tail

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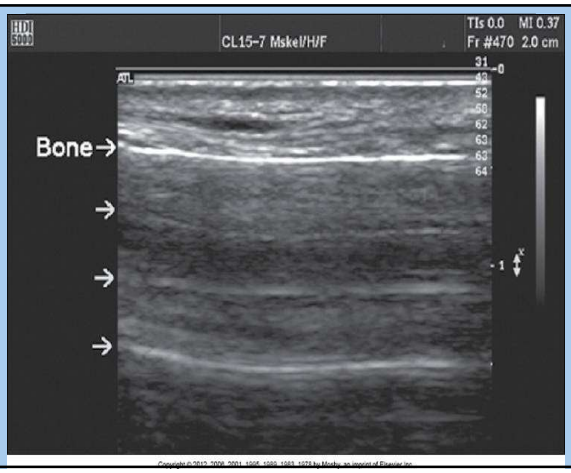

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REFRACTILE SHADOWING

- Aka. edge artifact
- When incident soundwave interacts with a curved surface, causing the soundwave to redirect in an oblique path
- Change in direction of sound beam results in hypoechoic band posterior to structure

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REFRACTILE SHADOWING (CONT'D)

- Another cause of refractile shadowing is tissue impedance mismatch different than average speed of sound within soft tissue (1540 m/sec)
- Seen at edge of round or oval ligament or as result of traumatic tear of a MS structure

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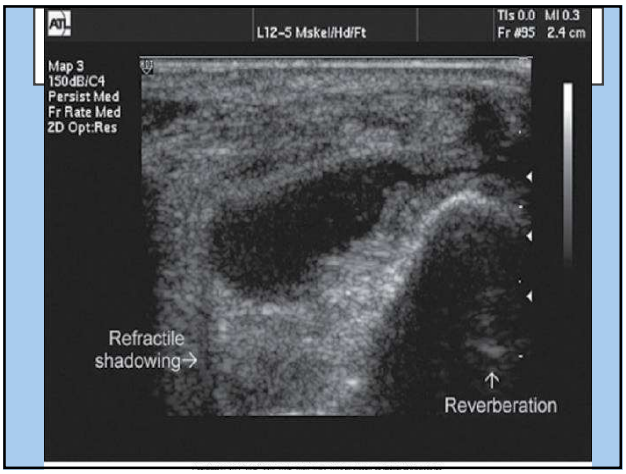

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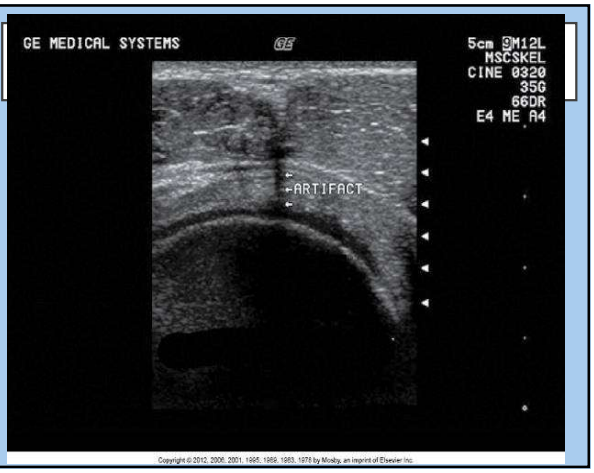

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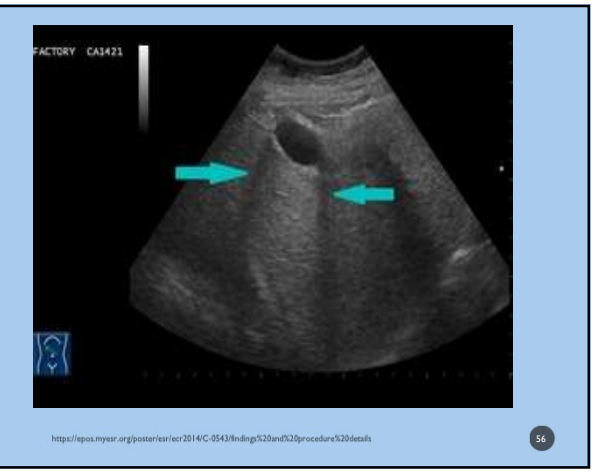

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SPEED ERROR

- Time of flight, or speed of sound, artifacts occur when returning sound wave has passed between two tissues with markedly different speeds
- Misrepresentation of return time results from assumption that speed of sound is constant 1540 m/sec

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SPEED ERROR (CONT'D)

- If speed of sound less than average in tissue, artifact appears to be farther away from transducer
- Faster speed results in artifact being closer to transducer on image
- Creation of this type of false information occurs most commonly when imaging obese patients at muscle-fat interface

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SPEED ERROR (CONT'D)

- Speed of sound artifact displaces image in anteroposterior (axial) plane.
- Speed artifact coupled with refraction, structure displays with incorrect shape

**Do not mistake very subtle artifact with transducer crystal malfunction

- Mechanical failure produces decrease in image information that begins at transducer face; time of flight artifact affects only image

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HOW DO I FIX THIS?????

ARTIFACT	CORRECTION TECHNIQUE
Ansitropy	Heel-to-toe rocking of transducer creates perpendicular angle of incidence to remove anisotropy
Reverberation	Use of a standoff pad or changing angle of incidence
Refractile	Compound imaging or tissue harmonics help reduce or eliminate artifact
Time of Flight (Speed Error)	Change angle of incidence

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SONOGRAPHIC EVALUATION OF MSK

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SONOGRAPHIC EVALUATION OF THE MUSCULOSKELETAL SYSTEM

- Rotator cuff
- Carpal tunnel
- Achilles tendon

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INDICATIONS FOR SHOULDER SONOGRAPHY

- Shoulder pain or swelling
- Pain with joint rotation
- Weakness with arm elevation
- Trauma
- Decreased range of motion
- Evaluation of soft tissue masses

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MINIMUM SHOULDER VIEWS OF THE ROTATOR CUFF

- View 1/2: Biceps tendon longitudinal and transverse (Do you have any money?)
- View 3/4: Subscapularis tendon longitudinal and transverse (I don't know.)
- View 5/6/7/8: Supraspinatus tendon in neutral and internal rotation (Let me check.)
- View 9/10: Infraspinatus/posterior glenoid labrum (I swear I don't.)
- View 11: Teres minor (I swear I don't.)

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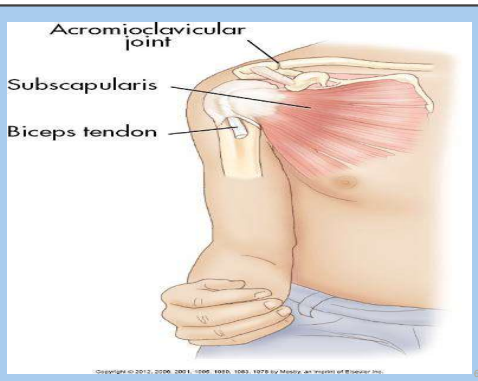
ROTATOR CUFF



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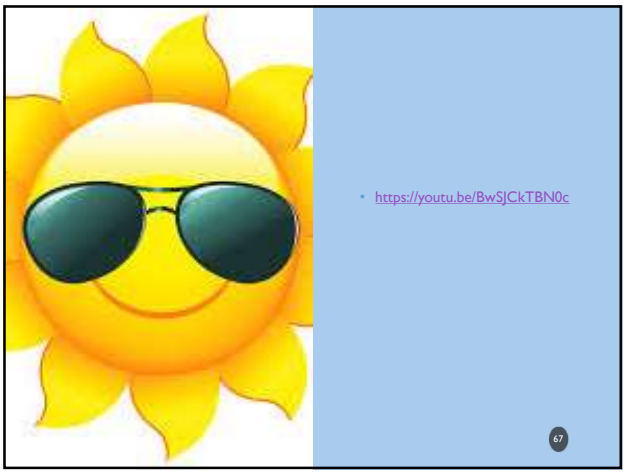

- https://youtu.be/BwSJCkTBN0c

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BICEPS TENDON

- 3- to 5-mm-thick and is easily located in the transverse plane, appearing as an echogenic oval structure within the bicipital groove of the humerus
- Bicipital groove is an indentation on the humerus located between the greater and lesser tuberosities
- Overlying transverse ligament encloses the open portion of the groove to house the biceps tendon

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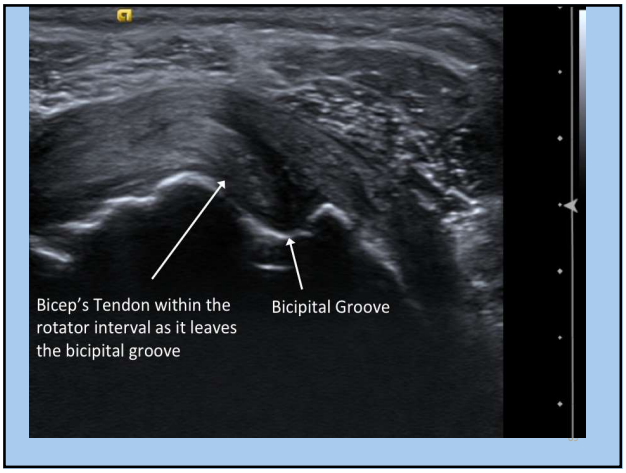

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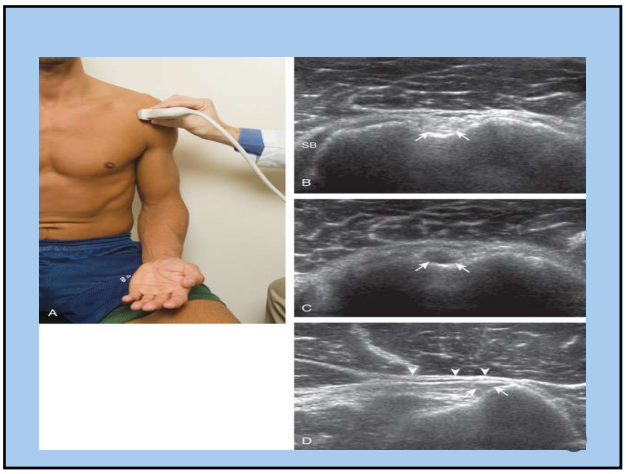

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SUBCAPSULARIS TENDON

- Subscapularis imaging begins by identifying the biceps tendon in the transverse plane at the level of the humeral head
- Using the biceps tendon as a landmark, the transducer is angled anteromedially to view the subscapularis
- The transverse view displays the tendon as an oval soft tissue structure

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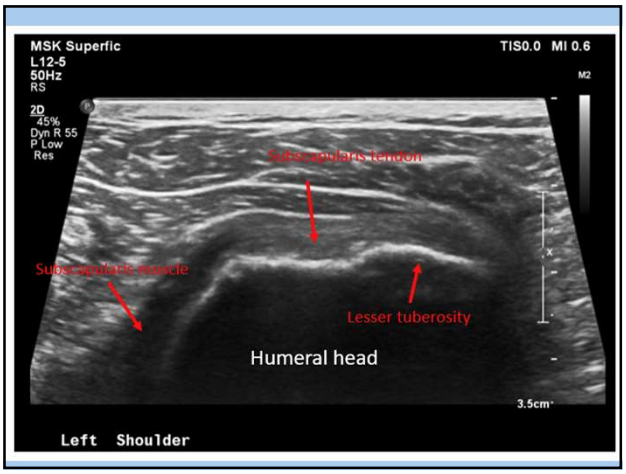

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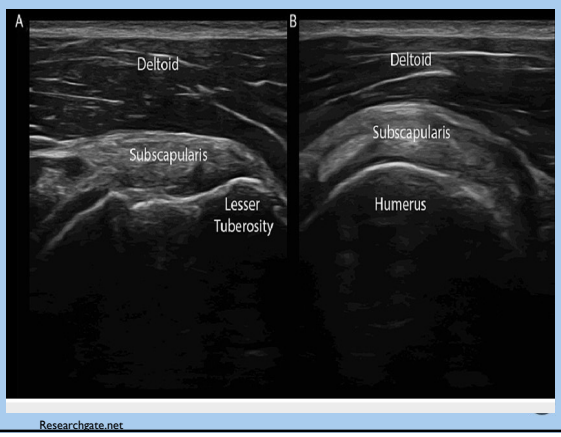

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SUPRASPINATUS TENDON

- Located lateral and posterior to the biceps tendon
- 3-7 mm
- Band-like tendon that has a medium-level echo texture
- Originates from the greater tuberosity of the humerus
- The acromion limits the field of view, requiring careful transducer and patient positioning

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SUPRASPINATUS TENDON (CONT'D)

- A portion of the tendon, called the critical zone, is the most likely location for injury
- Initial transverse and longitudinal views begin with the patient's arm in a neutral position; however, after localization of the tendon, the arm is repositioned into the **Bouffard** (on the hip) or **Crass** position (behind back)
  - stresses the tendons of the rotator cuff to emphasize any abnormalities
  - Also causes the supraspinatus to move anterior and out from under the acromion, allowing better visualization and a more thorough assessment of the tendon

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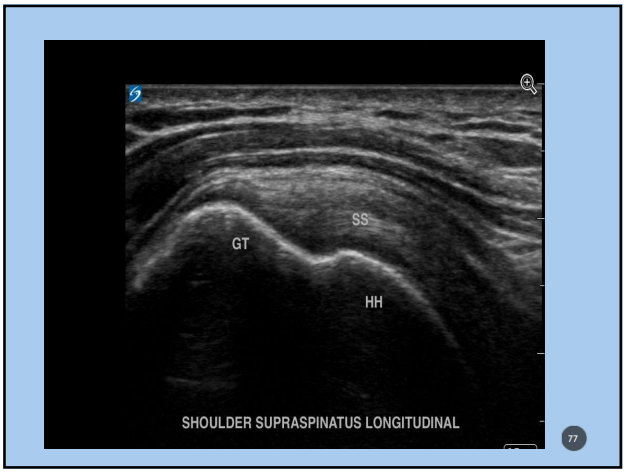

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INFRASPINATUS TENDON

- Two methods are available to localize the tendon:
  - The first involves rotating the patient to gain access to the posterior shoulder and positioning the hand on the patient's opposite shoulder.
  - The posterior glenoid labrum is a good landmark to help find the anteriorly located infraspinatus tendon

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INFRASPINATUS TENDON

- The second method has the patient's arm in the same position used while imaging the biceps tendon, locating the supraspinatus tendon, moving posterior and parallel to the scapular spine, and locating the infraspinatus tendon at its attachment to the posterior greater tuberosity of the humerus.
- Fluid imaged superficial to the infraspinatus tendon indicates bursal fluid, whereas posterior fluid indicates joint effusion

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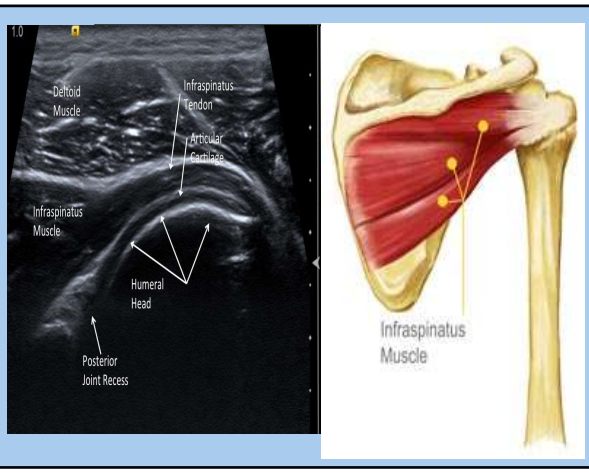

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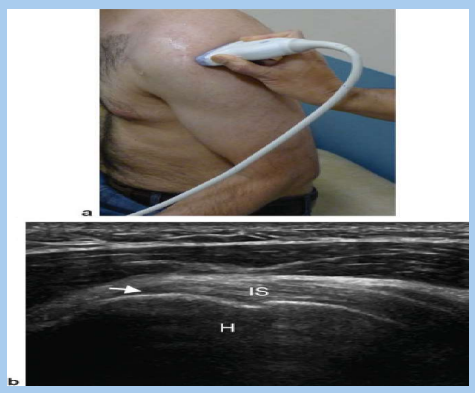

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TERES MINOR TENDON

- Lies parallel to the scapular spine and inferior to the infraspinatus tendon
- To differentiate the infraspinatus tendon from the teres minor, pay close attention to the plane of the tendon fibers
  - Horizontal fibers indicate the infraspinatus, whereas the teres minor is on an oblique plane
  - The teres minor tendon appears as a trapezoidal structure inferior to the infraspinatus tendon

82

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ACROMIOCLAVICULAR (AC) JOINT

- Joint in the shoulder where the clavicle meets with the scapula (shoulder blade)
- Superficial and easy to image
- Most common conditions are arthritis, fractures, and separations

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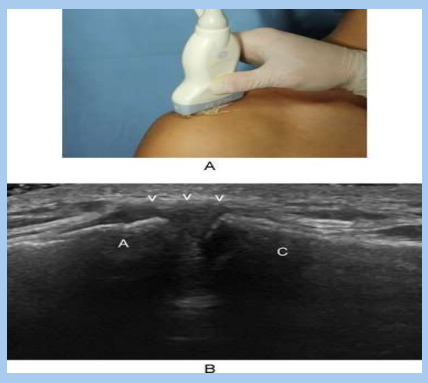

https://www.sciencedirect.com/science/article/abs/pii/S0720048X14005142

86

86

INDICATIONS FOR WRIST SONOGRAPHY

- Masses
- Palpable lesion
- Loss or decrease of digital mobility
- Pain and swelling
- Trauma
- Foreign body location
- Numbness of middle and index fingers
- Weakness or clumsiness of hand
- Tingling with nerve percussion (Tinel's sign)
- Pain with wrist flexion when sustained for minute or longer (Phalen's sign)

87

87

WRIST/HAND

- Benefit of sonographic wrist imaging is its ability to demonstrate the dynamics of the wrist and associated masses with finger movement
- "Hockey stick" probes are typically the transducer of choice when imaging the wrist, hand, and fingers
- An excess amount of gel or standoff pad should be used to optimize very superficial wrist structures

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WRIST/HAND (CONT'D)

- Wrist Protocol (Dorsal or Ventral)

Dorsal (palm down)

- Distal radioulnar joint (DRUJ)
- Evaluate radiocarpal and midcarpal joints
- Evaluate the triangular fibrocartilage near compartment VI
- Evaluate extensor tendon compartments (I-VI)
- Evaluate scapholunate and lunotriquetral ligaments
- Evaluate other joints depending on clinical symptoms

Ventral (Volar) (palm up)

- Evaluate flexor tendons
- Median nerve (carpal tunnel)
- Guyon canal (ulnar nerve)

89

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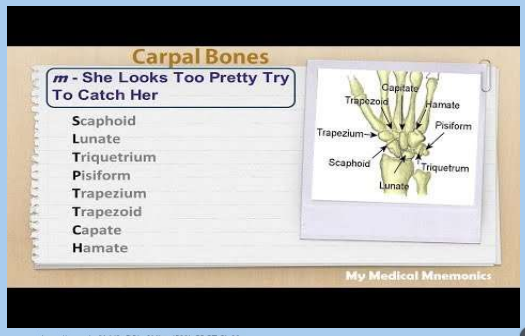
WRIST BONES



https://youtu.be/YpN5wDRb_3M?si=6P29IsGRGTrPjq98

90

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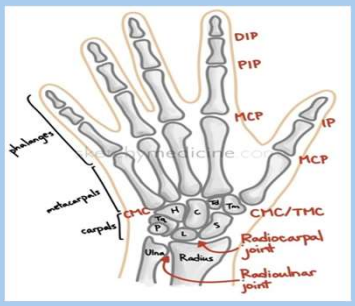
WRIST JOINTS

Distal radioulnar (DRUJ)
Radiocarpal (RCJ)
Midcarpal
Carpometacarpal (CMC)
Thumb metacarpal (TMC)
Metacarpophalangeal (MCP)
Interphalangeal (IP)
Proximal interphalangeal (PIP)
Distal interphalangeal (DIP)



http://sketchymedicine.com/2011/12/bones-and-joints-of-the-hand-and-wrist

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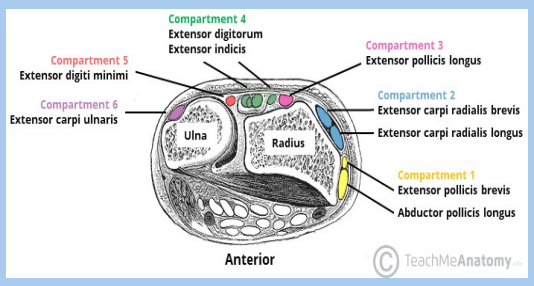
EXTENSOR COMPARTMENTS OF THE WRIST



https://teachmeanatomy.info/upper-limb/areas/extensor-tendon-compartments-wrist/

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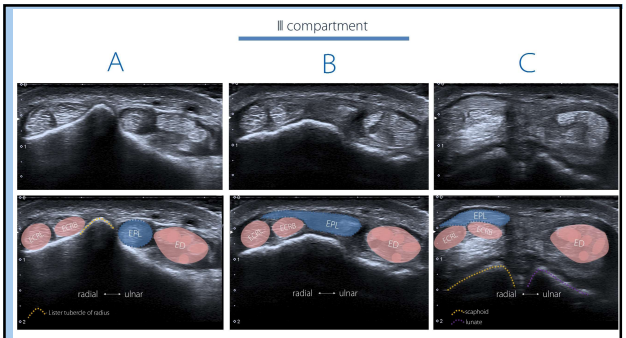

(EPL - extensor pollicis longus tendon). The probe is placed transversally as it is shown on fig. 11. It is moved distally (positions/pictures A - C). Picture A shows the "starting position" – EPL (extensor pollicis longus tendon) is situated on the ulnar side of the Lister tubercle, which is a perfect bony landbark. EPL tendon encroaches superficially (pictures B and C)to the tendons of the second compartment (ECRL - tendon of extensor carpi radialis longus, ECRB - tendon of extensor carpi radialis brevis), ED - tendons of extensor digiforum communis (IV compartment).

https://epos.myesr.org/posterimage/esr/ecr2014/119585/mediagallery/546820?deliveroriginal=1

93

93

PATIENT POSITIONING

- The patient is positioned with the arm at a 90-degree angle, and the palm pronated or supinated on the lap of the patient
- Place a small rolled-up towel under the wrist when examining the palmar (volar) portion of the wrist places the joint in a neutral position, also helps dorsal imaging of the wrist when the hand is palm down

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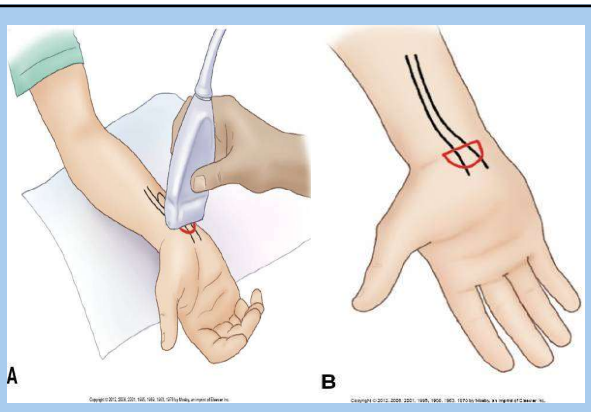

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CARPAL TUNNEL

- Located between the carpal bones and the overlying flexor retinaculum on the palmar side of the wrist
- Flexor retinaculum, also known as the transverse carpal ligament makes up the superficial border of the carpal tunnel, and covers an area extending from the distal radius to the metaphysis of the third metacarpal

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CARPAL TUNNEL (CONT'D)

- The attachment points of the transverse carpal ligament are the hook of the hamate and the pisiform bones on the ulnar side of the arm, and the tubercle of the trapezium and distal pole of the scaphoid on the radial side
  - make up the medial and lateral borders of the carpal tunnel
- Along with the median nerve, nine flexor tendons also pass through the carpal tunnel, causing an inherent reduction

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CARPAL TUNNEL (CONT'D)

- Contains the median nerve, flexor pollicis longus, and the eight flexor digitorum tendons that connect the muscles of the digits to the wrist
- The median nerve, which is of particular interest when diagnosing carpal tunnel syndrome, lies superficial and toward the radial side of the tunnel
  - provides sensory innervation of the lateral portion of the hand, the palmar surface of the thumb index, middle, and lateral half of the ring finger

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CARPAL TUNNEL (CONT'D)

- Guyon's canal- tunnel on the ulnar side of the wrist formed by the hook of the hamate and pisiform bones through which the ulnar nerve passes
- Ulnar tunnel syndrome- compression disorder because of Guyon's canal, just as the median nerve within the carpal tunnel
- Locate the ulnar artery at the wrist crease helps to orient and identify wrist structures

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CARPAL TUNNEL (CONT'D)

- The flexor digitorum tendons are hypoechoic structures just posterior to the median nerve
- Fibrillary hyperechoic tendon patterns help differentiate from the hypoechoic median nerve
- The median nerve also has a distinct hyperechoic border. The rounded or oval median nerve flattens as it continues through the carpal tunnel

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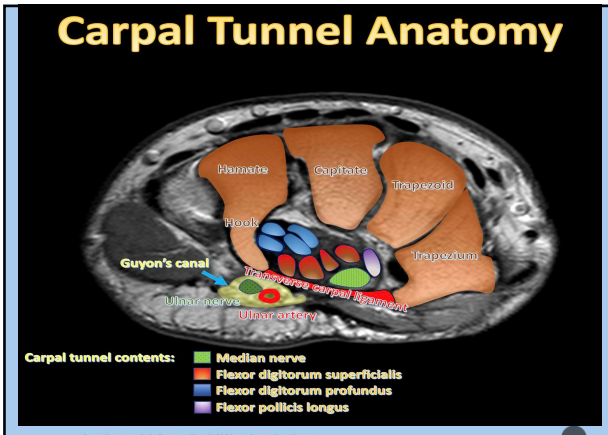

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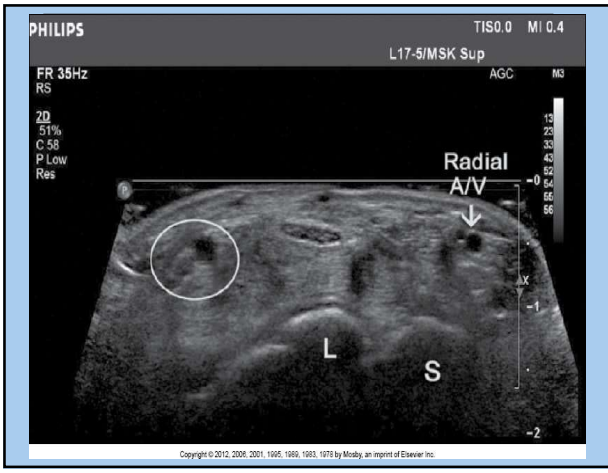

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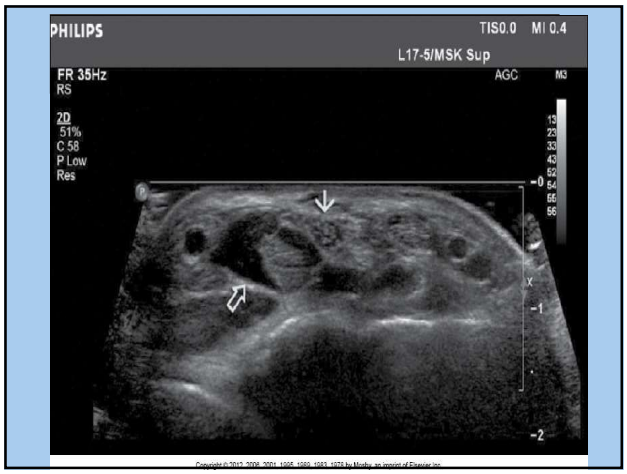
PHILIPS
TIS0.0 MI 0.4
L17-5/MSK Sup
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RS
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M3
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C 58
P Low
Res

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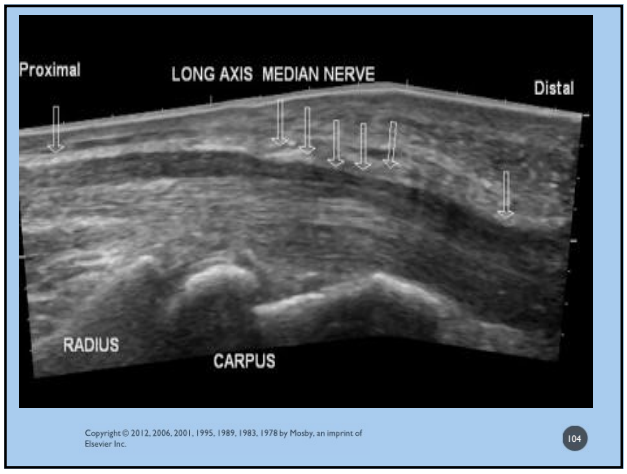
Proximal
LONG AXIS MEDIAN NERVE
Distal
RADIUS
CARPUS
Copyright © 2012, 2006, 2001, 1995, 1989, 1983, 1978 by Mosby, an imprint of Elsevier Inc.
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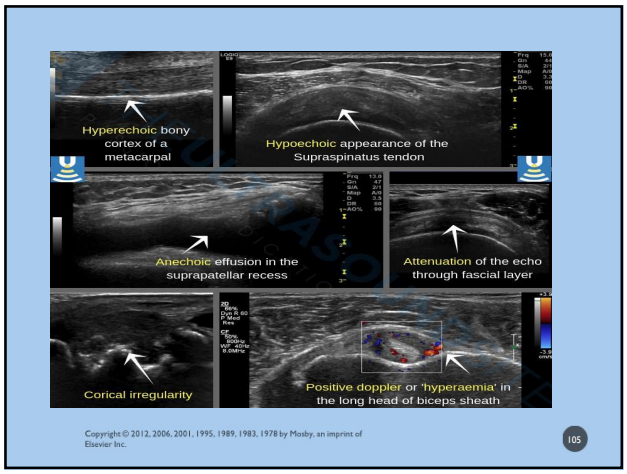
Hyperechoic bony cortex of a metacarpal
Hypoechoic appearance of the Supraspinatus tendon
Anechoic effusion in the suprapatellar recess
Attenuation of the echo through fascial layer
Corical irregularity
Positive doppler or 'hyperaemia' in the long head of biceps sheath
Copyright © 2012, 2006, 2001, 1995, 1989, 1983, 1978 by Mosby, an imprint of Elsevier Inc.
105

105

INDICATIONS FOR ACHILLES TENDON SONOGRAPHY

- Abnormal Thompson's test
- Trauma
- Displacement of Kager's fat pad on a radiograph
- Knot or bulge over proximal tendon
- Audible pop or snap followed by sharp pain
- Inability to stand on toes
- Swelling
- Heel pain >4 weeks
- Decreased strength or mobility
- Postoperative monitoring

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ACHILLES TENDON

- Connects the gastrocnemius and soleus muscles to the calcaneus
- Enables plantar flexion and flexion of the knee from the muscles of the calf and heel-allows moving the foot downward to push off when walking, and to rise up on the toes
- Overstretching can result in a partial or complete tear- most common site of occurrence being the distal portion of the tendon near the insertion to the calcaneus
- A limited blood supply to the Achilles tendon slows the healing process after injury, and results in increased risk of chronic and more severe outcomes

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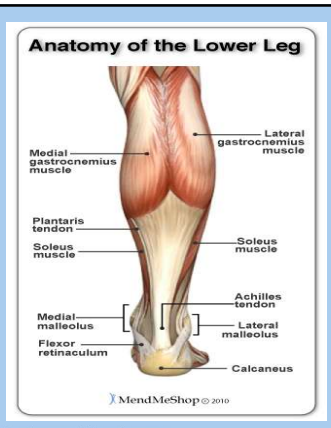

https://aidmyachilles.com/achilles-tendonitis-injury/achilles-tendon-anatomy-function.php

108

108

ACHILLES TENDON (CONT'D)

- The size of the Achilles allows imaging at frequencies as low as 5 MHz, although higher frequencies should be used as long as the image quality of the tendon is maintained
- Followed from its origin at the gastrocnemius and soleus muscles to the insertion on the calcaneus
- A complete scan includes transverse and sagittal views, with anteroposterior (AP) measurements obtained in the transverse view

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ACHILLES TENDON (CONT'D)

- A connective tissue sheath called the paratenon surrounds the Achilles tendon that promotes tendon gliding of 2 to 3 cm during movement
- The lack of a true synovial sheath results in a less echogenic border between the tendon and the surrounding tissue

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PATIENT POSITIONING

- Position the patient prone with the foot hanging over the edge of the cart or bed
- The foot may also be supported on a pillow or sponge for easier scanning and patient comfort
- Patients unable to lie prone may be scanned while on their side if the injured Achilles tendon is accessible

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ACHILLES TENDON (CONT'D)

- AP diameter of the normal tendon is approx. 5- 6 mm, varying with patient gender and body habitus.
- AP measurements should always be performed in the transverse plane, as diameters in the longitudinal plane tend to overestimate distance because of the oblique course of the tendon
- Dorsiflexion and plantar flexion of the foot, best imaged on the sagittal plane, increases ability to detect an Achilles tendon tear

112

112

ACHILLES TENDON (CONT'D)

- The size of the Achilles allows imaging at frequencies as low as 5 MHz, although higher frequencies should be used as long as the image quality of the tendon is maintained
- The tendon is followed from its origin at the gastrocnemius and soleus muscles to the insertion on the calcaneus
- A complete scan includes transverse and sagittal views, with anteroposterior (AP) measurements obtained in the transverse view

113

113

ACHILLES TENDON (CONT'D)

- Thompson's test- plantar flexion with squeezing of the calf, may be used to evaluate the integrity of the Achilles tendon
- When scanning the patient in the prone position, special attention must be given to the hypoechoic Kager's fat pad or pre-Achilles fat pad located deep in the Achilles tendon

114

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HOW TO DO……

- https://www.youtube.com/watch?v=sEb08KrqkcI
- https://youtu.be/bBxRBo0xd4o?si=_1V6uOpD-kU8FPOW

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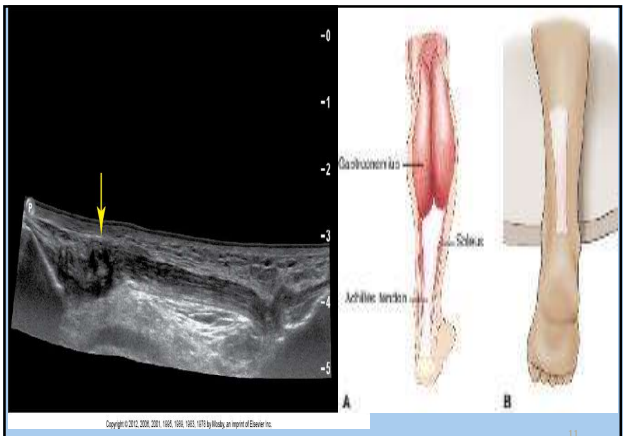

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PATHOLOGY OF THE MUSCULOSKELETAL SYSTEM

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SHOULDER/BICEPS TENDON SUBLUXATION/DISLOCATION

- Dislocation (subluxation) of biceps tendon from bicipital groove may be due to:
  - ✓Problem with transverse humeral ligament
  - ✓Abnormal development of bicipital groove or supraspinatus
  - ✓Subscapularis tears

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SHOULDER/BICEPS TENDON SUBLUXATION/DISLOCATION (CONT'D)

- Most common dislocation is deep to subscapularis anterior to glenohumeral joint capsule
- Medial dislocation results in empty groove that may fill with granulation and fibrous tissue
- Rotating arm from neutral to external position allows for real-time imaging of tendon dislocation or subluxation

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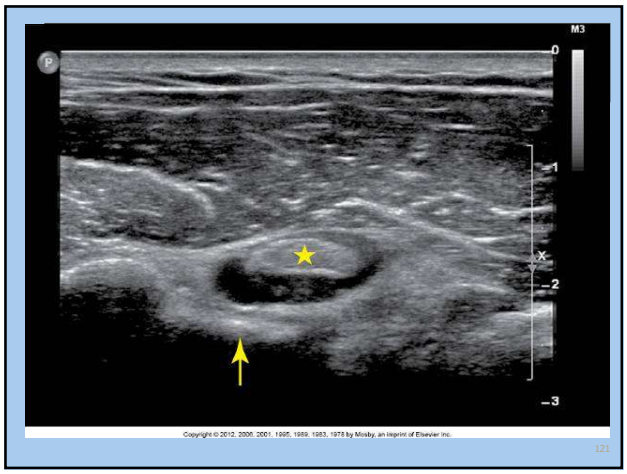

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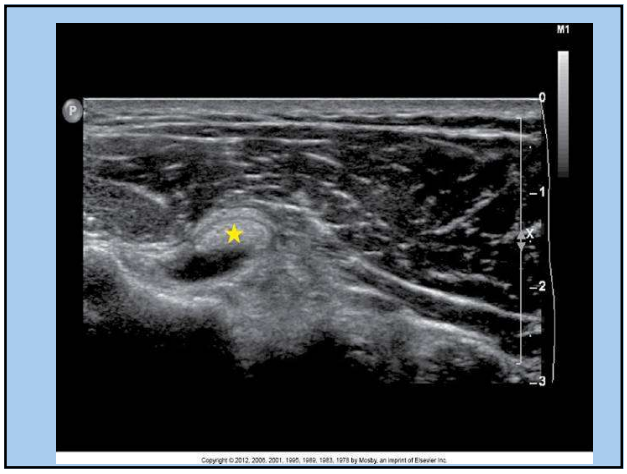


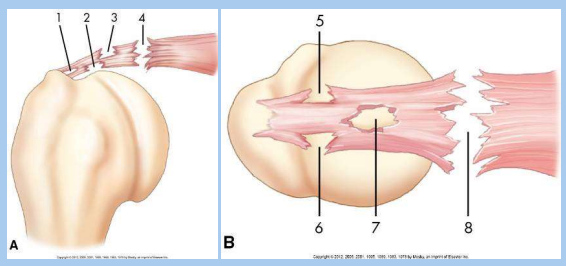
122

ROTATOR CUFF TEARS

- Classified as either partial-thickness or full-thickness tears
- Differentiation between two types is through determination of abnormal communication between glenohumeral joint and subacromial bursa
- Full-thickness tear has communication; partial thickness does not

123

ROTATOR CUFF TEARS



124

SONOGRAPHIC SIGNS OF A FULL-THICKNESS TEAR

****PRIMARY SIGNS****

- Naked tuberosity sign (deltoid muscle/humeral head)
- Tendon edge atrophy in chronic tear
- Retracted tendons
- Fiber discontinuity with interposed fluid
- Cleft in cuff of either hypoechoic or anechoic echo texture
- Distended SASD bursa in direct communication with joint (SASD=subacromial-subdeltoid)
- Compressed tendon
- Absence of rotator cuff
- Deltoid muscle or SASD bursa herniation into rotator cuff

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SONOGRAPHIC SIGNS OF A FULL-THICKNESS TEAR (CONT'D)

****SECONDARY SIGNS****

- Long head biceps tendon effusion
- Double effusion sign
- Erosions of greater tuberosity of humerus
- Cartilage interface sign
- Double effusion sign
- Glenohumeral joint effusion

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SONOGRAPHIC CRITERIA FOR PARTIAL-THICKNESS TEARS

- Critical zone of supraspinatus imaging with hypoechoic or hyperechoic focus
- Articular or bursal extension of hypoechoic lesion on two orthogonal planes
- Hypoechoic or echogenic line within cuff substance
- Anterior greater tuberosity regional irregularities
- Effusions of biceps tendon sheath
- Concave subdeltoid bursal surface

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PARTIAL-THICKNESS TEAR

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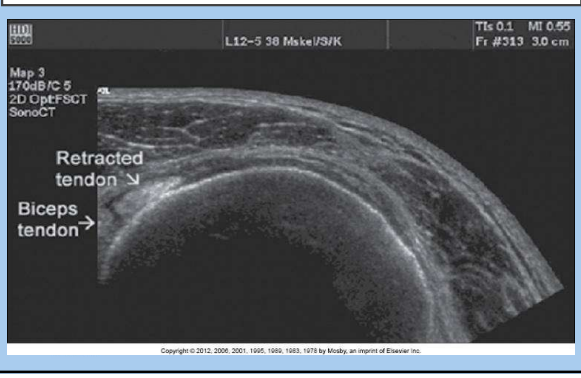
FULL-THICKNESS TEAR



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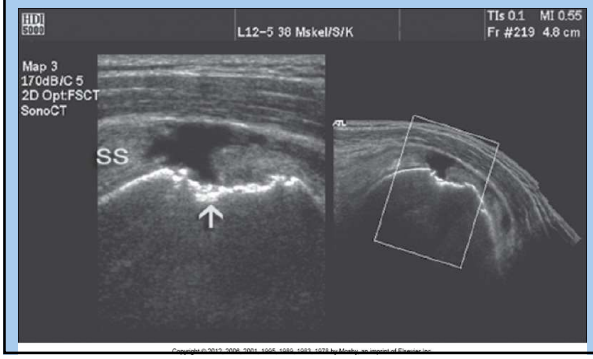
FULL-THICKNESS TEAR



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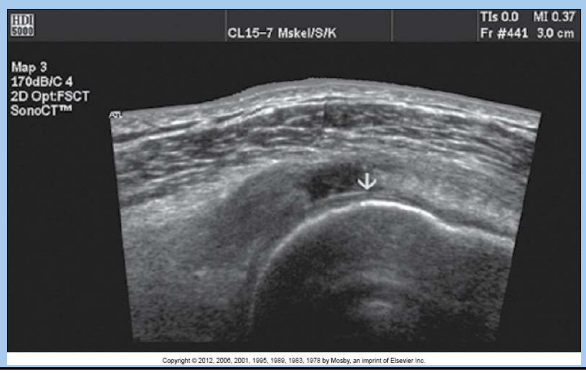
FULL-THICKNESS TEAR



131

TENDINITIS

- Common tendon inflammation abnormality due to age-related elasticity loss, rheumatoid arthritis, overuse, or acute trauma
- Tendinitis occurs in any tendon, more often in shoulder, wrist, heel, elbow
- Inflammatory condition has characteristic clinical symptoms of:
  -pain at tendinous insertion into bone
  -palpable mass in area of pain
  -decreased ROM

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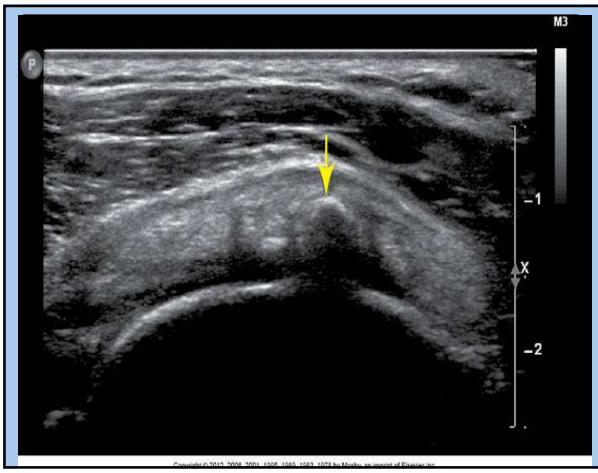
SONOGRAPHIC FEATURES OF TENDINITIS

- Focal or diffuse hypoechogenicity
- Enlargement of tendon in either focal or diffuse pattern
- Echogenic tendon fibrils within area of inflammation
- Calcifications with chronic tendinitis
- Increased color or power Doppler signal in periphery
- Coexisting bursitis
- Synovial sheath fluid

133



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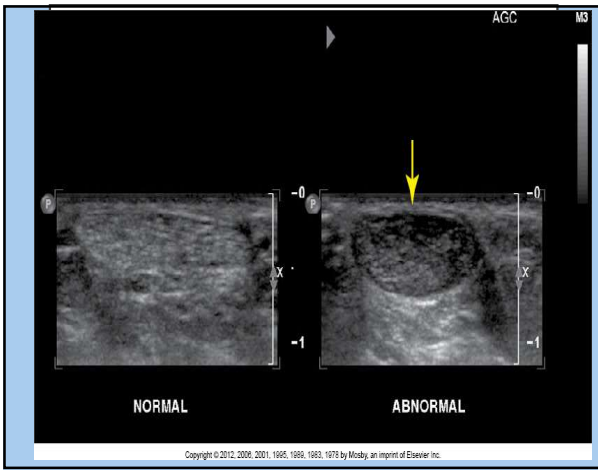

135

MUSCLE TEARS

- Most common pathologic condition of muscles of limbs
- Muscle strain related to exertion does not image with sonography because of lack of lesion; imaging of this type of pain-related problem helps differentiate tear from strain
- Two types of tears occur in muscle:
  1. distraction (indirect)
  2. compression (direct)

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Sonographic Appearance of Muscle Tear Grades

Grade	Appearance
I (elongation injury)	Normal, flame-shaped focal fiber discontinuity, small hematoma (<1cm)
II (partial rupture)	<½ of muscle fibers disrupted, hematoma <3 cm, interfascial hematoma, hypoechoic gap within muscle that changes position with transducer pressure
III (complete rupture)	>½ rupture of muscle resembling a soft tissue mass, hematoma >3cm, large interfacial hematoma

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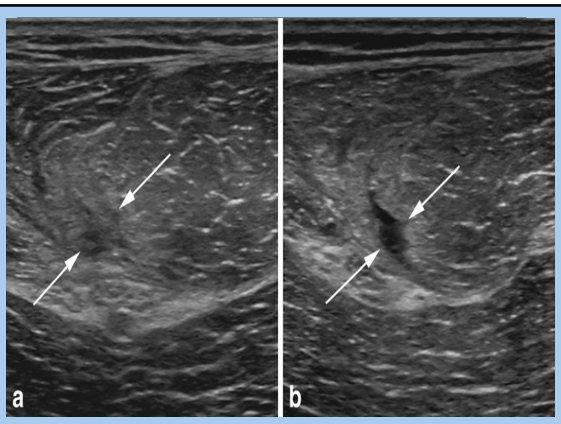
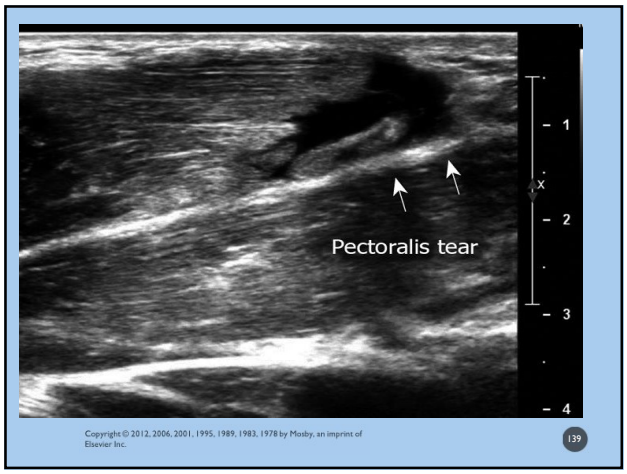


Hamstring muscle tear

138



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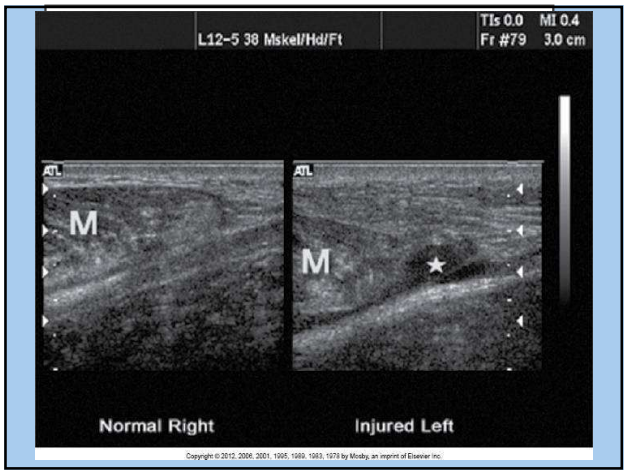

140

ARTHRITIS

- Defined as joint inflammation (acute or chronic)
- Over 100 types of arthritis
- Main types:
  - Osteoarthritis- most common, noninflammatory
  - Rheumatoid- automimmune, inflammatory
- Sonographic findings:
  - Edema, inflammation around joint capsule
  - May have calcifications
  - May have increased color Doppler flow

141

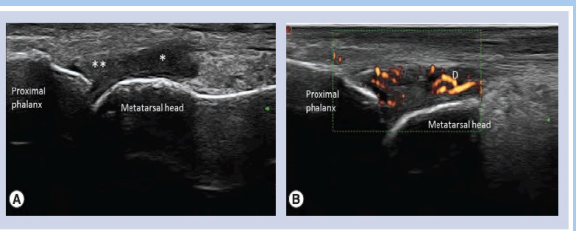

Figure 1. Grayscale and power Doppler ultrasound images of the first metatarsophalangeal joint in a patient with rheumatoid arthritis (dorsal longitudinal scan). (A) Grayscale ultrasonography demonstrates anechoic effusion (*) with hypoechoic synovial thickening (**). **(B)** Increased vascularization of thickened synovium as evidenced by the presence of power Doppler signal (D).

https://www.openaccessjournals.com/articles/using-ultrasound-to-image-the-foot-in-rheumatoid-arthritis-current-understanding-challenges-and-future-scope.html

142

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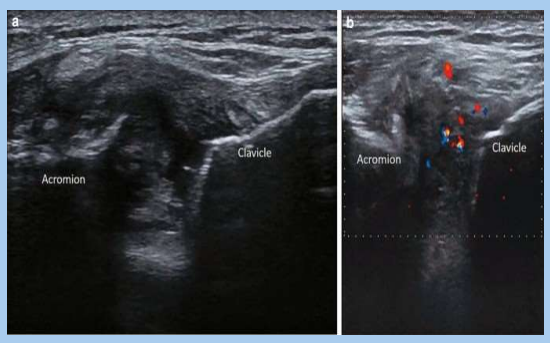
ACROMIOCLAVICULAR OSTEOARTHRITIS



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CARPAL TUNNEL SYNDROME (CTS)

- Entrapment of the median nerve characterized by median nerve compression and neuropathy
- Repetitive use of the same muscle groups results in hypertrophied muscles and trauma to the tendon sheath, resulting in tunnel narrowing
- Continued friction within the tunnel causes microtrauma to the epineurium of the median nerve, causing inflammation

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CTS (CONT'D)

- Clinical signs:
  - ✓Numbness of middle and index fingers
  - ✓Weakness or clumsiness of the hand
  - ✓Pain
  - ✓Positive Tineal or Phalen sign
  - ✓Weakness in affected hand (chronic)
- https://youtu.be/6bOYvEADHyU?si=4YEzsGeHs5OpA9Vh

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BAKER'S CYST

- Aka. Popliteal cyst
- Enlargement of the gastrocnemius- semimembraneous bursa located in the medial popliteal fossa (behind the knee)
- May dissect inferiorly into calf muscles or superiorly into thigh
- Causes:
  - ➢Meniscal tears
  - ➢Osteoarthritis
  - ➢Rheumatoid arthritis
  - ➢Joint effusion

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BAKER'S CYST (CONT'D)

- Clinical signs:
  - Swelling behind knee
  - Knee pain
  - Palpable lump behind knee
- Sonographic findings:
  - Anechoic fluid collection
    - ➢may be complex- loose bodies, septations, internal echoes

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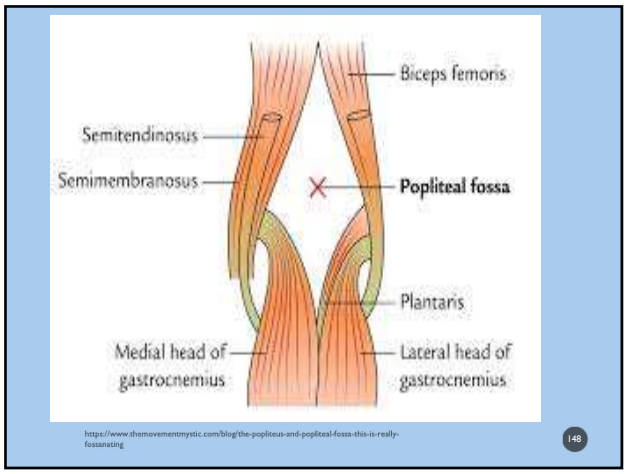
Biceps femoris
Semitendinosus
Semimembranosus
Popliteal fossa
Plantaris
Medial head of gastrocnemius
Lateral head of gastrocnemius
https://www.themovementmystic.com/blog/the-popliteus-and-popliteal-fossa-this-is-really-fossanating
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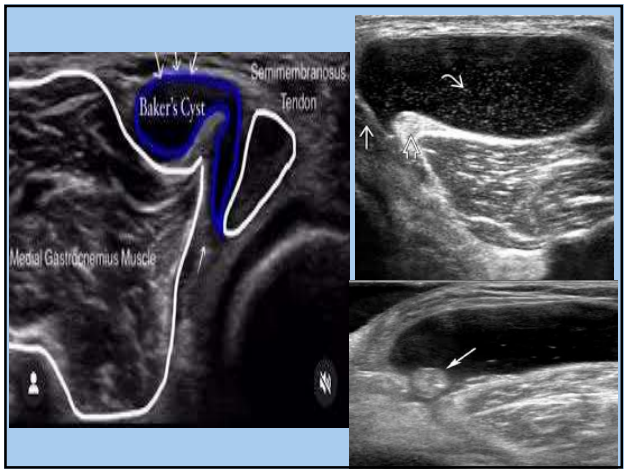
Baker's Cyst
Semimembranosus Tendon
Medial Gastrocnemius Muscle

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https://youtu.be/MRCT8ervOvQ
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REVIEW

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