Joint Ultrasound

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KEYWORDS

• Musculoskeletal imaging • Ultrasonography • Joints • Anatomy • Bursitis
• Ultrasound-guided procedures

KEY POINTS

- Joint ultrasound indications are rapidly expanding because of the technological improvements of modern equipments, high availability, and low cost compared with sophisticated imaging techniques.
- Proper operator skills and high-resolution transducers are demanded.
- Color and power Doppler examinations are recommended in every joint study; static imaging of joints should be followed by a dynamic examination.
- Ultrasound is limited in the diagnosis of intra-articular anatomy and pathologic processes that are hidden by bone structures.
- Ultrasound findings in an inflamed joint are nonspecific.
- Ultrasound guidance allows precise and time-saving performance of diagnostic and therapeutic procedures.

Video of a Cine loop showing the moving air bubbles in real-time accompanies this article at http://www.ultrasound.theclinics.com/

INTRODUCTION

Ultrasound is rapidly becoming the first-line modality for examination in the field of musculoskeletal imaging. Advanced ultrasound technology has increased imaging resolution, even at a higher level than magnetic resonance. The ability of Doppler imaging to evaluate vascularity and dynamic examination in real time and its low cost, and high availability are clear advantages over computed tomography (CT) and magnetic resonance imaging (MRI).[1,2] Reliable diagnoses and proper therapeutic interventions may be achieved through knowledge of ultrasound principles, techniques of examination, and ultrasound anatomy and abnormalities, and experience in scanning and performance of interventional procedures. Joint imaging and ultrasound-guided interventional procedures should follow the guidelines and general consensus published in the literature.[3–5] The article describes the normal anatomy and scanning technique of joints, as the first step to perform an effective ultrasound evaluation, followed by pathologic ultrasound findings and ultrasound-guided joint procedures.

ULTRASOUND TECHNOLOGY

Broadband high-resolution linear array transducers (7–15 MHz) provide enough penetration for the examination of large joints with an excellent resolution. A 3- to 9-MHz frequency is needed for a deeper penetration in a larger patient, at the expense of lower resolution.[6–8] Small field of view hockey stick–shaped transducers are ideal for evaluating small superficial joints and performing dynamic maneuvers.

Spatial compound sonography obtains information from several different angles of insonation and combines them to produce a single image, reducing speckle and improving definition of

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tissue planes, thus improving image quality on musculoskeletal ultrasound.[9]

Extended-field-of-view imaging technology allows display of large anatomy and the full extent of an abnormality, showing its relationship with adjacent structures over long distances and curved surfaces.[10]

Color and power Doppler systems allow the detection of low velocity flow in small vessels to correlate hyperemic changes with structural joint abnormalities.[11]

Ultrasound contrast media injection (after switching the machine to contrast menu, which has a low mechanical index and inversion recovery harmonics to optimize the microbubble response) has allowed the evaluation of microvasculature perfusion, leading to encouraging results in imaging arthritis and other rheumatologic conditions.[12]

SCANNING TECHNIQUE

Examination technique depends on the different joints, but as a rule of thumb, a 4-side B-mode scan is recommended, covering the joint from anterior, lateral, medial, and posterior sides. Color and power Doppler imaging are useful for showing the vascular anatomy. Dynamic maneuvers are functional tests to visualize joints during real-time examination.

NORMAL ANATOMY

Joint anatomy is adapted to specific functional requirements and varies among joints. Synovial joints are the most commonly examined with ultrasound. They are composed of the articulating bone surfaces covered by hyaline articular cartilage and the joint capsule, inserting marginally into the cortical bone and periosteum. The articular cartilage is seen as a hypoechoic smooth linear band over a regular hyperechoic line corresponding to the subchondral bone. Cartilage thickness may be accurately measured on ultrasound. The joint capsule and the peripheral boundaries of the cartilage and fibrous capsule, the so-called bare areas, are lined by a synovial membrane (**Fig. 1**). The synovial membrane is too thin to be visible. The capsule is reinforced by ligaments inserted just above the joint line. The joint capsule and ligaments appear hyperechoic. Similar to tendons, the ligaments are anisotropic; care should be taken to place the transducer as parallel as possible to avoid artifactual hypoechogenicity, which could mimic an abnormality.

Intra-articular fibrocartilaginous structures (such as menisci in the knee, the labrum in the hip and shoulder, the triangular fibrocartilage in the wrist, and the volar and plantar plates in hand and foot), intra-articular ligaments, fad pads (such as the Hoffa pad behind the patellar tendon and the elbow pads); and the synovial fluid in the joint space, act as shock absorbers and increase the congruence of the articular surfaces.[13] The fibrocartilaginous structures are homogeneously hyperechoic and adherent to the bone or joint capsule. Because of their deep position in the joint, they can only be partially evaluated. Intrajoint ligaments are invisible on ultrasound because of overlapping bones. Fat pads are hyperechogenic structures (**Fig. 2**).

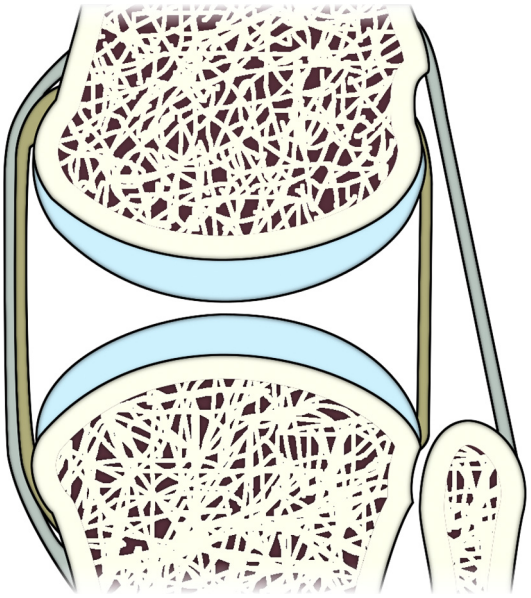

Fig. 1. Synovial joint anatomy, schematic drawing. Articular cartilage (*green*) covering the adjacent bone plates (*white*) and joint capsule (*brown*), which inserts beyond the articular cartilage. Note the articular cartilage different thicknesses from loading and weight-bearing demands. Ligaments (*gray*), either adjacent to the fibrous capsule (on the tibia side) or at a certain distance (on the fibular side), act to reinforce and stabilize the joint. A synovial membrane invests the joint cavity and the bone between the articular cartilage boundaries and the capsule insertion (bare area). Fibrocartilaginous structures and fat pads are void of synovial lining.

JOINT ABNORMALITIES

Joint Effusion

Ultrasound is highly sensitive, although not specific, in detecting joint fluid that may indicate a joint problem. Different types of synovial effusion (traumatic, inflammatory, infectious, or neoplastic) are not definitively differentiated based on their