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Ali Guermazi

**Imaging Insights on the Epidemiology and Pathophysiology of Osteoarthritis** **447**

David J. Hunter

This article highlights recent studies, particularly those with an emphasis on magnetic resonance imaging, that are providing unique insights into the relation between structures identified on imaging and the symptoms and genesis of osteoarthritis. These insights are changing the way disease prevalence is viewed and providing new insights into disease genesis. Furthermore, it is becoming increasingly apparent that the subchondral bone, periosteum, periarticular ligaments, periarticular muscle spasm, synovium, and joint capsule are all richly innervated and are the likely source of nociception in osteoarthritis. In addition, it is apparent that local tissue alterations in the bone and meniscus and alignment of the lower extremity are important in terms of disease genesis. The article is consistent with the literature in that much of the focus and understanding is knee-centric with less focus on the hip and hand.

**Imaging the Role of Biomechanics in Osteoarthritis** **465**

David J. Hunter and David R. Wilson

Osteoarthritis is widely believed to result from local mechanical factors acting within the context of systemic susceptibility. This narrative review delineates current understanding of the etiopathogenesis of osteoarthritis and more specifically examines the critical role of biomechanics in disease pathogenesis. There are several ways the mechanical forces across the joint can be measured, including some that rely heavily on imaging methods. These are described and methods to advance the field are proposed.

**Radiographic Grading and Measurement of Joint Space Width in Osteoarthritis** **485**

Marie-Pierre Hellio Le Graverand, Steve Mazzuca, Jeff Duryea, and Alan Brett

The progression of osteoarthritis is traditionally measured using radiographic joint space width (JSW). Numerous knee radiograph protocols have been developed with various levels of complexity and performance as it relates to detecting JSW loss (ie, joint space narrowing). Sensitivity to joint space narrowing is improved when radioanatomic alignment of the medial tibial plateau is achieved. Semiautomated software has been developed to improve the accuracy of JSW measurement over manual methods. JSW measurements include minimum JSW, mean JSW or joint space area, and JSW at fixed locations.

**Usefulness of Ultrasound in Osteoarthritis** **503**

Helen I. Keen and Philip G. Conaghan

Ultrasonography is a useful tool in understanding rheumatic conditions and in diagnosis and management. Much of the investigation into the

validity of ultrasonography and its clinical use has been undertaken in inflammatory arthritides. Although ultrasonography has been applied to osteoarthritis (OA) in clinical practice, there has been little investigation into the validity of ultrasonography in OA or its utility in clinical trials or routine clinical practice. This review outlines benefits and limitations of imaging OA with ultrasonography.

### **Magnetic Resonance Imaging-Based Semiquantitative and Quantitative Assessment in Osteoarthritis**

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Frank W. Roemer, Felix Eckstein, and Ali Guermazi

Whole organ magnetic resonance imaging (MRI)-based semiquantitative (SQ) assessment of knee osteoarthritis (OA), based on reliable scoring methods and expert reading, has become a powerful research tool in OA. SQ morphologic scoring has been applied to large observational cross-sectional and longitudinal epidemiologic studies as well as interventional clinical trials. SQ whole organ scoring analyzes all joint structures that are potentially relevant as surrogate outcome measures of OA and potential disease modification, including cartilage, subchondral bone, osteophytes, intra- and periarticular ligaments, menisci, synovial lining, cysts, and bursae. Resources needed for SQ scoring rely on the MRI protocol, image quality, experience of the expert readers, method of documentation, and the individual scoring system that will be applied. The first part of this article discusses the different available OA whole organ scoring systems, focusing on MRI of the knee, and also reviews alternative approaches. Rheumatologists are made aware of artifacts and differential diagnoses when applying any of the SQ scoring systems. The second part focuses on quantitative approaches in OA, particularly measurement of (subregional) cartilage loss. This approach allows one to determine minute changes that occur relatively homogeneously across cartilage structures and that are not apparent to the naked eye. To this end, the cartilage surfaces need to be segmented by trained users using specialized software. Measurements of knee cartilage loss based on water-excitation spoiled gradient recalled echo acquisition in the steady state, fast low-angle shot, or double-echo steady-state imaging sequences reported a 1% to 2% decrease in cartilage thickness annually, and a high degree of spatial heterogeneity of cartilage thickness changes in femorotibial subregions between subjects. Risk factors identified by quantitative measurement technology included a high body mass index, meniscal extrusion and meniscal tears, knee malalignment, advanced radiographic OA grade, bone marrow alterations, and focal cartilage lesions.

### **Magnetic Resonance Imaging Assessment of Subchondral Bone and Soft Tissues in Knee Osteoarthritis**

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Michel D. Crema, Frank W. Roemer, Monica D. Marra, and Ali Guermazi

Knee osteoarthritis (OA) has to be considered a whole joint disease. Magnetic resonance imaging (MRI) allows superior assessment of all joint tissues that may be involved in OA, such as the subchondral bone, synovium, ligaments, and periarticular soft tissues. Reliable MRI-based scoring systems are available to assess and quantify these structures

and associated pathology. Cross-sectional and longitudinal evaluation has enabled practitioners to understand their relevance in explaining pain and structural progression.

### **The Meniscus in Knee Osteoarthritis**

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Martin Englund, Ali Guermazi, and L. Stefan Lohmander

The meniscus is a critical tissue in the healthy knee joint because of its shock absorption and load distribution properties. Meniscal damage is a frequent finding on MRI of the osteoarthritis (OA) knee. The damage appears as horizontal, flap, or complex tears; meniscal maceration; or destruction. Asymptomatic meniscal lesions are common incidental findings on knee MRI of the middle-aged or older person. This challenges the health professional in choosing the best treatment. A meniscal tear can lead to knee OA, but knee OA can also lead to a spontaneous meniscal tear. A degenerative meniscal lesion often suggests early-stage knee OA. Surgical resection of nonobstructive degenerate lesions may merely remove evidence of the disorder while the OA and associated symptoms proceed.

### **Hip MRI and Its Implications for Surgery in Osteoarthritis Patients**

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Tallal C. Mamisch, Christoph Zilkens, Klaus A. Siebenrock, Bernd Bittersohl, Young-Jo Kim, and Stefan Werlen

Osteoarthritis (OA) of the hip joint stems from a combination of intrinsic factors, such as joint anatomy, and extrinsic factors, such as injuries, diseases, and load. Possible risk factors for OA are instability and impingement. Different surgical techniques, such as osteotomies of the pelvis and femur, surgical dislocation, and hip arthroscopy, are being performed to delay or halt OA. Success of salvage procedures of the hip depends on the existing cartilage and joint damage before surgery. The likelihood of therapy failure rises with advanced OA. For imaging of intra-articular hip pathology, MRI represents the best technique because it enables clinicians to directly visualize cartilage, it provides superior soft tissue contrast, and it offers the prospect of multidimensional imaging. However, opinions differ on the diagnostic efficacy of MRI and on the question of which MRI technique is most appropriate. This article gives an overview of the standard MRI techniques for diagnosis of hip OA and their implications for surgery.

### **Role of Imaging in Spine, Hand, and Wrist Osteoarthritis**

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Antoine Feydy, Etienne Pluot, Henri Guerini, and Jean-Luc Drapé

Osteoarthritis (OA) of the wrist is mainly secondary to traumatic ligamentous or bone injuries. Involvement of the radiocarpal joint occurs early on in the disease, whereas the mediocarpal joint is involved at a later stage. Metabolic diseases may also involve the wrist and affect specific joints such as the scapho-trapezio-trapezoid joint. Although OA of the wrist is routinely diagnosed on plain films, a thorough assessment of

cartilage injuries on computed tomographic arthrography, magnetic resonance imaging (MRI), or MR arthrography remains necessary before any surgical procedure. OA of the fingers is frequently encountered in postmenopausal women. Distal interphalangeal joints and trapezio-metacarpal joint are the most frequently involved joints. Whereas the clinical diagnosis of OA of the wrist and hand is straightforward, the therapeutic management of symptomatic forms remains unclear, with no clear guidelines. OA of the spine is related to degenerative changes of the spine involving the disc space, vertebral endplates, the facet joints, or the supportive and surrounding soft tissues. The sequelae of disc degeneration are among the leading causes of functional incapacity in both sexes, and are a common source of chronic disability in the working years. Disc degeneration involves structural disruption and cell-mediated changes in composition. Radiography remains usually the first-line imaging method. MRI is ideally suited for delineating the presence, extent, and complications of degenerative spinal disease. Other imaging modalities such as computed tomography, dynamic radiography, myelography, and discography may provide complementary information in selected cases, especially before an imaging-guided percutaneous treatment or spinal surgery. The presence of degenerative changes on imaging examinations is by no means an indicator of symptoms, and there is a high prevalence of lesions in asymptomatic individuals. This article focuses on imaging of OA of the wrist and hand, as well as lumbar spine OA, with an emphasis on current MRI grading systems available for the assessment of discovertebral lesions.

### **Pre- and Postoperative Assessment in Joint Preserving and Replacing Surgery**

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Adnan Sheikh and Mark Schweitzer

Advances in imaging technology have increased its suitability for diagnosing musculoskeletal disease. Modification of imaging techniques and improved image quality have led to increased use of computed tomography and magnetic resonance imaging in the assessment of postoperative complications. This article discusses the indications, pre- and postoperative imaging findings, and postoperative complications of knee and hip arthroplasty, articular cartilage repair, and high tibial osteotomy.

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