

National Education Curriculum

Specialty Curricula

Musculoskeletal Sonography

Musculoskeletal Sonography

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Musculoskeletal Sonography

Rationale: Accurate assessment and performance of musculoskeletal sonograms requires sonographers to assemble a comprehensive knowledge of the anatomy, physiology, and pathophysiology of joints, tendons, muscles, bursae, and ligaments that are sonographically accessible. An understanding of the sonographic appearances and dynamics of joints, tendons, muscles, bursae, and ligaments are essential for the performance of high-quality examinations.

Section I: Physics

1. Understand ultrasound artifacts as they relate to musculoskeletal sonography
2. Identify current and emerging technologies that can be utilized when scanning musculoskeletal structures
3. Understand appropriate transducers to use when scanning musculoskeletal structures

I. PHYSICS

- A. Ultrasound Artifacts
 1. Anisotropy
 2. Speed of sound artifacts
 3. Refractile shadowing
 4. Comet tail artifact
 5. Shadowing and acoustic enhancement
- B. Current Ultrasound Technologies
 - Gray scale techniques
 - a. B-mode
 - b. M-mode
 - c. 3D imaging
 - d. Harmonic imaging
 - e. Compound imaging
 - f. Extended field of view
 - Doppler techniques
 - a. Color Doppler
 - b. Pulsed wave Doppler
 - c. Power Doppler
 - d. Doppler tissue imaging
- C. Emerging Technologies
 1. Elastography
 2. Contrast agents
- D. Transducers
 1. Transducer types and frequency ranges
 - a. Linear array
 - b. Curvilinear array
 - c. Sector/phased array

Musculoskeletal Sonography

Section II: Normal Anatomic Structures

1. Understand normal anatomic structures as they relate to musculoskeletal sonography

II. Normal Anatomic Structures

- A. Sonographic Appearance (to include gray scale echogenicity and Doppler patterns)
 1. Muscles
 2. Ligaments
 3. Tendons
 4. Bursae
 5. Nerves
 6. Joints
 7. Bones
 8. Blood vessels
 9. Cartilage
 10. Fat
 11. Fascia
 12. Differentiation of the sonographic appearance between adult and pediatric populations and developmental changes

Musculoskeletal Sonography

Section II: Shoulder

1. Understand the anatomy of the shoulder
2. Demonstrate knowledge of the indications for performing a sonographic evaluation of the shoulder
3. Establish a comprehensive sonographic protocol/technique for evaluating the shoulder
4. Understand pathologies related to the shoulder

III. SHOULDER

A. Anatomy

1. Rotator cuff anatomy
 - a. Biceps tendon/sheath
 - b. Subscapularis tendon
 - c. Supraspinatus tendon
 - d. Infraspinatus tendon
 - e. Acromioclavicular joint
 - f. Subacromial/subdeltoid bursa
 - g. Supraspinatus, infraspinatus, subscapularis, and teres minor muscles
2. Bony anatomy
 - a. Scapula
 - b. Clavicle
 - c. Proximal humerus
3. Ligaments
 - a. Coracohumeral ligament
 - b. Glenohumeral ligament
 - c. Transverse humeral ligament
 - d. Glenoid labrum
4. Bursae
 - a. Subscapular bursa
 - b. Subdeltoid bursa
 - c. Subacromial bursa
 - d. Subcoracoid bursa
5. Muscles
 - a. Flexors
 - i) Coracobrachialis
 - ii) Pectoralis major
 - b. Extensors
 - i) Teres major
 - ii) Latissimus dorsi

Musculoskeletal Sonography

- c. Abductors
 - i) Supraspinatus
 - ii) Deltoid
- 6. Joints
 - a. Glenohumeral joint
 - b. Sternoclavicular joint
 - c. Acromioclavicular joint
 - d. Scapulothoracic joint
- 7. Nerves
 - a. Axillary nerve
- 8. Blood supply
 - a. Subclavian artery
 - i) Axillary artery
 - ii) Brachial artery
- B. Indications
 - 1. Shoulder pain or swelling
 - 2. Weakness with arm elevation
 - 3. Dislocation
 - 4. Trauma
 - 5. Decreased range of motion
 - 6. Evaluation of soft tissue masses
 - 7. Evaluation of bursitis, tenosynovitis, and effusion
- C. Sonographic Technique
 - 1. Shoulder-rotator cuff
 - a. Patient position
 - i) Seated
 - b. Arm positions
 - i) Palm up, elbow flexed straight external rotation
 - ii) Dynamic internal/external
 - iii) Place palm on back pocket
 - c. Views
 - i) Longitudinal/transverse biceps/sheath
 - ii) Longitudinal/transverse subscapularis tendon
 - iii) Longitudinal/transverse supraspinatus and infraspinatus tendons
 - iv) Transverse posterior joint space/labrum
 - v) Acromioclavicular joint

Musculoskeletal Sonography

vi) Longitudinal/transverse supraspinatus, infraspinatus, and teres minor muscles

D. Pathology/Pathophysiology

1. Shoulder

- a. Biceps tendon pathologies
- b. Subluxation/dislocation
- c. Rotator cuff tear
- d. Tendinopathy
- e. Acromioclavicular joint arthritis
- f. Subdeltoid effusion/bursitis
- g. Fatty degeneration of cuff muscles
- h. Infection
- i. Masses
- j. Calcification/crystal deposits
- k. Fracture
- l. Impingement syndrome
- m. Foreign bodies
- n. Sternoclavicular pathology (arthropathy and arthritis)
- o. Evaluation of postsurgical anatomy and hardware
- p. Differentiation between adult and pediatric pathologies

Musculoskeletal Sonography

Section IV: Elbow

1. Understand the anatomy of the elbow
2. Demonstrate knowledge of the indications for performing a sonographic evaluation of the elbow
3. Establish a comprehensive sonographic protocol/technique for evaluating the elbow
4. Understand pathologies related to the elbow

IV: ELBOW

- A. Anatomy
 - 1. Bony anatomy
 - a. Distal humerus
 - i) Medial epicondyle
 - ii) Lateral epicondyle
 - iii) Capitulum
 - iv) Trochlea
 - v) Olecranon fossa
 - b. Radius - proximal
 - i) Head
 - ii) Neck
 - iii) Tuberosity
 - c. Ulna - proximal
 - i) Coronoid process
 - ii) Tuberosity
 - iii) Olecranon
 - 2. Ligaments
 - a. Lateral collateral ligament
 - i) Lateral ulnar collateral ligament
 - ii) Lateral radial collateral ligament
 - iii) Accessory lateral collateral ligament
 - iv) Annular ligament
 - b. Medial collateral ligament/ulnar collateral ligament
 - i) Anterior bundle
 - ii) Posterior bundle
 - iii) Transverse bundle
 - 3. Tendons
 - a. Distal biceps tendon
 - b. Common extensor tendon
 - c. Common flexor tendon

Musculoskeletal Sonography

4. Bursae
 - a. Olecranon bursa
 - b. Bicipitoradial bursa
 5. Muscles
 - a. Flexors
 - i) Biceps Brachii
 - ii) Brachialis
 - iii) Brachioradialis
 - iv) Flexor digitorum superficialis (FDS)
 - b. Extensors
 - i) Triceps brachii
 - c. Rotators
 - i) Supinator
 - ii) Pronator teres
 - iii) Pronator quadratus
 6. Joints
 - a. Radiocapitellar joint
 - b. Humeroulnar joint
 - c. Proximal radioulnar joint
 - d. Ulnotrochlear joint
 7. Nerves
 - a. Ulnar nerve
 - b. Radial nerve
 - i) Posterior interosseous nerve
 - c. Median nerve
 - i) Anterior interosseous nerve
 8. Blood supply
 - a. Brachial artery
 - i) Ulnar artery
 - ii) Radial artery
 - iii) Profunda brachii
- B. Indications
1. Pain/injury/trauma
 - a. Tendon/ligament rupture
 - b. Dislocation
 - c. Fracture

Musculoskeletal Sonography

2. Swelling
 3. Overuse syndromes
 - a. Epicondylitis [medial (Golfer's Elbow) & lateral (Tennis Elbow)]
 - b. Triceps tendon enthesopathy
 4. Inflammatory disorders
 - a. Bursitis
 - b. Intraarticular effusion
 5. Entrapment neuropathy
 - a. Cubital tunnel syndrome
 - b. Radial tunnel syndrome
 - c. Snapping tricep syndrome
 6. Weakness
 7. Evaluation of soft tissue masses
 8. Evaluation of bursitis, tenosynovitis and effusion
- C. Sonographic Technique
1. The joint should be evaluated approximately 5cm proximal and 5cm distal to the elbow
 - a. Patient position
 - i) Seated
 - b. Arm positions
 - i) Palm up, palm down, elbow flexed, elbow straightened, and crawling crab
 - ii) Dynamic maneuvers
 2. Valgus stress
 3. Varus stress
 4. Flexion and extension
 5. Pronation and supination
 - a. Views
 - i) Anterior elbow
 - Biceps tendon at insertion onto radial tuberosity
 - Biceps muscle
 - Brachioradialis tendon and muscle
 - Anterior elbow joint
 - Median nerve – if applicable
 - ii) Lateral elbow
 - Common extensor tendon (CET)
 - Radial collateral ligament complex
 - Dynamic stretching of the CET

Musculoskeletal Sonography

- Radiocapitellar joint with dynamic stressing
- iii) Medial elbow
 - Common flexor tendon
 - Ulnar collateral ligament (UCL)
 - Ulnotrochlear joint with dynamic stressing
 - Ulnar nerve – if applicable
 - Dynamic – Ulnar nerve – if applicable
- iv) Posterior elbow
 - Triceps muscle and tendon
 - Posterior elbow joint
 - Loose body evaluation
 - Ulnar nerve and Dynamic ulnar nerve – if applicable
- v) Evaluate in longitudinal and transverse planes with color Doppler or power Doppler to evaluate for hyperemia

D. Pathology/Pathophysiology

1. Elbow

- a. Tendon pathology
 - i) Epicondylitis
 - Lateral epicondylitis (Tennis Elbow)
 - Medial epicondylitis (Golfer's Elbow)
 - ii) Distal biceps tendon
 - iii) Distal triceps tendon
- b. Ligament pathology
 - i) Medial collateral ligament
 - ii) Radial collateral ligament
- c. Joint effusion
- d. Dislocation
- e. Infection
- f. Masses/cysts (i.e. elbow ganglion)
- g. Fracture
- h. Foreign bodies
- i. Calcifications/loose bodies/crystal deposits
- j. Nerve entrapment or compression
- k. Evaluation of postsurgical anatomy and hardware
- l. Differentiation between adult and pediatric pathologies

Musculoskeletal Sonography

Section V: Wrist & Hand

1. Understand the anatomy of the wrist and hand
2. Demonstrate knowledge of the indications for performing a sonographic evaluation of the wrist and hand
3. Establish a comprehensive sonographic protocol/technique for evaluating the wrist and hand
4. Understand pathologies related to the wrist and hand

V: WRIST & HAND

A. Anatomy

1. Bony anatomy
 - a. Carpal bones
 - i) Scaphoid
 - ii) Lunate
 - iii) Triquetrum
 - iv) Pisiform
 - v) Trapezium
 - vi) Trapezoid
 - vii) Capitate
 - viii) Hamate
 - b. Metacarpals
 - c. Phalanges
2. Ligaments
 - a. Scapholunate ligament (SLL)
 - b. Lunotriquetral ligament (LTL)
 - c. Triangular fibrocartilage
 - i) Forms the triangular fibrocartilage complex (TFCC)
 - d. Collateral ligaments (fingers)
 - e. Palmar ligament
 - f. Pulley system
 - i) Annular pulleys (A1-A5)
 - ii) Cruciform pulleys (C1-3)
3. Tendons
 - a. Dorsal wrist
 - i) Compartment 1
 - Extensor pollicis brevis (EPB)
 - Abductor pollicis longus (APL)
 - ii) Compartment 2
 - Extensor carpi radialis brevis (ECRB)

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- Extensor carpi radialis longus (ECRL)
 - Lister's tubercle
 - iii) Compartment 3
 - Extensor pollicis longus (EPL)
 - iv) Compartment 4
 - Tendons of extensor digitorum
 - Extensor indicis proprius tendon
 - v) Compartment 5
 - Extensor digiti minimi (EDM)
 - vi) Compartment 6
 - Extensor carpi ulnaris (ECU)
 - b. Ventral wrist
 - i) Flexor digitorum superficialis tendons (FDS)
 - ii) Flexor digitorum profundus tendons (FDP)
 - iii) Flexor pollicis longus (FPL)
 - iv) Flexor carpi radialis (FCR)
 - v) Flexor carpi ulnaris (FCU)
 - c. Fingers
 - i) Long extensor tendon
 - ii) Central band
 - iii) Lateral bands
 - iv) Lateral slip
 - v) Central slip
 - vi) Flexor digitorum superficialis tendon (FDS)
 - vii) Flexor digitorum profundus tendon (FDP)
4. Bursae
- a. Radial bursa
 - b. Ulnar bursa
5. Muscles
- a. Abductor pollicis longus
 - b. Abductor digiti minimi
 - c. Dorsal interosseous muscles
 - d. Palmar interosseous muscles
 - e. Flexor digiti minimi brevis muscle
 - f. Lumbrical muscles
6. Joints

Musculoskeletal Sonography

- a. Distal radioulnar (DRUJ)
 - b. Radiocarpal (RCJ)
 - c. Midcarpal
 - d. Carpometacarpal (CMC)
 - e. Thumb metacarpal (TMC)
 - f. Metacarpophalangeal (MCP)
 - g. Interphalangeal (IP)
 - h. Proximal interphalangeal (PIP)
 - i. Distal interphalangeal (DIP)
- 7. Nerves
 - a. Ulnar nerve (Guyon canal)
 - b. Median nerve (Carpal tunnel)
- 8. Blood supply
 - a. Radial artery
 - b. Ulnar artery
- B. Indications
 - 1. Pain/injury/trauma
 - 2. Swelling
 - 3. Early arthritis
 - 4. Inflammatory disorders of the tendons
 - 5. Entrapment neuropathy
 - a. Carpal tunnel syndrome
 - 6. Weakness
 - 7. Evaluation of soft tissue masses
 - 8. Evaluation of bursitis, tenosynovitis, and effusion
 - 9. Evaluation of ligament tears
 - 10. Evaluation of pulley lesions in the fingers
 - 11. Monitoring patients with chronic and rheumatoid arthritis
- C. Sonographic Technique
 - 1. Perform the exam on the area that is symptomatic (evaluate the dorsal or ventral wrist, and/or fingers)
 - a. Patient position
 - i) Seated
 - b. Wrist/hand positions
 - i) Palm up (supinated), palm down (pronated), thumb side up, pronation with ulnar deviation, possible flexion of the fingers, elbow flexed
 - ii) Dynamic maneuvers

Musculoskeletal Sonography

- Flexion and extension – evaluate for trigger finger
- Valgus stress of the ulnar collateral ligament – evaluate for a stenner lesion

c. Views

i) Dorsal wrist

- Distal radioulnar joint (DRUJ)
- Evaluate radiocarpal and midcarpal joints
- Evaluate extensor tendon compartments (I-VI)
- Evaluate scapholunate & lunotriquetral ligaments

ii) Ventral (volar) wrist

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

iii) Hands/fingers

- Evaluate other joints based on clinical symptoms to include:
 - Carpometacarpal joint
 - Metacarpophalangeal joint
 - Proximal interphalangeal joint
 - Distal interphalangeal joint
- Evaluate the five annular pulleys

iv) Evaluate in longitudinal and transverse planes with color Doppler or power Doppler to evaluate for hyperemia

D. Pathology/Pathophysiology

1. Wrist/hand

a. Tendon pathology

- i) Tenosynovitis
- ii) DeQuervain disease
- iii) Intersection syndrome
- iv) Tendon tears
- v) Pulley lesions

- Rock climber's finger
- Trigger finger

b. Ligament pathology

- i) Triangular fibrocartilage complex
- ii) Ulnar collateral ligament
 - Ligament tears in the thumb
 - Stener lesion

Musculoskeletal Sonography

- c. Joint effusion
- d. Dislocation
- e. Infection
- f. Masses/cysts (i.e., ganglia)
- g. Fracture
- h. Foreign bodies
- i. Calcifications/loose bodies/crystal deposits
- j. Nerve entrapment or compression
- k. Evaluation of postsurgical anatomy and hardware
- l. Differentiation between adult and pediatric pathologies

Musculoskeletal Sonography

Section VI: Adult Hip

1. Understand the anatomy of the adult hip
 2. Demonstrate knowledge of the indications for performing a sonographic evaluation of the adult hip
 3. Establish a comprehensive sonographic protocol/technique for evaluating the adult hip
 4. Understand pathologies related to the adult hip
-

V: ADULT HIP

A. Anatomy

1. Bony anatomy
 - a. Pelvic bones
 - i) Ilium
 - Anterior superior iliac spine (ASIS)
 - Anterior inferior iliac spine (AIIS)
 - ii) Ischium
 - iii) Pubis
 - iv) Acetabulum (labrum)
 - b. Proximal femur
 - i) Femoral head (fovea capitis)
 - ii) Femoral neck
 - iii) Greater trochanter
 - iv) Lesser trochanter
 - v) Intertrochanteric line
2. Ligaments
 - a. Iliofemoral ligament
 - b. Ischiofemoral ligament
 - c. Pubofemoral ligament
 - d. Ligamentum capitis femoris
3. Tendons
 - a. Iliopsoas tendon
 - b. Gluteus medius tendon
 - c. Gluteus minimus tendon
 - d. Gluteus maximus tendon
 - e. Iliotibial (IT) band
 - f. Adductor longus tendon
 - g. Rectus femoris tendon
4. Bursae
 - a. Greater trochanteric bursa

Musculoskeletal Sonography

- b. Iliopectineal (iliopsoas) bursa

5. Muscles

- a. Iliacus muscle
- b. Iliopsoas muscle
- c. Piriformis muscle
- d. Sartorius muscle
- e. Gluteus maximus muscle
- f. Gluteus minimus muscle
- g. Gluteus medius muscle
- h. Pectineus muscle
- i. Hamstring muscles (semitendinosus, semimembranosus, and biceps femoris)
- j. Adductor muscles (adductor longus, adductor brevis, adductor magnus)
- k. Gracilis muscle
- m. Tensor fascia lata (TFL)
- n. Quadriceps muscles (rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius)

6. Joints

- a. Hip joint

7. Nerves

- a. Femoral nerve
- b. Sciatic nerve
- c. Obturator nerve

8. Blood supply

- a. Obturator artery
- b. Medial and lateral circumflex arteries
- c. Femoral artery
- d. Inferior gluteal arteries

B. Indications

- 1. Pain/injury/trauma
- 2. Swelling
- 3. Hip effusion
- 4. Snapping of the hip
- 5. Hip bursitis
- 6. Hip tendinosis

C. Sonographic Technique

- 1. Performed along the anterior, medial, lateral/posterior, or posterior aspects of the hip depending on the symptomatic area

Musculoskeletal Sonography

- a. Patient position
 - i) Supine (anterior and medial evaluation), decubitus (unaffected hip side down for lateral/posterior evaluation), and prone (posterior evaluation)
 - b. Hip/leg positions
 - i) Leg in neutral position (anterior and posterior evaluation)
 - ii) Thigh abducted, externally rotated, and knee bent (medial evaluation)
 - c. Dynamic maneuvers
 - i) Iliopsoas snapping
 - Hip flexion with external rotation and abduction followed by hip extension and internal rotation
 - ii) Iliotibial band snapping
 - Hip flexion and extension or symptom-driven dynamic maneuver
 - d. Anterior evaluation
 - i) Anterior joint recess
 - ii) Iliopsoas tendon
 - iii) Rectus femoris muscle
 - iv) Sartorius muscle
 - v) Tensor fascia lata (TFL)
 - vi) Labrum
 - e. Medial evaluation
 - i) Adductor muscles
 - ii) Gracilis muscle
 - iii) Adductor longus tendon
 - iv) Iliopsoas tendon
 - f. Lateral/posterior evaluation
 - i) Gluteal muscles (minimus, medius, maximus)
 - ii) Gluteal tendons (minimus, medius)
 - iii) Tensor fascia lata (TFL)
 - g. Posterior evaluation
 - i) Hamstring muscles
 - ii) Sciatic nerve
 - h. Evaluate in longitudinal and transverse planes with color doppler or power doppler to evaluate for hyperemia
- D. Pathology/Pathophysiology
- 1. Hip
 - a. Tendon pathology
 - i) Tendonosis

Musculoskeletal Sonography

- ii) Tendon tears
- iii) Snapping hip
- b. Bursitis
- c. Joint effusion
- d. Dislocation
- e. Infection
- f. Masses/cysts
- g. Fracture
- h. Foreign bodies
- i. Calcifications/crystal deposits
- j. Nerve entrapment or compression
- k. Evaluation of postsurgical anatomy and hardware (including prosthetic hip)
- l. Differentiation between adult and pediatric pathologies

Musculoskeletal Sonography

Section VII: Pediatric Hip

1. Understand the anatomy of the pediatric hip
 2. Demonstrate knowledge of the indications for performing a sonographic evaluation of the pediatric hip
 3. Establish a comprehensive sonographic protocol/technique for evaluating the pediatric hip
 4. Understand pathologies related to the pediatric hip
-

VII: PEDIATRIC HIP

A. Anatomy

1. Bones and joints

a. Pelvic girdle

- i) Ilium
- ii) Ischium
- iii) Pubis

b. Femur

- i) Femoral head

c. Fascia lata

d. Muscles

- i) Anterior/extensor
- ii) Medial/adductor
- iii) Posterior/hamstring and gluteal

2. Femoral triangle

a. Anterior of upper thigh

- i) Inguinal ligament
- ii) Adductor longus muscle
- iii) Sartorius muscle

3. Gluteal region

4. Hip joint

a. Acetabulum

- i) Acetabular labrum

b. Femoral head

c. Iliofemoral ligament

Musculoskeletal Sonography

B. Functions

1. Flexion
2. Extension
3. Abduction
4. Adduction
5. Medial rotation
6. Lateral rotation

C. Indications for Sonographic Examination

1. Developmental displacement in neonate

a. Risk factors

- i) First born child
- ii) Female
- iii) Breech birth
- iv) Family history
- v) Intrauterine conditions

b. Causes

- i) Genetic
- ii) Mechanical
- iii) Physiologic

2. Abnormal hip examination

3. Response to treatment

D. Sonographic Technique

1. Patient preparation
2. Transducer selection
3. Patient position
4. Image optimization
5. Examination protocol
 - a. Coronal with neutral hip position
 - i) Push/pull movement of hip
 - ii) Document signs of subluxation/dislocation
 - b. Coronal with hip flexion

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- i) Push/pull movement of hip
 - ii) Barlow maneuver
 - Adduction with gentle pushing
 - iii) Document signs of subluxation
 - c. Transverse with hip flexion
 - i) Push/pull movement of hip
 - ii) Barlow maneuver
 - iii) Ortolani test
 - d. Transverse with neutral position of hip
 - e. Measurements using Graf's technique
 - 6. Assessment of hip during treatment
 - a. May be performed while patient is in Pavlik harness
 - b. Contraindications
- E. Pathology/Pathophysiology
- 1. Dislocation of the hip
 - a. Acquired (traumatic or non-traumatic)
 - b. Teratogenic
 - c. Developmental displacement of the hip (DDH)
 - i) Common congenital anomaly especially in females
 - ii) Dysplastic, subluxed, dislocatable or dislocated hips
 - d. Sonographic findings
 - i) Femoral head
 - Normal, subluxed, dislocated
 - ii) Stability
 - Normal, dislocatable, reducible, irreducible
 - iii) Acetabulum
 - Normal, immature, dysplastic
 - 2. Hip effusion
 - a. Widening of joint space with displacement of femur laterally
 - i) Toxic synovitis
 - ii) Septic arthritis

Musculoskeletal Sonography

b. Scan plane is anterior and parallel to femoral neck, patient supine, hip in neutral position

i) Hips should be symmetrical in sonographic appearance

c. Sonographic findings

i) Anterior recess of joint capsule distends anteriorly

ii) Echogenicity of fluid may indicate hemorrhage, transudate, or exudate

3. Proximal femoral focal deficiency

a. Congenital underdevelopment of proximal femur with varying degrees of severity

F. Correlative and/or Prior Imaging

1. Radiography

2. Computed tomography

3. Magnetic resonance

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Section VIII: Knee

1. Understand the anatomy of the knee
2. Demonstrate knowledge of the indications and limitations when performing a sonographic evaluation of the knee
3. Establish a comprehensive sonographic protocol/technique for evaluating the knee
4. Understand pathologies related to the knee

VIII: KNEE

A. Anatomy

1. Bony anatomy
 - a. Distal femur
 - i) Medial epicondyle
 - ii) Lateral epicondyle
 - iii) Trochlea
 - b. Patella
 - c. Tibia
 - d. Fibula
2. Ligaments
 - a. Patellar ligament
 - b. Oblique popliteal ligament
 - c. Arcuate popliteal ligament
 - d. Medial collateral ligament (MCL)
 - e. Lateral collateral ligament (LCL)
 - f. Cruciate ligaments
 - i) Anterior cruciate ligament (ACL)
 - ii) Posterior cruciate ligament (PCL)
3. Menisci
 - a. Medial menisci
 - b. Lateral menisci
4. Tendons
 - a. Quadriceps tendon
 - b. Medial longitudinal patellar retinaculum
 - c. Lateral longitudinal patellar retinaculum
 - d. Iliotibial (IT) band
 - e. Biceps tendon
 - f. Common patellar tendon
 - g. Pes anserinus

Musculoskeletal Sonography

- i) Gracilis tendon
 - ii) Semitendinosus tendon
 - iii) Sartorius tendon
 - h. Semimembranosus tendon
 - i. Popliteus tendon
- 5. Bursae
 - a. Suprapatellar bursa
 - b. Prepatellar bursa
 - c. Infrapatellar bursa
 - d. Pes anserine bursa
 - e. Gastrocnemio-semimembranosus bursa
- 6. Muscles
 - a. Quadriceps muscles (rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius)
 - b. Hamstring muscles (semitendinosus, semimembranosus, and biceps femoris)
 - c. Sartorius muscle
 - d. Gastrocnemius muscle (medial and lateral heads)
 - e. Soleus muscle
 - f. Tensor fascia lata (TFL)
 - g. Peroneus longus muscle
- 7. Joints
 - a. Knee joint
 - i) Femorotibial joint
 - ii) Patellofemoral joint
 - iii) Superior tibiofibular joint
- 8. Plicae
 - a. Infrapatellar plica
 - b. Suprapatellar plica
 - c. Medial plica
 - d. Lateral plica
- 9. Fat pads
 - a. Suprapatellar quadriceps fat pad
 - b. Suprapatellar prefemoral fat pad
 - c. Infrapatellar (hoffa's) fat pad
- 10. Nerves
 - a. Obturator nerve
 - b. Sciatic nerve

Musculoskeletal Sonography

- i) Common peroneal nerve (CPN)
 - ii) Tibial nerve (TN)
 - c. Saphenous nerve
- 11. Blood supply
 - a. Genicular arteries
 - i) Superior medial
 - ii) Inferior medial
 - iii) Posterior
 - iv) Superior lateral
 - v) Inferior lateral
 - b. Popliteal artery
 - c. Anterior tibial artery
- B. Indications
 - 1. Pain/injury/trauma
 - a. Tendon/ligament rupture
 - b. Dislocation
 - c. Fracture
 - 2. Swelling
 - 3. Joint effusion
 - 4. Inflammatory disorders
 - 5. Bursitis
- C. Sonographic Technique
 - 1. Performed along the anterior, medial, lateral, or posterior aspects of the knee depending on the symptomatic area
 - a. Patient position
 - i) Supine (anterior, medial, and lateral evaluation) and prone (posterior evaluation)
 - b. Knee/leg positions
 - i) Knee flexed (anterior evaluation)
 - ii) Leg externally rotated, and knee flexed (medial evaluation)
 - iii) Leg internally rotated and knee flexed (lateral evaluation)
 - iv) Leg extended (posterior evaluation)
 - c. Dynamic maneuvers
 - i) Valgus stress
 - ii) Varus stress
 - iii) Flexion and extension
 - d. Anterior evaluation

Musculoskeletal Sonography

- i) Quadriceps tendon
 - ii) Suprapatellar bursa
 - iii) Trochlea of the femur
 - iv) Patellar tendon
 - v) ITB insertion
 - vi) Pes anserine insertion
 - vii) Fat pads
 - e. Medial evaluation
 - i) Medial collateral ligament (MCL)
 - ii) Pes anserine tendon
 - iii) Medial meniscus
 - iv) Semimembranosus tendon
 - f. Lateral evaluation
 - i) Biceps femoris tendon
 - ii) Lateral collateral ligament (LCL)
 - iii) IT Band
 - iv) Lateral meniscus
 - v) Popliteus tendon
 - vi) Common peroneal nerve
 - g. Posterior evaluation
 - i) Tibial nerve
 - ii) Sciatic nerve
 - iii) Peroneal nerve
 - iv) Posterior cruciate ligament (PCL)
 - v) Gastrocnemio-semimembranosus bursa
 - vi) Pes anserinus
 - h. Evaluate in longitudinal and transverse planes with color Doppler or power Doppler to evaluate for hyperemia
- D. Pathology/Pathophysiology
 - 1. Knee
 - a. Tendon pathology
 - i) Tendonosis
 - ii) Tendon tears
 - b. Bursitis
 - c. Joint effusion
 - d. Dislocation
 - e. Infection

Musculoskeletal Sonography

- f. Masses/cysts (i.e., baker cyst)
- g. Fracture
- h. Foreign bodies
- i. Calcifications/crystal deposits
- j. Nerve entrapment or compression
- k. Medial plica syndrome
- l. Iliotibial band friction syndrome (ITBFS)
- m. Iliotibial band tendinopathy
- n. MCL and LCL injury
- o. Evaluation of postsurgical anatomy and hardware
- p. Differentiation between adult and pediatric pathologies

Musculoskeletal Sonography

Section IX: Ankle & Foot

1. Understand the anatomy of the ankle and foot
 2. Demonstrate knowledge of the indications for performing a sonographic evaluation of the ankle and foot
 3. Establish a comprehensive sonographic protocol/technique for evaluating the ankle and foot
 4. Understand pathologies related to the ankle and foot
-

IX: ANKLE & FOOT

A. Anatomy

1. Bony anatomy
 - a. Distal tibia
 - i) Medial malleolus
 - b. Distal fibula
 - i) Lateral malleolus
 - c. Tarsal bones
 - i) Talus
 - ii) Calcaneus
 - Sustentaculum tali
 - iii) Cuboid
 - iv) Navicular
 - v) Medial cuneiform
 - vi) Intermediate cuneiform
 - vii) Lateral cuneiform
 - d. Metatarsal bones
 - e. Phalanges
2. Ligaments
 - a. Posterior tibiofibular ligament
 - b. Anterior tibiofibular ligament
 - c. Lateral collateral ligament
 - i) Anterior talofibular ligament (ATFL)
 - ii) Calcaneofibular ligament (CFL)
 - iii) Posterior talofibular ligament
 - d. Bifurcate ligament
 - i) Calcaneonavicular ligament
 - ii) Calcaneocuboid ligament
 - e. Deltoid ligament
 - f. Interosseous talocalcaneal ligament

Musculoskeletal Sonography

- g. Dorsal talonavicular ligament
- h. Dorsal cuboideonavicular ligament
- i. Dorsal cuneonavicular ligament
- j. Dorsal intercuneiform ligaments
- k. Dorsal tarsometatarsal ligaments
- l. Dorsal metatarsal ligaments
- m. Dorsal cuneocuboid ligament
- n. Dorsal calcaneocuboid ligament
- o. Long plantar ligament
- p. Lateral talocalcaneal ligament
- q. Short plantar ligament
- r. Plantar calcaneonavicular (spring) ligament
- s. Posterior talocalcaneal ligament
- t. Medial talocalcaneal ligament
- u. Tibiocalcaneal ligament
- v. Anterior tibiotalar ligament
- w. Tibionavicular ligament
- x. Posterior tibiotalar ligament
- y. Collateral ligaments
- 3. Retinaculum/fascia
 - a. Superior extensor retinaculum
 - b. Inferior extensor retinaculum
 - c. Superior peroneal retinaculum
 - d. Inferior peroneal retinaculum
 - e. Flexor retinaculum
 - f. Plantar fascia
 - i) Plantar plate
- 4. Tendons
 - a. Achilles tendon
 - b. Plantaris tendon
 - c. Anterior tibial tendon
 - d. Posterior tibial tendon
 - e. Peroneus longus tendon (PL)
 - f. Peroneus brevis tendon (PB)
 - g. Extensor hallucis tendon (EHL)
 - h. Extensor digitorum longus tendon (EDL)

Musculoskeletal Sonography

- i. Flexor hallucis longus tendon (FHL)
- j. Flexor digitorum longus tendon (FDL)
- k. Calcaneal tendon
- 5. Bursae
 - a. Retrocalcaneal bursa
 - b. Subcutaneous calcaneal bursa
 - c. Subcutaneous bursa of medial malleolus
 - d. Intertarsal bursa
 - e. Metatarsophalangeal bursa
- 6. Muscles
 - a. Dorsal flexor muscles
 - i) Tibialis anterior
 - ii) Peroneus tertius
 - iii) Extensor digitorum longus
 - iv) Extensor hallucis longus
 - b. Plantar flexor muscles
 - i) Gastrocnemius
 - ii) Soleus
 - iii) Plantaris
 - iv) Flexor digitorum longus
 - c. Foot invertor muscle
 - i) Tibialis posterior
 - d. Foot evertor muscles
 - i) Peroneus longus
 - ii) Peroneus brevis
 - e. Abductor hallucis muscle
 - f. Flexor digitorum brevis muscle
 - g. Abductor digiti minimi muscle
 - h. Lumbrical muscles
- 7. Joints
 - a. Ankle joint
 - b. Subtalar joint
 - c. Cuboideonavicular joint
 - d. Cuneonavicular joint
 - e. Transverse talar joint
 - i) Calcaneocuboid joint

Musculoskeletal Sonography

- ii) Talonavicular joint
 - f. Tarsometatarsal joints
 - i) Digits 1-3 known as Lisfranc joint
 - ii) Digits 1-4 known as cuboid metatarsal joint
 - g. Intermetatarsal joints
 - h. Metatarsal-phalangeal joints (MTP)
 - i. Proximal and distal interphalangeal joints (PIP & DIP)
 - 8. Fat pad
 - a. Kager's fat pad
 - 9. Nerves
 - a. Tibial nerve (TN)
 - i) Medial calcaneal nerve (MCN)
 - b. Deep peroneal nerve (DPN)
 - c. Lateral plantar nerve (LPN)
 - d. Medial plantar nerve (MPN)
 - e. Saphenous nerve
 - f. Superficial peroneal nerve (SPN)
 - g. Sural nerve
 - 10. Blood supply
 - a. Anterior tibial artery
 - b. Posterior tibial artery
 - c. Peroneal artery
- B. Indications
- 1. Pain/injury/trauma
 - a. Tendon/ligament rupture
 - b. Dislocation
 - c. Fracture
 - d. Morton's neuroma
 - f. Plantar fasciitis
 - 2. Swelling
 - 3. Joint effusion
 - 4. Inflammatory disorders
 - 5. Bursitis
- C. Sonographic Technique
- 1. Performed along the anterior, medial, lateral, or posterior aspects of the ankle depending on the symptomatic area

Musculoskeletal Sonography

- a. Patient position
 - i) Supine (anterior, medial, and lateral evaluation) and prone (posterior evaluation)
- b. Ankle/foot positions
 - i) Knee bent/plantar surface of the foot is down (anterior evaluation)
 - ii) Ankle externally rotated (medial evaluation)
 - iii) Ankle internally rotated (lateral evaluation)
 - iv) Toes pointing down/foot off of the edge of patient table (posterior evaluation)
- c. Dynamic maneuvers
 - i) Lateral
 - Peroneal tendon subluxation evaluation during eversion circumduction
 - ii) Medial
 - Dorsiflexion and inversion to check for tibialis posterior tendon instability
 - iii) Posterior
 - Dorsiflexion/plantar flexion to evaluate the Achilles tendon
- d. Anterior evaluation
 - i) Extensor tendons
 - ii) Anterior joint recess of the ankle joint
 - iii) Anterior talofibular ligament
 - iv) Anterior tibiofibular ligament
 - v) Calcaneofibular ligament
 - vi) Dorsal midtarsal ligaments
- e. Medial evaluation
 - i) Tibialis posterior tendon
 - ii) Flexor digitorum longus tendon
 - iii) Tarsal tunnel and tibial nerve
 - iv) Flexor hallucis longus tendon
 - v) Deltoid ligament
- f. Lateral evaluation
 - i) Peroneal tendons
- g. Posterior evaluation
 - i) Flexor hallucis longus tendon
 - ii) Achilles tendon
 - iii) Kager's fat pad
 - iv) Posterior ankle joint recess
 - v) Plantar fascia
- h. Evaluate in longitudinal and transverse planes with color Doppler or power Doppler to evaluate for hyperemia

Musculoskeletal Sonography

2. Performed along the plantar or dorsal aspects of the foot depending on the symptomatic area
 - a. Patient position
 - i) Supine
 - b. Ankle/foot positions
 - i) Foot dorsiflexed (toes pointed toward ceiling)
 - c. Dynamic maneuvers
 - i) Dorsiflex the 2-4 metatarsophalangeal (MTP) joint to evaluate tendon movement, the integrity of the plantar plate, and for plantar tears
 - d. Longitudinal axis of the plantar surface of the foot (evaluating for morton's neuroma)
 - i) Digits 1-5, assess the metatarsophalangeal (MTP) joints
 - ii) Assess the flexor hallucis longus (FHL) tendon on the 1st digit
 - iii) Assess the flexor digitorum longus (FDL) tendons of the 2-5th digits
 - iv) Evaluate the Plantar plates along the 1-5 digits
 - v) Assess the 1-4 interspaces
 - Assess for neuroma
 - Bursitis
 - vi) Mulder's test
 - If a neuroma is seen, attempt to visualize in the transverse/short axis by performing the mulder's test
 - Place the probe in short axis over the interspace containing the neuroma
 - Squeeze with your non-scanning hand the mid-portion of the foot
 - May see the neuroma pop in the interspace
- D. Pathology/Pathophysiology
 1. Ankle/foot
 - a. Tendon pathology
 - i) Tendonosis
 - ii) Tendon tears
 - b. Bursitis
 - c. Joint effusion
 - d. Dislocation
 - e. Infection
 - f. Masses/cysts (i.e., morton's neuroma, plantar fascia fibromatosis)
 - g. Fracture
 - h. Foreign bodies
 - i. Calcifications/crystal deposits
 - j. Nerve entrapment or compression

Musculoskeletal Sonography

- k. Evaluation of postsurgical anatomy and hardware
- l. Differentiation between adult and pediatric pathologies

Musculoskeletal Sonography

Section X: Hernia Evaluation

1. Understand where hernias can occur in the abdomen and in the groin areas
 2. Demonstrate knowledge of the indications for performing a sonographic evaluation to evaluate for hernia
 3. Establish a comprehensive sonographic protocol/technique for evaluating hernias
-

X: HERNIA EVALUATION

- A. Definition
 1. Protrusion of a part or structure through the tissues normally containing it
 2. Can contain fat or bowel
- B. Type
 1. Hernia type is determined by location
 2. Groin hernias
 - a. Inguinal (indirect and direct)
 - b. Femoral
 3. Anterior abdominal wall hernias
 - a. Umbilical
 - b. Linea alba
 - c. Spigelian
 - d. Incisional
- C. Abdominal hernia evaluation with ultrasound
 1. Utilize a 7 or 12 MHz linear transducer (or possibly a 5-7 MHz curvilinear transducer)
 2. Have patient in the supine position
 3. Ask the patient to point to the area of tenderness or lump
 4. Have the patient valsava once over the area of interest to see if area truly herniates
 5. Can scan over the area with patient standing upright depending on area of interest
- D. Groin hernia evaluation with ultrasound
 1. Utilize a 7 or 12 MHz linear transducer (or possibly a 5-7 MHz curvilinear transducer)
 2. Have patient in the supine position
 3. Ask the patient to point to the area of tenderness or lump
 4. Identify the inferior epigastric artery and vein (IEA and IEV) in the groin (indirect and direct inguinal hernias)
 - a. Have the patient valsava while over the inferior epigastric vessels
 - i) If the hernia protrudes anterior and lateral in respect to the inferior epigastric vessels, then this is an indirect inguinal hernia (these hernias are located anterior to the spermatic cord)
 - ii) If the hernia protrudes inferior and medial in respect to the inferior epigastric vessels, then this is a direct inguinal hernia (these hernias are located posterior to the spermatic cord)

Musculoskeletal Sonography

- 5. Identify the femoral artery and vein (CFA and CFV) (femoral hernias)
 - a. Have the patient valsalva while over the femoral vessels
 - b. Typically these types of hernias will be seen medial to the femoral vessels
- E. Evaluate postsurgical anatomy

Musculoskeletal Sonography

Section XI: Chest Wall

1. Understand the anatomy of the chest wall
 2. Demonstrate knowledge of the indications for performing a sonographic evaluation of the chest wall
 3. Establish a comprehensive sonographic protocol/technique for evaluating the chest wall
 4. Understand pathologies related to the chest wall
-

XI: CHEST WALL

A. Anatomy

1. Skin
2. Subcutaneous fat
3. Muscles
4. Joints
5. Bone
6. Cartilage
7. Intercostal spaces
8. Anatomic variants

B. Indications

1. Localized pain
2. Abnormal palpations
3. Chest wall swelling
4. Palpable abnormalities
5. Interventional guidance

C. Sonographic Technique

1. Utilize a 7 or 12 MHz linear transducer (or possibly a 5-7 MHz curvilinear transducer)
2. Patient position
 - a. Supine position to evaluate the anterior chest
 - b. Sitting position for evaluating the lateral and posterior chest
3. Lesion assessment
 - a. Evaluate in at least two orthogonal planes, avoiding excess pressure (due to compressing potential vasculature)
 - b. Use an abundance of gel to reduce transducer pressure and to optimize skin contact, preventing air artifacts
 - c. Utilize the contralateral chest for comparison

Musculoskeletal Sonography

D. Pathology/Pathophysiology

1. Trauma

- a. Rib fracture
- b. Costochondral junction and costal cartilage fractures
- c. Fractures involving other bony structures of the chest wall (clavicle, scapula, sternum, vertebral spinous processes)
- d. Muscle injuries
- e. Hematoma

2. Infection

- a. Cellulitis
- b. Abscess
- c. Septic arthritis
 - i) Joint effusion

3. Tumors

- a. Benign tumors
 - i) Lipoma
 - ii) Epidermoid cyst
 - iii) Vascular malformations
 - iv) Lymphatic malformations
 - v) Elastofibroma dorsi
 - vi) Neurogenic tumors
- b. Malignant tumors
 - i) Liposarcoma
 - ii) Chest wall metastases
- c. Tumor-like lesions
 - i) Fat necrosis
 - ii) Ganglion cyst
 - iii) Joint degeneration
 - iv) Lymphadenopathy

4. Differentiation between adult and pediatric pathologies

Musculoskeletal Sonography

Section XII: Ultrasound-Guided Interventions

1. Understand the types of musculoskeletal ultrasound-guided interventions that can be performed
 2. List indications for performing invasive procedures
 3. Describe the sonographic technique for interventional procedures
 4. Describe the role of sonography in interventional procedures
 5. List various complications associated with interventional procedures
-

IX: Musculoskeletal (MSK) Ultrasound (US)-Guided Interventions

A. Purpose/Definition

1. MSK US-guided interventions are minimally invasive procedures with both diagnostic and therapeutic purposes
 - a. Tendon sheath, joint, and bursal therapeutic injections
 - b. Aspiration of fluid collections, bursae, and joints
 - c. Biopsies
 - d. Ablations
 - e. Dry needling
 - f. Nerve mapping
 - g. Nerve block
 - h. Surgical planning
2. Procedures may be performed in the adult and pediatric populations

B. Ultrasound Preparation

1. Select the transducer based on frequency/penetration needs and footprint
2. Plan the procedure entry site to visualize the relevant anatomy, surrounding vascular structures, and the tip of the needle.

C. Consent Process

1. Risks of procedures
2. Benefits of the procedure
3. Alternatives to the procedure
4. Describe how the procedure is performed
5. Witnessing/signing of the consent
6. Time out

D. Patient Preparation

1. The procedural area should be sterilely cleaned and prepped
2. The operator/sonographer should wear sterile gloves and use a sterile US probe cover

E. Ultrasound-Guided Visualization

1. The needle is seen as a linear hyperechoic structure
2. The operator/sonographer needs to watch the needle on the screen, while keeping the tip in view

Musculoskeletal Sonography

F. Complications

1. Bleeding
2. Infection
3. Inflammation
4. Local tissue atrophy
5. Cartilage damage
6. Tendon rupture
7. Corticosteroid systemic effects
 - a. Flushing
 - b. Hyperglycemia

G. Contraindications

1. Inability to give consent
2. Inability to cooperate
3. Corticosteroid contraindications
 - a. Fracture
 - b. Intra-articular infection
 - c. Frequency of receiving corticosteroids
 - i) Corticosteroid injections should be performed a maximum of four times a year for any joint
 - ii) There should be at least 6 weeks between any two injections

H. Types of Procedures

1. Shoulder
 - a. Glenohumeral joint injection
 - i) Indications
 - Rheumatoid arthritis (RA)
 - Adhesive capsulitis
 - Osteoarthritis (OA)
 - ii) Procedure
 - 21-gauge needle
 - Scan the joint posteromedially or posterolateral (depending on patient body habitus and preference of the operator)
 - Direct the tip of the needle toward the posterior aspect of the humeral head
 - b. Acromioclavicular (AC) joint injection
 - i) Indications
 - Osteolysis of the distal clavicle
 - Osteoarthritis (OA)
 - ii) Procedure

Musculoskeletal Sonography

- Identify the AC joint by identifying the bony landmarks and hypoechoic joint space
 - Needle is inserted using a lateral to medial approach
 - c. Subacromial subdeltoid bursa injection
 - i) Indications
 - Thickened or distended due to rotator cuff tear or subacromial impingement
 - ii) Procedure
 - View the supraspinatus tendon longitudinally
 - Insert the needle using a lateral to medial approach
 - Avoid inserting the needle in the underlying rotator cuff to prevent injury to the tendon
 - d. Calcific tendinosis lavage
 - i) Indications
 - Calcific deposition within the tendon
 - ii) Procedure
 - 21-gauge needle
 - Identify the calcific deposit
 - The center of the calcification is punctured
 - Successive propulsion and aspiration with the syringe plunger is performed under sonographic guidance
 - A cloudlike calcium settles into the barrel of the syringe with the aspiration
 - A new syringe with a corticosteroid and anesthetic mix can be injected into the subacromial bursa at the end of the procedure
 - e. Long head biceps tendon sheath injection
 - i) Indications
 - Diagnosis or treatment of tendinopathy in the biceps tendon
 - ii) Procedure
 - The biceps tendon is visualized in short axis at the bicipital groove
 - The injection can be performed directly in the tendon sheath by targeting the fluid within the long head biceps tendon (LHBT) sheath.
 - The needle is introduced from a lateral approach
 - The needle tip should be visualized within the tendon sheath adjacent to the tendon
 - The injectate should fill the sheath and this should be visualized using ultrasound-guidance
- 2. Elbow
 - a. Joint injection and aspiration
 - i) Indication

Musculoskeletal Sonography

- Elbow pain
 - ii) Procedure
 - Scan from a posterolateral approach
 - Identify the hypoechoic trochlear and capitellum cartilage
 - Evaluate for joint fluid and intra-articular bodies
 - The needle is introduced from a superolateral approach through the triceps muscle
 - b. Tendon injection
 - i) Indication
 - Injection of the common extensor tendon for lateral epicondylitis
 - ii) Procedure
 - The needle is introduced from an inferolateral approach along the tendon fibers
 - c. Nerve injection
 - i) Indication
 - Peripheral neuropathy
 - Compression of the posterior interosseous nerve (PIN)
 - ii) Procedure
 - Ulnar nerve evaluation
 - Identify the ulnar nerve between the olecranon and the medial epicondyle
 - The needle is introduced from a lateral approach
 - Posterior interosseous nerve (PIN)
 - Identify the PIN just distal to the elbow
 - The needle is introduced from the lateral side through the supinator muscle
- 3. Wrist
 - a. Joint injection
 - i) Indication
 - Arthritis
 - Septic arthritis
 - Synovial biopsy
 - ii) Procedure
 - Pronate the patient's palm
 - Wrist is in mild flexion and is supported on a towel roll
 - 22- to 25-gauge needle is used

Musculoskeletal Sonography

- The needle is introduced just distal to the radius between the thumb and index finger extensor tendon
 - b. Tendon injection
 - i) Indication
 - DeQuervain tenosynovitis
 - Pain
 - ii) Procedure
 - The extensor pollicis brevis (EPB) and abductor pollicis longus (APL) tendons are visualized in short axis
 - The needle is introduced using a dorsal needle approach to inject fluid around the tendons
 - c. Nerve injection
 - i) Indication
 - Median nerve neuropathy
 - Pain
 - ii) Procedure
 - The patient's hand is supinated, and the probe is placed in the transverse short axis
 - The median nerve is identified in the carpal tunnel
 - The needle approach should be medial to lateral
 - The radial and ulnar arteries are visualized to avoid those vascular structures
 - d. Ganglion injection
 - i) Indication
 - Symptomatic ganglion
 - ii) Procedure
 - Pronate the patient's wrist on a towel roll to visualize the ganglion
 - The needle is introduced in between the extensor tendons until the needle tip is visualized within the ganglion
- 4. Adult hip
 - a. Aspiration and injection
 - i) Indication
 - Aspiration of joint effusion
 - Septic arthritis
 - Corticosteroid injection for osteoarthritis (OA)
 - ii) Procedure
 - Patient is in the supine position with the affected hip in internal rotation

Musculoskeletal Sonography

- The probe is placed in the oblique sagittal plane along the axis of the femoral neck to visualize the anterior recess of the joint
- b. Bursa injection (iliopsoas bursa injection)
 - i) Indication
 - Distention of the bursa due to degenerative, arthritic, or post-traumatic causes
 - Pain
 - ii) Procedure
 - Patient is in the supine position
 - The probe is placed in transverse near the level of the acetabulum
 - Visualize hyperechoic iliopsoas tendon
 - The needle is advanced from a lateral to medial approach into the iliopsoas bursa
 - An injectate distends the iliopsoas bursa after injection
 - The needle is advanced using a dorsal needle approach to inject fluid around the tendons
- c. Bursa injection (greater trochanteric bursa injection)
 - i) Indication
 - Acute and chronic inflammation
 - Pain
 - ii) Procedure
 - The patient is placed in the lateral decubitus position
 - Place probe transversely along the greater trochanter (GT)
 - The needle is introduced from a lateral to medial approach into the greater trochanteric bursa
 - An injectate distends the iliopsoas bursa after injection
- d. Nerve injection [lateral femoral cutaneous nerve (LFCN)]
 - i) Indication
 - Lateral femoral cutaneous nerve (LFCN) entrapment
 - ii) Procedure
 - The patient is placed in the supine position
 - The transducer is placed parallel with the inguinal ligament.
 - Visualize the lateral femoral cutaneous nerve (LFCN) by moving the probe in a medial inferior direction
 - The needle is inserted from a lateral to medial approach for a perineural injection
- e. Nerve injection [sciatic nerve (SN)]
 - i) Indication

Musculoskeletal Sonography

- Sciatic pain
- ii) Procedure
 - The patient is placed in the supine position with the hip abducted
 - The needle is introduced from the medial aspect of the thigh, toward the sciatic nerve.
 - An anesthetic is injected to ensure perineural location and to assist in identifying the sciatic nerve
 - An injectate is then introduced
- f. Quadratus femoris muscle injection
 - i) Indication
 - Ischiofemoral impingement
 - ii) Procedure
 - The patient is placed in the prone position
 - The curvilinear transducer is placed in transverse at the level of the lesser trochanter
 - Visualize the quadratus femoris muscle in the ischiofemoral space between the lesser trochanter and sciatic nerve
 - The needle is inserted from a lateral to medial approach into the muscle for an intramuscular injection
- 5. Knee
 - a. Aspiration and injection (superolateral approach)
 - i) Indication
 - Aspiration of joint effusion
 - Septic arthritis
 - Corticosteroid injection for osteoarthritis (OA)
 - ii) Procedure
 - The patient is placed in the supine position with the knee slightly flexed with a rolled towel under the knee
 - Using a lateral approach, the needle is introduced superior to the patella into the suprapatellar recess joint fluid
 - b. Aspiration and injection (Baker cyst)
 - i) Indication
 - Symptomatic Baker cyst
 - ii) Procedure
 - Patient is placed in the prone position
 - The transducer is placed in the axial plane
 - The needle is introduced from a posteromedial approach, into the Baker cyst

Musculoskeletal Sonography

- c. Patellar tendon injection
 - i) Indication
 - Tendinopathy
 - ii) Procedure
 - Patient is in the supine position with the knee extended
 - The patellar tendon is visualized in short axis
 - The needle is introduced from medial to lateral approach
 - d. Nerve injection (common peroneal nerve cyst injection and aspiration)
 - i) Indication
 - Pain that may present with foot drop
 - ii) Procedure
 - Patient is in the supine position with the knee extended laterally
 - Visualize the common peroneal nerve near the fibular head
 - The needle is introduced from a lateral to medial approach to target the cyst or nerve sheath
6. Ankle/foot
- a. Aspiration and injection (tibiotalar joint)
 - i) Indication
 - Synovitis
 - Arthritis
 - Impingement
 - Traumatic effusion
 - ii) Procedure
 - The patient's foot is positioned in slight plantar flexion
 - The needle is introduced into the joint space to aspirate fluid
 - b. Aspiration and injection [first metatarsophalangeal (MTP) joint]
 - i) Indication
 - Acute or chronic pain due to arthritis, inflammation, or trauma
 - ii) Procedure
 - The patient's foot should be placed in anatomic position with the knee flexed
 - The needle is introduced into the joint space using an anterior needle approach
 - c. Tendon injection [posterior tibial tendon (PTT)]
 - i) Indication
 - Tendinopathy
 - Tenosynovitis

Musculoskeletal Sonography

- ii) Procedure
 - The tendon is visualized at the medial ankle just above the medial malleolus
 - The needle is introduced using a posterior approach along the medial side of the ankle
 - Effusions can be aspirated prior to injection
- d. Tendon injection [flexor hallucis longus (FHL)]
 - i) Indication
 - Tendinopathy
 - Tenosynovitis
 - ii) Procedure
 - The patient is placed in the prone position with the foot placed on a towel roll
 - The FHL is visualized along the medial ankle just inferior to the medial malleolus
 - Introduce the needle from lateral to medial through the Kager fat pad
- e. Nerve injection (sural nerve)
 - i) Indication
 - Pain
 - Nerve entrapment
 - Trauma
 - ii) Procedure
 - The needle should be introduced between the posterior border of the lateral malleolus and the achilles tendon
 - The small saphenous vein is visualized adjacent to the nerve
 - Anesthetic is injected
- f. Nerve injection [superficial peroneal nerve (SPN)]
 - i) Indication
 - Pain
 - Nerve entrapment
 - Trauma
 - ii) Procedure
 - The probe is placed transversely to scan the short axis of the nerve from its origin down to the lateral malleolus
 - The needle is introduced from a lateral to medial in-plane
- g. Morton's neuroma
 - i) Indication
 - Pain on the plantar side of foot near toes/interspaces

Musculoskeletal Sonography

- Feeling of walking on a small pebble
- Burning sensation in the ball of the foot that radiates to the toes
- Numbness/tingling in the foot/toes

ii) Procedure

- The probe is placed the longitudinal plane at the level of the metatarsal heads on the plantar side
- Squeeze the toes together to visually displace the neuroma along the plantar aspect of the foot (mulder sign)
- Introduce the needle in the affected interspace (between the toes)

f. Platelet-rich plasma (PRP) injections

i) Indication

- Treatment to help accelerate wound healing with joint injury and trauma and joint injury
- Treatment for tendinopathy or tendinosis

ii) Procedure

- The PRP injection procedure is typically performed in conjunction with percutaneous or tendon fenestration
- The injection can lead to improvement in pain, strength, and function of the symptomatic area

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Abbreviations

Shoulder

ACJ – Acromioclavicular Joint
BT – Biceps Tendon
IS – Infraspinatus Muscle
IST – Infraspinatus Tendon
SS – Supraspinatus Muscle
SST – Supraspinatus Tendon

Elbow

ALCL – Accessory Lateral Collateral Ligament
AIN – Anterior Interosseous Nerve
AL – Annular Ligament
CET – Common Extensor Tendon
CFT – Common Flexor Tendon
CTS – Carpal Tunnel Syndrome
DBT – Distal Biceps Tendon
FDS - Flexor Digitorum Superficialis
LCL – Lateral Collateral Ligament
LUCL – Lateral Ulnar Collateral Ligament
PIN – Posterior Interosseous Nerve
RCL – Lateral Radial Collateral Ligament
UCL – Ulnar (medial) Collateral Ligament

Wrist & Hand

APL - Abductor Pollicis Longus Tendon
CMC – Carpometacarpal Joint
DIP - Distal interphalangeal Joint
DRUJ - Distal Radioulnar Joint
ECRB - Extensor Carpi Radialis Brevis Tendon
ECRL - Extensor Carpi Radialis Longus Tendon
ECU – Extensor Carpi Ulnaris Tendon
EDM - Extensor Digiti Minimi Tendon
EPB - Extensor Pollicis Brevis Tendon
EPL - Extensor Pollicis Longus Tendon
FCR - Flexor Carpi Radialis Tendon
FCU - Flexor Carpi Ulnaris Tendon
FDS - Flexor Digitorum Superficialis Tendons
FDP - Flexor Digitorum Profundus Tendons
FPL - Flexor Pollicis Longus Tendons
IP – Interphalangeal Joint
LTL - Lunotriquetral Ligament
MCP – Metacarpophalangeal Joint
PIP - Proximal interphalangeal Joint
RCJ – Radiocarpal Joint
SLL – Scapholunate Ligament
TFCC – Triangular Fibrocartilage Complex
TMC - Thumb Metacarpal Joint

Adult Hip

ASIS - Anterior Superior Iliac Spine
AIIS - Anterior Inferior Iliac Spine
IT Band – Iliopsoas Tendon Band
TFL - Tensor Fascia Lata

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Knee

ACL - Anterior Cruciate Ligament
CPN - Common Peroneal Nerve
IT Band – Iliopsoas Tendon Band
ITBFS - Iliotibial Band Friction Syndrome
MCL - Medial Collateral Ligament
LCL - Lateral Collateral Ligament
PCL - Posterior Cruciate Ligament
TFL - Tensor Fascia Lata
TN - Tibial Nerve

Ankle & Foot

ATFL - Anterior Talofibular Ligament
CFL - Calcaneofibular Ligament
DIP - Distal Interphalangeal Joints
DPN - Deep Peroneal Nerve
EDL - Extensor Digitorum Longus Tendon
EHL - Extensor Hallucis Longus Tendon
FDL - Flexor Digitorum Longus Tendon
LCL - Lateral Collateral Ligament
LPN - Lateral Plantar Nerve
MCN - Medial Calcaneal Nerve
MPN - Medial Plantar Nerve
MTP - Metatarsal-Phalangeal Joints
PIP - Proximal Interphalangeal Joints
PL - Peroneus Longus Tendon
PB - Peroneus Brevis Tendon
SPN - Superficial Peroneal Nerve
TN - Tibial Nerve

Hernia

CFA – Common Femoral Artery
CFV – Common Femoral Vein
IEA – Inferior Epigastric Artery
IEV – Inferior Epigastric Vein

Ultrasound-Guided Interventions

APL - Abductor Pollicis Longus Tendon
ACJ – Acromioclavicular Joint
EPB - Extensor Pollicis Brevis Tendon
FHL - Flexor Hallucis Longus Tendon
GT - Greater Trochanter
LFCN - Lateral Femoral Cutaneous Nerve
LHBT - Long Head Biceps Tendon
MTP - Metatarsophalangeal Joint
OA – Osteoarthritis
PIN - Posterior Interosseous Nerve
PRP - Platelet-Rich Plasma Injections
PTT - Posterior Tibial Tendon
RA – Rheumatoid Arthritis
SN - Sciatic Nerve
SPN - Superficial Peroneal Nerve

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