Imaging in Osteoarthritis

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KEYWORDS

• Osteoarthritis • Imaging • MR imaging • Cartilage • Meniscus • Bone marrow • Knee • Radiography

KEY POINTS

- Radiography remains the most commonly used imaging technique for establishing an imaging-based diagnosis of osteoarthritis.
- Major limitations of radiography are inability to visualize most tissues of the joint other than bone and its lack of association with clinical symptoms.
- In osteoarthritis research, MR imaging has played an important role in understanding the natural history of the disease and in the search for new therapies.
- Clinical relevance of MR imaging findings related to osteoarthritic joints remains unclear due to high prevalence in asymptomatic persons.
- Ultrasound may be a useful imaging technique for osteoarthritis, particularly of small joints of the hand.

INTRODUCTION

Osteoarthritis (OA) is a joint disorder that primarily affects the elderly population worldwide and is a major public health concern. For instance, almost 10% of the US population lives with symptomatic knee OA by age 60.[1] The annual health care expenditures related to OA have been estimated at $US186 billion.[2] Arthroplasty is an effective therapy for late-stage disease, and there is an on-going research effort exploring effective nonsurgical therapies, including disease-modifying drugs of OA. The increasing importance of imaging in OA for diagnosis, prognostication, and follow-up is well recognized. Conventional radiography remains the gold-standard imaging technique for the evaluation of OA in both clinical practice and research, but it has limitations, which were demonstrated by large MR imaging–based OA studies in recent years.[3,4] Traditionally, cartilage has been thought to be the central feature of OA and the primary target for intervention. However, nowadays OA is considered a disease of the whole joint, involving osseous and nonosseous articular and periarticular tissues. Only MR imaging can assess all structures of the joint, including cartilage, meniscus, ligaments, muscle, subchondral bone marrow, and synovium and is able to visualize the joint in a 3-dimensional (3D) fashion without the projectional limitations of radiography.[5] Moreover, MR imaging enables the assessment of 3D cartilage morphology and biochemical composition. This article describes the roles and limitations of different imaging

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modalities and discusses the optimum imaging protocol, imaging diagnostic criteria of OA, differential diagnoses, and what the referring physician needs to know.

ANATOMIC STRUCTURES RELEVANT TO OSTEOARTHRITIS

OA can affect articular and periarticular structures, including osteochondral and nonosteochondral tissues. Traditionally, OA was thought to be primarily a degenerative disease of articular cartilage, but recent research studies have revealed OA is a whole-joint process. Affected tissues include hyaline cartilage, subchondral bone and bone marrow, menisci in the knee, labrum in the shoulder and hip, periarticular ligaments and tendons, periarticular bursae, synovium-lined joint capsule, intervertebral discs in the spine, and triangular fibrocartilage complex (TFCC) in the wrist. Imaging features of each OA-affected tissues/lesions are described later in this article.

IMAGING TECHNIQUES FOR OSTEOARTHRITIS AND RELEVANT REVIEW OF LITERATURE

Conventional Radiography

Radiography is an inexpensive and most commonly used modality for imaging of OA. It allows detection of OA-associated bony features, such as osteophytes, subchondral sclerosis, and cysts.[6] Radiography can also determine joint space width (JSW), which is a surrogate marker for cartilage thickness and meniscal integrity in knees, but direct visualization of these articular structures is impossible using radiographic techniques. Despite this limitation, slowing of radiographically detected joint space narrowing (JSN) remains the only structural end point currently approved by the US Food and Drug Administration to demonstrate efficacy of disease-modifying OA drugs in phase 3 clinical trials. OA is radiographically defined by the presence of marginal osteophytes.[7] Worsening of JSN is the most commonly used criterion for the assessment of structural OA progression, and the total loss of JSW is one of the structural indicators for arthroplasty.

In the knee joint, JSN is caused not only by cartilage loss but also by changes in the meniscus, such as meniscal extrusion and meniscal substance loss.[8] The lack of sensitivity and specificity of radiography for the detection of most of OA-associated articular tissue damage, and its poor sensitivity to change over time, are other limitations of radiography.[9] Changes in joint positioning can also be problematic in longitudinal studies and can affect the quantitative measurement of various radiographic parameters, including JSW.[10] Despite these limitations, radiography remains the gold standard for establishing an imaging-based diagnosis of OA and for assessment of structural modification in clinical trials of OA.

Semiquantitative analysis

The severity of radiographic OA can be assessed with semiquantitative scoring systems. The Kellgren and Lawrence (KL) grading system[11] (**Box 1**) is a widely accepted method for defining radiographic OA based on the presence of a definite osteophyte (= grade 2). However, KL grading has its limitations; in particular, KL grade 3 includes all degrees of JSN, regardless of the actual extent (**Fig. 1**). Recently, the so-called atrophic phenotype of knee OA, characterized by definite

Box 1
Diagnostic criteria

Radiography-based criteria: simplified KL grade

- Radiographic OA if grade 2 or above
- Grade 0 = no feature of OA
- Grade 1 = equivocal osteophytes
- Grade 2 = definite osteophytes
- Grade 3 = JSN
- Grade 4 = bone-on-bone appearance

MR imaging–based criteria: proposed by the OARSI OA Imaging Working Group

A *definition of tibiofemoral OA on MR imaging* = the presence of both group [A] features or one group [A] feature and 2 or more group [B] features.

Group [A] after exclusion of joint trauma within the last 6 months (by history) and exclusion of inflammatory arthritis (by radiographs, history, and laboratory parameters): (i) definite osteophyte formation, (ii) full-thickness cartilage loss.

Group [B]: (i) subchondral BML or cyst not associated with meniscal or ligamentous attachments, (ii) meniscal subluxation, maceration, or degenerative (horizontal) tear, (iii) partial-thickness cartilage loss (where full-thickness loss is not present), (iv) bone attrition.

A *definition of patellofemoral OA* requires all of the following involving the patella and/or anterior femur: (i) definite osteophyte formation, (ii) partial- or full-thickness cartilage loss.