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The role of imaging in osteoarthritis

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A B S T R A C T

Osteoarthritis (OA) is the most prevalent joint disorder with no approved disease-modifying treatment available. The importance of imaging in assessing all joint structures involved in the disease process, including articular cartilage, meniscus, subarticular bone marrow, and synovium for diagnosis, prognostication, and follow-up, has been well recognized. In daily clinical practice, conventional radiography is still the most commonly used imaging technique for the evaluation of a patient with known or suspected OA and radiographic outcome measures are still the only approved end point by regulatory authorities in clinical trials.

The ability of magnetic resonance imaging (MRI) to visualize all joint structures in three-dimensional fashion including tissue ultrastructure has markedly deepened our understanding of the

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natural history of the disease. This article describes the roles and limitations of different imaging modalities for clinical practice and research in OA, with a focus on radiography and MRI and an emphasis on the knee joint.

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Knee osteoarthritis (OA) is a major public health problem that primarily affects the elderly. Almost 10% of the U. S. population suffers from symptomatic knee OA by the age of 60 [1]. Its prevalence is increasing in the aging population and it is a frequent cause of dependency in lower-limb tasks [2–4]. In total, the health-care expenditures of this condition have been estimated at $US189 billion annually [5]. Despite this, there are no approved interventions that ameliorate structural progression of this disorder.

The increasing importance of imaging in osteoarthritis for diagnosis, prognostication, and follow-up is well recognized by both clinicians and OA researchers. While conventional radiography is the gold standard imaging technique for the evaluation of known or suspected OA in clinical practice and research, it has limitations that have become apparent in the course of large magnetic resonance imaging (MRI)-based knee osteoarthritis studies [6,7]. Pathological changes may be evident in all structures of a joint with OA, although traditionally researchers have viewed articular cartilage as the central feature and as the primary target for intervention and measurement. Of the commonly employed imaging techniques, only MRI can assess all structures of the joint, including cartilage, meniscus, ligaments, muscle, subarticular bone marrow, and synovium, and thus can show the knee as a whole organ three-dimensionally. In addition, it can directly help in the assessment of cartilage morphology and composition. This imaging modality, therefore, plays a crucial role in increasing our understanding of the natural history of OA and in the development of new therapies. The advantages and limitations of conventional radiography, MRI, and other techniques, such as ultrasound, nuclear medicine, computed tomography (CT), and CT arthrography, in the imaging of OA in both clinical practice and research are described in this review article.

Review criteria

This a nonsystematic, narrative review based on a comprehensive literature search in PubMed, using the following search terms in various combinations: “radiography,” “magnetic resonance imaging”; “computed tomography,” “PET,” “osteoarthritis,” “semi-quantitative scoring”; “morphometry,” “knee”; “hand”; “hip” and “spine.” All articles identified were English-language full-text papers between 2000 and 2013, focusing on recent published research. The reference lists of identified papers were also used to identify further relevant articles, and relevant references published prior to 2000 were included where appropriate. Because of the abundance of publications on the topic over the past years, the authors had to prioritize inclusion of publications based on personal judgment of potential relevance to the readership.

Radiography

Radiography is the simplest, least-expensive, and most widely deployed imaging modality. It enables detection of OA-associated bony features, such as osteophytes, subchondral sclerosis, and cysts [8]. Radiography can also determine joint space width (JSW), a surrogate of cartilage thickness and meniscal integrity, but precise measurement of each of these articular structures is not possible by conventional X-ray-based methods [6,7]. Despite this limitation, slowing of radiographically detected joint space narrowing (JSN) is the only structural end point currently approved by the U.S. Food and Drug Administration (FDA) to demonstrate efficacy of disease-modifying OA drugs in phase-III clinical trials. Osteoarthritis is radiographically defined by the presence of marginal osteophytes [9]. Progression of JSN is the most commonly used criterion for the assessment of structural OA progression, and the total loss of JSW (“bone-on-bone” appearance) is one of the indicators for joint replacement [10].