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The American College of Radiology will periodically define new practice parameters and technical standards for radiologic practice to help advance the science of radiology and to improve the quality of service to patients throughout the United States. Existing practice parameters and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

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Amended 2014 (Resolution 39)*

ACR–AIUM–SPR–SRU PRACTICE PARAMETER FOR THE PERFORMANCE OF THE MUSCULOSKELETAL ULTRASOUND EXAMINATION

PREAMBLE

This document is an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. Practice Parameters and Technical Standards are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care[1]. For these reasons and those set forth below, the American College of Radiology and our collaborating medical specialty societies caution against the use of these documents in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the practice parameters, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in the practice parameters when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations of available resources, or advances in knowledge or technology subsequent to publication of the practice parameters. However, a practitioner who employs an approach substantially different from these practice parameters is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment. Therefore, it should be recognized that adherence to these practice parameters will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of these practice parameters is to assist practitioners in achieving this objective.

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[1] Iowa Medical Society and Iowa Society of Anesthesiologists v. Iowa Board of Nursing, ___ N.W.2d ___ (Iowa 2013) Iowa Supreme Court refuses to find that the *ACR Technical Standard for Management of the Use of Radiation in Fluoroscopic Procedures* (Revised 2008) sets a national standard for who may perform fluoroscopic procedures in light of the standard's stated purpose that ACR standards are educational tools and not intended to establish a legal standard of care. See also, Stanley v. McCarver, 63 P.3d 1076 (Ariz. App. 2003) where in a concurring opinion the Court stated that "published standards or guidelines of specialty medical organizations are useful in determining the duty owed or the standard of care applicable in a given situation" even though ACR standards themselves do not establish the standard of care.

I. INTRODUCTION

The clinical aspects contained in specific sections of this practice parameter (Introduction, Supervision and Interpretation of Ultrasound Examination, Specifications for Individual Examinations, and Equipment Specifications) were developed collaboratively by the American College of Radiology (ACR), the American Institute of Ultrasound in Medicine (AIUM), the Society for Pediatric Radiology (SPR), and the Society of Radiologists in Ultrasound (SRU). Recommendations for physician requirements, written request for the examination, procedure documentation, and quality control vary among the organizations and are addressed by each separately.

This practice parameter has been developed to assist practitioners performing a musculoskeletal (MSK) ultrasound examination. While it is not possible to detect every abnormality, adherence to the following practice parameter will maximize the probability of detecting most abnormalities that occur.

II. INDICATIONS

Indications for musculoskeletal ultrasound include, but are not limited to:

1. Pain or dysfunction.
2. Soft tissue or bone injury.
3. Tendon or ligament pathology.
4. Arthritis, synovitis, or crystal deposition disease.
5. Intra-articular bodies.
6. Joint effusion.
7. Nerve entrapment, injury, neuropathy, mass, or subluxation.
8. Evaluation of soft tissue masses, swelling, or fluid collections.
9. Detection of foreign bodies in the superficial soft tissues.
10. Planning and guiding for an invasive procedure.
11. Congenital or developmental anomalies.
12. Postoperative or postprocedural evaluation.

MSK ultrasound should be performed when there is a valid medical reason. There are no absolute contraindications.

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

Each organization will address this section in its document. ACR language is as follows:

See the ACR–SPR–SRU Practice Parameter for Performing and Interpreting Diagnostic Ultrasound Examinations.

IV. WRITTEN REQUEST FOR THE EXAMINATION

Each organization will address this section in its document. ACR language is as follows:

The written or electronic request for musculoskeletal ultrasound should provide sufficient information to demonstrate the medical necessity of the examination and allow for its proper performance and interpretation.

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). Additional information regarding the specific reason for the examination or a provisional diagnosis would be helpful and may at times be needed to allow for the proper performance and interpretation of the examination.

The request for the examination must be originated by a physician or other appropriately licensed health care provider. The accompanying clinical information should be provided by a physician or other appropriately licensed health care provider familiar with the patient's clinical problem or question and consistent with the state scope of practice requirements. (ACR Resolution 35, adopted in 2006)

V. SUPERVISION AND INTERPRETATION OF ULTRASOUND EXAMINATIONS

A physician must be available for consultation with the sonographer on a case-by-case basis. Ideally the physician should be on-site and available to participate actively in the ultrasound examination when required. It is recognized, however, that geographic realities may not permit the presence of an on-site physician in all locations. In this case, a supervising physician should be available for quality assurance and sonographer supervision via a picture archiving and communication system (PACS).

VI. SPECIFICATIONS FOR INDIVIDUAL EXAMINATIONS

Depending on the clinical request and the patient's presentation, the ultrasound examination can involve a complete assessment of a joint or anatomic region or it can be focused on a specific structure of interest. If a focused study is performed, it is essential to have a full understanding of the relevant abnormalities, including those that may correspond to the patient's symptoms.

General ultrasound scanning principles apply. Transverse and longitudinal views should always be obtained with the transducer parallel (that is, ultrasound beam perpendicular) to the axis of the region of interest to minimize artifact. Abnormalities should be measured in orthogonal planes. Patient positioning for specific examinations may vary depending on the indication, clinical condition, and patient's age.

A. Specifications of the Shoulder Examination

Patients should be examined in the sitting position when possible, preferably on a rotating seat. Examination of the shoulder should be tailored to the patient's clinical circumstances and range of motion. Color and power Doppler may be useful in detecting hyperemia within the joint or surrounding structures.

The long head of the biceps tendon should be examined with the forearm in supination and resting on the thigh or with the arm in slight external rotation. The tendon is examined in a transverse plane (short axis), where it emerges from under the acromion, to the musculotendinous junction distally. Longitudinal views (long axis) should also be obtained. These views should be used to detect fluid or intra-articular loose bodies within the bicipital tendon sheath, and to determine whether the tendon is properly positioned within the bicipital groove, subluxated, dislocated, or torn.

The rotator cuff should be examined for signs of tear, tendinosis, and/or calcification. Both long axis and short axis views of each tendon should be obtained.

To examine the subscapularis tendon, the elbow remains at the side while the arm is placed in external rotation. The subscapularis is imaged from the musculotendinous junction to the insertion on the lesser tuberosity of the humerus. Dynamic evaluation as the patient moves from internal to external rotation may be helpful.

To examine the supraspinatus tendon, the arm can be extended posteriorly, and the palmar aspect of the hand can be placed against the superior aspect of the iliac wing with the elbow flexed and directed toward midline (instruct patient to place the hand in the back pocket). Other positioning techniques also may be helpful.

To scan the supraspinatus and infraspinatus tendons along their long axis, it is important to orient the transducer approximately 45 degrees between the sagittal and coronal planes to obtain a longitudinal view. The transducer then should be moved anteriorly and posteriorly to completely visualize the tendons.

Short axis views of the tendons should be obtained by rotating the probe 90 degrees to the long axis**.** The tendons are visualized by sweeping medially to the acromion and laterally to their insertions on the greater tuberosity of the humerus. The more posterior aspect of the infraspinatus and teres minor tendons should be examined by placing the transducer at the level of the glenohumeral joint below the scapular spine while the forearm rests on the thigh with the hand supinated. Internal and external rotation of the arm is helpful in identifying the infraspinatus muscle and its tendon and in detecting small joint effusions. To visualize the teres minor tendon, the medial edge of the probe should be angled slightly inferiorly.

Throughout the examination of the rotator cuff, the cuff should be compressed with the transducer to detect nonretracted tears. In evaluating rotator cuff tears, comparison with the contralateral side may be useful. Dynamic evaluation of the rotator cuff also is useful – for example, to evaluate the rotator cuff for impingement or assess cuff tear extent. In patients with a rotator cuff tear, the supraspinatus, infraspinatus, and teres minor muscles should be examined for atrophy that may alter surgical management.

During the rotator cuff examination, the subacromial-subdeltoid bursa should be examined for the presence of bursal thickening or fluid. It is also important to evaluate the glenohumeral joint with the probe placed in the transverse plane from a posterior approach to evaluate for effusions, intra-articular loose bodies, synovitis, or bony abnormalities. If symptoms warrant, the suprascapular notch and spinoglenoid notch also may be evaluated. The acromioclavicular joint should be evaluated with the probe placed at the apex of the shoulder, bridging the acromion and distal clavicle [1-3].

Ultrasound is very useful in evaluating infants with glenohumeral dysplasia. These infants are examined in a decubitus position, and older children are examined seated. The shoulder is scanned from a posterior approach to evaluate the relationship between the humeral head and glenoid, as well as the shape of the posterior glenoid. Both static and dynamic images are obtained. The shoulder is scanned through the full range of internal to external rotation. Posterior subluxation is assessed visually and by measuring the α angle, which is the angle between the posterior margin of the scapula and the line drawn tangentially to the humeral head and posterior edge of the glenoid. The normal value of the α angle is 30 degrees or less. The clavicle and proximal humerus are also evaluated for fracture [4].

B. Specification of an Elbow Examination

The patient is seated with the arm extended and the hand in supination, resting on a table, and the examiner sitting in front of the patient. The elbow may also be examined with the patient supine and the examiner on the same side as the elbow of interest. The examination is divided into 4 quadrants: anterior, medial, lateral, and posterior. The examination may involve a complete assessment of one or more of the 4 quadrants or be focused to a specific structure, depending on the clinical presentation. Color and power Doppler may be useful in detecting hyperemia within the joint or surrounding structures.

1. Anterior
   The anterior joint space and other recesses of the elbow are assessed for effusion, synovial proliferation, and loose bodies. Longitudinal and transverse scanning of the anterior humeroradial and humeroulnar joints and coronoid and radial fossae is performed to assess the articular cartilage and cortical bone. The annular recess of the neck of the radius is scanned dynamically with the patient alternatively supinating and pronating the forearm. The same dynamic assessment can be made for the biceps tendon and its attachment to the radial bicipital tuberosity. Evaluation of the brachialis muscle, the adjacent radial and brachial vessels, and the median and radial nerves can also be performed as clinically warranted.

1. Lateral
   The patient extends the arm and places both palms together, or if the patient is supine the forearm is placed across the abdomen. This position allows assessment of the lateral epicondyle and the attachments of the common extensor tendon, as well as the more proximal attachments of the extensor carpi radialis longus and brachioradialis. The hand is then pronated with the transducer on the posterolateral aspect of the elbow to scan the radial collateral ligament.

2. Medial
   The hand is placed in supination, or if the patient is supine, the upper limb is placed in abduction and external rotation to expose the medial side of the elbow. The medial epicondyle, common flexor tendon,

and ulnar collateral ligament are scanned in both planes. The ulnar nerve is visualized in the cubital tunnel between the olecranon process and medial epicondyle. Static examination of the ulnar nerve may be facilitated by placing the elbow in an extended position. Dynamic subluxation of the ulnar nerve is assessed by imaging with flexion and extension of the elbow. Dynamic examination with valgus stress is performed to assess integrity of the ulnar collateral ligament. During stress testing, the elbow must be slightly flexed to disengage the olecranon from the olecranon fossa.

3. Posterior

   The palm is placed down on the table, or if the patient is supine the forearm is placed across the abdomen, with the elbow flexed to 90 degrees. The posterior joint space, triceps tendon, olecranon process, and olecranon bursa are assessed [5-7].

C. Specifications of the Wrist and Hand Examination

The patient sits with hands resting on a table placed anteriorly or on a pillow placed on the patient's thighs. Alternatively, the examination can be performed with the patient supine. The volar examination requires the wrists to be placed flat or in mild dorsiflexion with palm up, and during both ulnar and radial deviation to delineate all the necessary anatomy. The dorsal scan requires the wrist to be placed palm down with mild volar flexion. The examination may involve a complete assessment of one or more of the 3 anatomic regions described below or is focused to a specific structure, depending on the clinical presentation. Color and power Doppler may be useful in detecting hyperemia within the joint or surrounding structures.

1. Volar

   Transverse and longitudinal images should be obtained from the volar wrist crease to the thenar muscles. The transducer will require angulation to compensate for the normal contour of the wrist. The flexor retinaculum, flexor digitorum profundus, and superficialis tendons and the adjacent flexor pollicis longus tendon should be identified within the carpal tunnel. Dynamic imaging with flexion and extension of the fingers will demonstrate normal motion of these tendons. The median nerve lies superficial to these tendons and deep to the flexor retinaculum and it moves with the tendons but with less amplitude on dynamic imaging. The distal end of the median nerve is tapered and divides into multiple divisions for the hand. The palmaris longus tendon lies superficial to the retinaculum. On the radial side of the wrist, the flexor carpi radialis longus tendon lies within its own canal. It is important to evaluate the region of the flexor carpi radialis and the radial artery for occult ganglion cysts, which typically originate from the radiocarpal joint capsule. On the ulnar side, branches of the ulnar nerve and artery lie within Guyon's canal. The flexor carpi ulnaris tendon and pisiform bone border the ulnar aspect of Guyon's canal. All of the tendons can be followed to their sites of insertion if clinically indicated.

2. Ulnar

   Placing the transducer transversely on the ulnar styloid and moving distally will allow visualization of the triangular fibrocartilage complex (TFCC) in its long axis. The transducer is then moved 90 degrees to view the short axis of the TFCC. The ulnomeniscal homologue may be seen just deep to the extensor carpi ulnaris tendon. This tendon should be viewed in supination and pronation to assess for subluxation.

3. Dorsal

   Structures are very superficial on the dorsal surface, and a high frequency transducer is required with or without the use of a standoff pad. The extensor retinaculum divides the dorsal aspect of the wrist into 6 compartments, which accommodate 9 tendons. These tendons are examined in their short axes initially and then in their long axes in static and dynamic mode, the latter being performed with flexion and extension of the fingers. The tendons can be followed to their sites of insertion when clinically indicated. Moving the transducer transversely distal to Lister's tubercle identifies the dorsal aspect of the scapholunate ligament, a site of symptomatic ligament tears and ganglion cysts. The remaining intercarpal ligaments are not routinely assessed. In patients with suspected inflammatory arthritis, the dorsal radiocarpal, midcarpal, metacarpophalangeal, and, if symptomatic, the proximal interphalangeal joints are evaluated from the volar and dorsal aspects in both the longitudinal and transverse planes for effusion, synovial hypertrophy, and bony erosions. Other joints of the wrist and hand are similarly evaluated as clinically indicated [8,9].

D. Specifications of a Hip Examination

Depending on the patient's habitus, a lower frequency transducer may be required to scan the hip. However, the operator should use the highest possible frequency that provides adequate penetration. The patient is placed supine to examine the anterior hip and turned as necessary to visualize the posterior, medial and/or lateral hip. The examination may involve a complete assessment of one or more of the 4 anatomic regions of the hip described below, or be focused to on a specific structure depending on the clinical presentation. Color and power Doppler may be useful in detecting hyperemia within the joint or surrounding structures.

1. Anterior
   A sagittal oblique plane parallel to the long axis of the femoral neck is used for evaluating the femoral head, neck, joint effusion, and synovitis. The sagittal plane is used for the labrum, the iliopsoas tendon and bursa, the femoral vessels, and the sartorius and rectus femoris muscles. The above structures are then scanned in the transverse plane, perpendicular to the original scan plane. When a "snapping hip" is suspected, dynamic scanning is performed over the region of interest using the same movement that the patient describes as precipitating the complaint. The "snapping hip" is usually related to the iliopsoas tendon as it passes anteriorly over the superior pubic bone or laterally where the iliotibial tract crosses the greater trochanter [10].

2. Lateral
   In the lateral decubitus position, with the symptomatic side up, transverse and longitudinal scans of the greater trochanter, greater trochanteric bursa, gluteus medius, gluteus maximus, gluteus minimus, and tensor fascia lata should be performed. An iliotibial tract that snaps over the greater trochanter can be assessed in this position using dynamic flexion-extension.

3. Medial
   The hip is placed in external rotation with 45-degree knee flexion (frog-leg position). The distal iliopsoas tendon, due to its oblique course, may be better seen in this position. The adductor muscles are imaged in their long axis with the probe in a sagittal oblique orientation, with short axis images obtained perpendicular to this plane. In addition, the pubic bone and symphysis and the distal rectus abdominis insertion should be evaluated.

4. Posterior
   The patient is prone with the legs extended. Transverse and longitudinal views of the glutei, hamstrings, and sciatic nerve are obtained. The glutei are imaged obliquely from origin to greater trochanter (gluteus medius and minimus) and linea aspera (gluteus maximus). The sciatic nerve is scanned in its short axis from its exit at the greater sciatic foramen, deep to the gluteus maximus. It can be followed distally, midway between the ischial tuberosity and the greater trochanter, lying superficial to the quadratus femoris muscle [11].

For information on the Neonatal hip, see the ACR–AIUM–SPR–SRU Practice Parameter for the Performance of the Ultrasound Examination for Detection and Assessment of Developmental Dysplasia of the Hip.

E. Specifications of a Prosthetic Hip Examination

The hip is assessed for joint effusions and extra-articular fluid collections, often as part of an ultrasound-guided procedure for fluid aspiration in the clinical scenario of possible prosthetic joint infection. The region of the greater trochanter and iliopsoas are evaluated for fluid collections or tendon abnormalities such as tendinosis or tear of the iliopsoas, gluteus medius, and gluteus minimus tendons [12,13].

F. Specifications of a Knee Examination

The examination is divided into 4 quadrants. The examination may involve a complete assessment of one or more of the 4 quadrants of the knee described below, or be focused to a specific structure depending on the clinical presentation. Color and power Doppler may be useful in detecting hyperemia within the joint or surrounding structures.

1. Anterior
   The patient is supine with knee flexed to 30 degrees. Longitudinal and transverse scans of the quadriceps and patellar tendons, patellar retinacula, and suprapatellar recess are obtained. The distal femoral trochlear cartilage can be assessed with the probe placed in the suprapatellar space in the transverse plane and with the knee in maximal flexion. Longitudinal views of the cartilage over the medial and lateral femoral condyles are added as indicated. The prepatellar, superficial, and deep infrapatellar bursae are also evaluated.
2. Medial
   The patient remains supine with slight flexion of the knee and hip and with slight external rotation of the hip. Alternatively, the patient may be placed in the lateral decubitus position. The medial joint space is examined. The medial collateral ligament, the pes anserine tendons and bursa, and the medial patellar retinaculum are scanned in both planes. The anterior horn and body of the medial meniscus may be identified in this position, particularly with valgus stress. If meniscal pathology is suspected either clinically or by ultrasound, further imaging with magnetic resonance imaging (MRI) or computed tomography (CT) arthrography if there are contraindications to MRI is advised.

3. Lateral
   The patient remains supine with the ipsilateral leg internally rotated or in a lateral decubitus position. A pillow may be placed between the knees for comfort. From posterior to anterior the popliteus tendon, biceps femoris tendon, fibular collateral ligament, and iliotibial band are scanned. The lateral patellar retinaculum can also be assessed in this position (as well as in the anterior position). The joint line is scanned for lateral meniscal pathology, with varus stress applied as needed.

4. Posterior
   The patient lies prone with the leg extended. The popliteal fossa, semimembranosus, medial and lateral gastrocnemius muscles, tendons, and bursae are assessed. To confirm the diagnosis of a popliteal cyst, the comma shaped extension toward the posterior joint has to be visualized sonographically in the posterior transverse scan between the medial head of gastrocnemius and semimembranosus tendon. In addition, the posterior horns of both menisci can be evaluated. The posterior cruciate ligament may be identifiable in a sagittal oblique plane in this position [14,15].

G. Specifications of an Ankle and Foot Examination

Ultrasound examination of the ankle is divided into 4 quadrants (anterior, medial, lateral and posterior). The examination may involve a complete assessment of one of the 4 quadrants described below, or be focused to a specific structure depending on the clinical presentation. Examination of the foot is most often focused to a particular structure to answer the clinical question (for example, plantar fasciitis, Morton's neuroma, or ganglion cyst). Color and power Doppler may be useful in detecting hyperemia within the joint or surrounding structures.

1. Anterior
   The patient lies supine with the knee flexed and the plantar aspect of the foot flat on the table. The anterior tendons are assessed in long axis and short axis planes from their musculotendinous junctions to their distal insertions. From medial to lateral, this tendon group includes the tibialis anterior, extensor hallucis longus, extensor digitorum longus, and peroneus tertius tendons (the latter being congenitally absent in some patients). The anterior joint recess is scanned for effusion, loose bodies, and synovial thickening. The anterior joint capsule is attached to the anterior tibial margin and the neck of the talus, and the hyaline cartilage of the talus appears as a thin hypoechoic line. The anterior inferior tibiofibular

ligament of the syndesmotic complex is assessed by moving the transducer proximally over the distal tibia and fibula, superior and medial to the lateral malleolus, and scanning in an oblique plane.

2. Medial
The patient is placed in a lateral decubitus position with the medial ankle facing upward. The posterior tibial, flexor digitorum longus, and flexor hallucis longus tendons (located in this order from anterior to posterior) are initially scanned in the short axis plane proximal to the medial malleolus to identify each tendon. They are then assessed in long axis and short axis planes from their proximal musculotendinous junctions in the supramalleolar region to their distal insertions. To avoid anisotropy, the angulation of the transducer must be adjusted continuously for the ultrasound beam to remain perpendicular to the tendons as they curve under the medial malleolus. The same holds true when assessing the lateral aspect of the ankle, as described below. The tibial nerve can be scanned by identifying it between the flexor digitorum tendon anteriorly and the flexor hallucis longus tendon posteriorly, at the level of the malleolus. The nerve can then be followed proximally and distally. The flexor hallucis longus may also be scanned in the posterior position, medial to the Achilles tendon. The deltoid ligament is scanned longitudinally from its attachment to the medial malleolus to the navicular, talus, and calcaneus.

3. Lateral
The patient is placed in a lateral decubitus position with the lateral ankle facing upward. The peroneus brevis and longus tendons are identified proximal to the lateral malleolus in their short axis planes, and they can then be assessed in long axis and short axis planes from their proximal (supramalleolar) musculotendinous junctions to their distal insertions. The peroneus longus can be followed in this manner to the cuboid groove where it turns to course medially along the plantar aspect of the foot to insert on the base of the first metatarsal and medial cuneiform. This latter aspect of the tendon can be scanned in the prone position as clinically indicated. The peroneus brevis tendon is followed to its insertion on the base of the fifth metatarsal. The peroneus brevis and longus tendons are assessed for subluxation using real time images with dorsiflexion and eversion. Circumduction of the ankle can also be a helpful maneuver. The lateral ligament complex is examined by placing the transducer on the tip of the lateral malleolus in the following orientations: anterior and posterior horizontal oblique for the anterior and posterior talofibular ligaments, and posterior vertical oblique for the calcaneofibular ligament.

4. Posterior
The patient is prone with feet extending over the end of the table. The Achilles tendon is scanned in the long axis and short axis planes from the musculotendinous junctions (medial and lateral heads of the gastrocnemius and soleus muscles) to the site of insertion on the posterior surface of the calcaneus. Dynamic scanning with plantar and dorsiflexing may aid in the evaluation of tears. The plantaris tendon lies along the medial aspect of the Achilles tendon and inserts on the posteromedial calcaneus. It should be noted that this tendon may be absent as a normal variant but is often intact in the setting of a full-thickness Achilles tendon tear. The retrocalcaneal bursa, between the Achilles and superior calcaneus, is also assessed. Assessment for a superficial retro Achilles bursa is facilitated by floating the transducer on ultrasound gel and evaluating for fluid within the subcutaneous tissues. The plantar fascia is scanned in both long axis and short axis planes from its proximal origin on the medial calcaneal tubercle distally where it divides and merges into the soft tissues.

5. Digital
In patients with suspected inflammatory arthritis, the metatarsophalangeal joints and, if symptomatic, the proximal interphalangeal joints are evaluated from the plantar and dorsal aspects in both the longitudinal and transverse planes for effusion, synovial hypertrophy, synovial hyperemia, and bony erosions. Other joints of the foot are similarly evaluated as clinically indicated.

6. Interdigital
The patient is supine with the foot dorsiflexed 90 degrees to the ankle. Either a dorsal or plantar approach can be used. The latter will be described here. The transducer is placed longitudinally on the plantar aspect of the first interdigital space, and the examiner applies digital pressure on the dorsal surface. The transducer is moved laterally with its center at the level of the metatarsal heads. The process is repeated

for the remaining interspaces and then repeated in the transverse plane. When a Morton's neuroma is clinically suspected, pressure can be applied to reproduce the patient's symptoms. The intermetatarsal bursa lies on the dorsal aspect of the interdigital nerve, and care must be taken to correctly identify a neuroma and differentiate it from the bursa [16,17].

H. Specifications of a Peripheral Nerve Examination

Nerves have a fascicular pattern with hypoechoic longitudinal neuronal fascicles interspersed with hyperechoic interfascicular epineurium. In addition, they have a hyperechoic superficial epineurium. As a nerve bifurcates each fascicle enters one of the subdivisions without splitting. Nerves course adjacent to vessels and are readily distinguished from the surrounding tendons with a dynamic examination, during which the nerve demonstrates relatively little movement compared to the adjacent tendons. Nerves may become more hypoechoic as they pass through fibro-osseous tunnels, as the fascicles become more compact. Examination in the short axis plane is usually preferred to assess the course of the nerve, as it may be difficult to separate the nerve itself from the surrounding tendons and muscles on a longitudinal scan. Assessment at the level of fibro-osseous tunnels may require dynamic examination. A statically dislocated nerve is readily identifiable on ultrasound, but an intermittently subluxating nerve requires dynamic examination. Perhaps the most commonly subluxating nerve is the ulnar nerve within the cubital tunnel (see elbow examination). Entrapment neuropathies also typically occur within fibro-osseous tunnels, (e.g., cubital and Guyon tunnels for the ulnar nerve, carpal tunnel for the median nerve, fibular neck for the common peroneal nerve, and the tarsal tunnel for the tibial nerve). Adjacent pathology of tendons, soft tissues, and bone can be readily evaluated to determine the potential underlying cause of the nerve dysfunction. In addition, congenital abnormalities, (e.g., accessory muscles or vessels) can be assessed [18].

I. Specifications of a Soft Tissue Mass Examination

The mass should be scanned in both long axis and short axis planes. Ultrasound is an excellent method for differentiating solid from cystic masses. The mass should be measured in 3 orthogonal dimensions and its relationship to surrounding structures, particularly joints, neurovascular bundles, and tendons, determined. Compressibility of the lesion should be evaluated. Color or power Doppler evaluation may help to delineate intralesional and extralesional vessels and vascularity of the mass [19].

J. Specifications of Interventional Musculoskeletal Ultrasound

Ultrasound is an ideal imaging modality for image guidance of interventional procedures within the MSK system. The usual standards for interventional procedures apply (i.e., review prior imaging, appropriate consent, local anesthetic, sterile conditions). The use of a sterile drape that surrounds the prepped site, a sterile ultrasound probe cover, and sterile gloves will lower risk of contamination and infection. Ultrasound provides direct visualization of the needle, monitors the needle pathway, and shows the position of the needle within the target area. Direct visualization of the needle allows the practitioner to avoid significant intralesional and extralesional vessels, adjacent nerves, or other structures at risk.

Prior to any procedure, an ultrasound examination to characterize the target area and its relationship to surrounding structures is performed. Color or power Doppler is useful to delineate any vessels within the target zone. Ideally the shortest pathway to the region of interest should be selected, with consideration given to regional neurovascular structures. The transducer is aligned in the same longitudinal plane as the needle. The needle can be attached directly to the transducer or held free hand. Either way, the needle is visualized throughout the procedure. Slight to and fro movement or injection of a small amount of sterile saline or air may be beneficial in visualizing the needle. In cases of biopsy, focal areas of vascularity indicate viable tissue for pathological examination.

K. Specifications for Ultrasound Examination for Detecting Foreign Bodies

Most foreign bodies are associated with an acoustic shadow or comet tail artifact. Foreign bodies also commonly have a surrounding soft tissue reaction**.** Once a foreign body is detected, ultrasound can be used to demonstrate its relationship to adjacent structures. In addition to a high frequency linear array transducer, detection of foreign bodies in superficial subcutaneous tissues may require a standoff pad [20]. Color and power Doppler may be useful in detecting the tissue reaction that often surrounds a soft tissue foreign body. When available, 3D imaging may be useful in localization.

VII. DOCUMENTATION

Each organization will address this section in its document. ACR language is as follows:

Reporting should be in accordance with ACR Practice Parameter for Communication of Diagnostic Imaging Findings. Adequate documentation is essential for high-quality patient care. There should be a permanent record of the ultrasound examination and its interpretation. Comparison with prior relevant imaging studies may prove helpful. Images of all appropriate areas, both normal and abnormal, should be recorded. Variations from normal size should generally be accompanied by measurements. The initials of the operator should be accessible on the images or electronically on PACS. Images should be labeled with the patient identification, facility identification, examination date, and image orientation. An official interpretation (final report) of the ultrasound examination should be included in the patient's medical record. Retention of the ultrasound examination images should be based on clinical need and relevant legal and local healthcare facility requirements.

VIII. EQUIPMENT SPECIFICATIONS

Musculoskeletal ultrasound should be performed with high-resolution linear array transducers with a broad bandwidth. Frequencies between 7.5 and 12 MHz are generally preferred, with frequencies lower and higher required for deep and very superficial structures, respectively. Transducers with a small footprint should be used in assessing smaller structures, (e.g., interphalangeal joints). Linear array transducers accentuate anisotropy due to the lack of divergent beam geometry. Color and power Doppler are valuable in assessing hyperemia in inflammatory or reparative tissue, determining the vascularity of a soft tissue mass, differentiating cystic lesions from vessels, and assisting in ultrasound-guided biopsy and aspiration [21]. Doppler frequencies should be set to optimize flow detection. Tissue harmonic imaging, compound imaging, and extended field of view may all be useful in musculoskeletal ultrasound.

IX. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION

Each organization will address this section in its document. ACR language is as follows:

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education appearing under the heading *Position Statement on QC & Improvement, Safety, Infection Control, and Patient Education* on the ACR website (http://www.acr.org/guidelines).

Equipment performance monitoring should be in accordance with the ACR Technical Standard for Diagnostic Medical Physics Performance Monitoring of Real Time Ultrasound Equipment.

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