

Osteoarthritis and Cartilage



Review

Osteoarthritis year in review 2015: imaging



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SUMMARY

Purpose: This narrative review covers original publications related to imaging in osteoarthritis (OA) published in English between 1 April 2014 and 30 April 2015. Novel lessons relating to imaging are described.

Methods: An extensive PubMed database search was performed based on, but not limited to the terms “OA” in combination with “Magnetic resonance imaging (MRI)”, “Imaging”, “Radiography”, “Ultrasound”, “Computed tomography (CT)” and “Nuclear medicine” to extract relevant studies. *In vitro* data and animal studies were excluded. This review focuses on the new developments and observations based on the aforementioned imaging modalities, as well as a ‘whole-organ’ approach by presenting findings from different tissues (bone, meniscus, synovium, muscle and fat) and joints (hip, lumbar spine and hand).

Results and conclusions: Over the past year, studies using imaging have made a major contribution to the understanding of the pathogenesis of OA. Significant work has continued at the knee, with MRI now being increasingly used to assess structural endpoints in clinical trials. This offers the exciting opportunity to explore potential disease modifying OA therapies. There has been a clear interest in the role of bone in the pathogenesis of OA. There is now a growing body of literature examining the pathogenesis of OA at the hip, lumbar spine and hand. The future of imaging in OA offers the exciting potential to better understand the disease process across all joints and develop more effective preventive and therapeutic interventions.

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Introduction

Imaging modalities have made a major contribution to our understanding of the pathogenesis of osteoarthritis (OA). Available modalities include radiography, ultrasonography, computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography (PET).

MRI is becoming the most widely used modality in epidemiological studies for assessment of joint structures. Compositional MRI enables the assessment of cartilage integrity. In addition to articular cartilage and subchondral bone, imaging assessments of other tissues such as fat, muscle, meniscus, and synovium are now commonplace and helping to understand OA as a ‘whole-organ’

disease. Although a large body of research has focussed on the knee, the past year has seen an extension of such work examining other joints, including the hip, lumbar spine and hand.

This narrative review covers original research published between 1 April 2014 and 30 April 2015, and examines imaging in OA – a year in review. This review focuses on the new developments and observations based on imaging between these time frames.

Methods

A literature search was performed using the PubMed database, based on but not limited to the terms “OA” in combination with “MRI”, “ultrasound”, “radiography”, “CT” or “nuclear medicine”. Only original articles published in English were included. Review articles, *in vitro* data and animal data were excluded. A total of 480 publications were identified. Studies considered by the authors to provide novel scientific and/or clinical information were included in this review.

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New lessons from older imaging modalities

New lessons from radiography

Bone shape is important in knee OA – but is it cause or effect?

In a cross-sectional study of 1,324 people with and without radiographic knee OA admitted to hospital with knee pain, relative to controls, people with knee OA demonstrated a longer femur mediolateral and a shorter femur anteroposterior length, together with a greater difference between these two lengths and a greater difference between the tibia mediolateral and femur mediolateral length¹. Another study examined the differences in bone texture among participants with different stages of knee OA and age- and gender-matched healthy controls². Bone density-related and structure-related parameters quantitatively evaluated from plain radiographs were higher in OA knees than control knees². The multicentre osteoarthritis study (MOST) utilised lower-limb radiography to examine whether hip and pelvic geometry were associated with the presence of compartment-specific knee OA³. Knees with lateral tibiofemoral OA had reduced femoral offset, increased height of hip centre, more valgus neck-shaft angle and increased abductor angle compared with those without knee OA. In contrast, knees with medial tibiofemoral OA were associated with a more varus neck-shaft angle and a decreased abductor angle³. Nevertheless, the cross-sectional nature of these studies precludes any comment as to whether bone shape predated or was a consequence of OA.

Systemic bone mineral density (BMD) is linked to radiographic OA – particularly osteophytosis

High bone mass, defined according to BMD Z scores on dual X-ray absorptiometry, was associated with an increased prevalence of radiographic knee and hip OA^{4–6}. High bone mass had a stronger association with osteophytosis than joint space narrowing at the knee⁴. High bone mass was associated with increased prevalence of radiographic hip OA, osteophytes, and subchondral sclerosis, but not the prevalence of joint space narrowing⁵. Moreover, enthesophytes were associated with high bone mass and enthesophyte grade was positively associated with BMD at both the total hip and lumbar spine. Osteophytes were positively associated with enthesophytes, suggesting a strong interrelationship between osteophytes, enthesophytes, and high bone mass⁶. Taken together, these data suggest a potential hypertrophic phenotype of OA, characterised by increased bone formation (osteophytes and enthesophytes) rather than joint space narrowing, and related to a high systemic BMD.

New lessons from CT

A novel measure of subchondral BMD and articular cartilage

Although most previous research using cone beam computed tomography (CBCT) in joint disorders has focussed on the temporomandibular joint, last year this technique was extrapolated to the knee joint. CBCT detects changes in volumetric BMD of subchondral bone. A recent study determined volumetric BMD of cortical bone, trabecular bone, subchondral trabecular bone and subchondral plate of 10 cadaver (*ex vivo*) and 10 volunteer (*in vivo*) distal femora using a clinical CBCT scanner⁷. Strong linear correlations were found between the volumetric BMD values measured with the CBCT and CT scanners. The differences between the volumetric BMD of cortical bone, trabecular bone and subchondral bone were similar and independent of the scanner⁷. Arthrographic images enabled sensitive detection of cartilage lesions. The contrast agent partition in intact cartilage (International Cartilage Repair Society, ICRS, grade 0) was lower than that of cartilage surrounding the ICRS

grade I–IV lesions⁸. Another study used contrast enhanced CBCT to image contrast agent diffusion in isolated human menisci and found that shorter delay between injection and imaging (e.g., 40 min) could be feasible in clinical diagnostics of meniscal pathologies⁹. These findings suggest that CBCT enables not only quantitative analyses of articular cartilage, but also subchondral bone volumetric BMD. This technique could provide an exciting future for alternative means of diagnosing knee pathologies.

New lessons from ultrasound

Ultrasonographic abnormalities are common and correlate with clinical endpoints

In the past year, several studies have correlated ultrasound findings with radiographic and clinical features of knee OA. A recent cross-sectional study has attempted to develop standardized musculoskeletal ultrasound procedures and scoring for detecting knee OA by assessing morphological changes and inflammation¹⁰. The ability of ultrasound score to discern various degrees of knee OA was tested by using plain radiography and the 'Knee injury and Osteoarthritis Outcome Score' (KOOS) domains as comparators. Ultrasound score was found to be reliable and valid in detecting knee OA by showing all aspects of knee OA¹⁰.

Ultrasound is sensitive for detection of synovial abnormalities and effusion. A case–control study found that effusion and synovial hypertrophy were more common in knees with OA than those without OA, and that the severity of effusion and synovial hypertrophy were moderately correlated with radiographic severity of knee OA¹¹. Similarly, an ultrasound hip study showed that large joint effusions correlated with radiographic findings of rapidly destructive OA¹². Meniscal bulging was shown to be associated with radiographic joint space narrowing and K–L grades; meniscal bulging and presence of Baker's cyst and joint effusion were associated with worse pain or poorer function¹³.

Ultrasound is more sensitive than radiographs in detecting osteophytes

The Newcastle Thousand Families birth cohort is the first to assess the prevalence of ultrasound features of OA in a population-based study¹⁴. The presence of osteophytes and effusion were scored from knee images, osteophytes and femoral head abnormality for hip images, and osteophytes for the hand images. The prevalence of osteophytes was 70% at the distal interphalangeal joint, 3% for index proximal interphalangeal joint, 10% for metacarpophalangeal joint, and 41% for thumb base carpometacarpal joint. Prevalence was 30% for knee osteophytes and 24% (right) and 20% (left) for knee effusions. The prevalence of hip OA was 41%. Ultrasound evidence of generalised OA (48%) and isolated hand OA (31%) was common, compared to isolated hip or knee OA (5%) and both hip and knee OA (3%). The higher prevalence of hand and hip OA observed in this study compared with previous radiographic studies, supports the hypothesis that ultrasound is more sensitive than radiography in detecting OA, particularly for osteophytes¹⁴. Further work will be needed to determine its role in clinical settings and epidemiological studies.

Ultrasound provides a comprehensive assessment of cartilage at arthroscopy

Arthroscopic ultrasound imaging has been used to quantitatively evaluate articular cartilage. A study found higher ICRS grades on ultrasound images than those based on conventional arthroscopy, since ultrasound reveals additional information such as the relative depth of cartilage lesion¹⁵. Ultrasound reflection and scattering in cartilage varied significantly along the ICRS scale. The findings of this study suggest a role of arthroscopic ultrasound

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