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Review

Osteoarthritis year in review 2016: imaging

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SUMMARY

Purpose: The current narrative review covers original research related to imaging in osteoarthritis (OA) in humans published in English between April 1st 2015 and March 31st 2016, in peer reviewed journals available in Medline via PubMed (http://www.ncbi.nlm.nih.gov/pubmed/).
Methods: Relevant studies in humans, subjectively decided by the authors, contributing significantly to the OA imaging field, were selected from an extensive Medline search using the terms "Osteoarthritis" in combination with "MRI", "Imaging", "Radiography", "X-rays", "Ultrasound", "Computed tomography", "Nuclear medicine", "PET-CT", "PET-MRI", "Scintigraphy", "SPECT". Publications were sorted according to relevance for the OA imaging research community with an emphasis on high impact special interest journals using the software for systematic reviews www.covidence.org.
Results: An overview of newly published studies compared to studies reported previous years is presented, followed by a review of selected imaging studies of primarily knee, hip and hand OA focussing on (1) results for detection of OA and OA-related pathology (2) studies dealing with treatments and (3) studies focussing on prognosis of disease progression or joint replacement.
A record high number of 1420 articles were published, among others, of new technologies and tools for improved morphological and pathophysiological understanding of OA-related changes in joints. Also, imaging data were presented of monitoring treatment effect and prognosis of OA progression, primarily using established radiographic, magnetic resonance imaging (MRI), and ultrasound (US) methods.
Conclusion: Imaging continues to play an important role in OA research, where several exciting new technologies and computer aided analysis methods are emerging to complement the conventional imaging approaches.

Introduction

Imaging studies and in particular magnetic resonance imaging (MRI) of the knees have provided solid evidence that osteoarthritis (OA), regardless of anatomical location, is a whole joint disease involving all joint related structures including soft tissues, bone and cartilage[1–4]. The basic pathophysiological processes that cause OA and lead to OA progression as well as the pain-causing mechanisms remain unclear, but low-grade inflammation in the periarticular structures seems to play an important role related to both pain, decreased function and disease progression[5,6].

Medical imaging seems to play an increasingly important role in terms of OA disease detection and monitoring as well as for advancing current understanding of disease mechanisms.

This review will focus on original research related to imaging and OA in humans, published in peer-reviewed journals in English between April 1st 2015 and March 31st 2016. The review is divided into imaging modalities related to (1) OA diagnosis, (2) treatment response and (3) predictive value for OA progression or joint replacement with primary focus on OA of the knee, hip and hand.

Material and methods

The search strategy was identical to those applied in the annual imaging reviews since 2012[7–10]. Relevant studies in the field of OA

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imaging in humans were selected from a Medline search via PubMed, using the search terms “Osteoarthritis” in combination with “MRI”, “Imaging”, “Radiography”, “X-ray”, “Ultrasound”, “Computed tomography”, “Nuclear medicine”, “PET-CT”, “PET-MR”, “Scintigraphy”, “SPECT” search string; ((imaging[Title/Abstract] OR MRI[Title/Abstract] OR radiograph*[Title/Abstract] OR magnetic resonance[Title/Abstract] OR ultrasound[Title/Abstract] OR computer tomograph*[Title/Abstract]) OR (CT[Title/Abstract] OR US [Title/Abstract] OR nuclear medicine[Title/Abstract])) AND (OA[Title/Abstract] OR osteoarthr*[Title/Abstract]) Filter: Publication date from 2015/01/04 to 2016/03/31; limited to humans. Original articles were subjectively sorted by the authors according to relevance, novelty, and impact.

Results

Since the introduction of the “Year in review” series in 2010, we have seen an increasing number of papers dealing with imaging in OA (Fig. 1) and last year 1420 papers were published corresponding to a 38% increase compared to 2011–12.

Conventional radiography (CR) is still the most widely used imaging modality with slight increases in studies using MRI and the combination of MRI and CR (Table I).

The knee joint still seems to be the primary joint of interest with an increase of knee joint studies of 10% compared to 2014–2015, seconded by studies of the hip joint that also demonstrate a slight increase (Table II).

In 2015–2016 there was also a tendency towards moving from narrative to systematic reviews and meta-analyses (data not shown). It is also worth mentioning that OARSI published the “OARSI Clinical Trials Imaging Guidelines” for knee, hip and hand in May 2015[11–13], which define the minimum imaging standards in clinical OA trials.

What is new in CR

Diagnosis

The association between radiographic evidence of hip OA and hip pain was investigated in more than 5000 persons from the Framingham study and the Osteoarthritis Initiative (OAI). Only 9–16% of hips in patients with frequent hip pain showed radiographic evidence of OA and only 21–24% of hips with radiographic hip OA were painful[14]. These results bring about important questions regarding the relevance of using CR especially in early OA assessment.

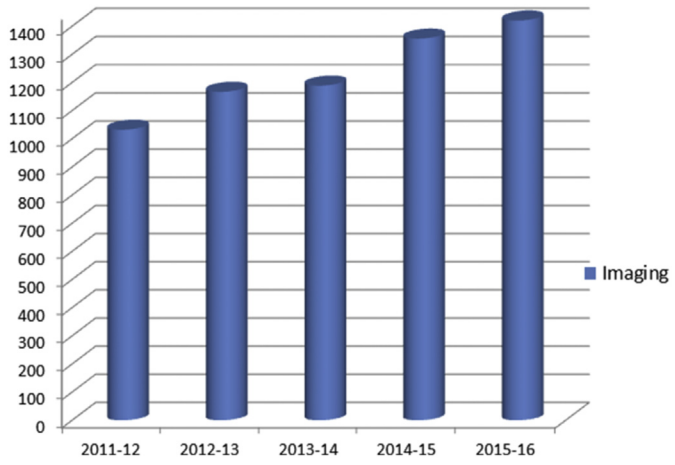

Fig. 1. Number of original imaging studies in OA published yearly since 2011.

Several radiological scores have been proposed for grading of OA. Using standing CR in more than 1000 knees with varying severity of OA, it was concluded that tibio-femoral OA was almost twice as common when using the OARSI atlas criteria compared to the Kellgren–Lawrence grade (KLG)[15] — a discrepancy, which likely contributes to the large variability of OA prevalence observed in the literature[16]. Another study assessed the concurrent validity and sensitivity to change of KLG, OARSI joint-space narrowing (JSN) and the compartmental grading scale for knee OA (KOA). It was stated that all radiographic grading scales were suitable to assess KOA severity, but showed only moderate sensitivity to change[17]. This should be taken into account when using the radiographic scores to monitor KOA over time.

KLG 4 is regarded as radiographic “end-stage OA”. However, it was shown that fluctuations in the severity of bone marrow lesions (BMLs), synovitis, joint effusion and cartilage loss evaluated by MRI were common in KLG-4 knees over a period of 30 months[18], thus KLG-4 does not necessarily represent true end-stage OA from an MRI point of view.

Another modality related to CR is dual energy X-ray absorption (DXA) scanning. DXA has lately gained some interest in OA research, and an association between high bone mass in the femoral neck of women and the severity of radiographic KOA has been reported[19]. Another study found similar reproducibility of hip OA scores between DXA scans and CR[20].

Treatment response

Joint space width (JSW) measurements from standing weight bearing (WB) CR are still the recommended standard for assessment of structural progression in clinical trials of OA[21]. Power calculations and sample-size estimates using CR as primary outcome in clinical trials were debated in a study of hip OA where repeated measurements of JSW by an experienced reader and subsequent calculations of smallest detectable difference (SDD) enabled a post-hoc calculation of a theoretical sample-size to measure significant changes over time. Surprisingly the sample-size estimates seemed to be U-shaped where a reduction of SDD from 0.75 mm to 0.45 mm JSW reduced the theoretical sample-size from 6588 patients to 377 patients, but when SDD was set even lower the required sample-size increased again[22]. Such findings question the use of CR JSN for evaluation of OA treatment response.

Prognosis/predictive value

Radiographic and clinical prognostic factors for OA disease progression have been widely explored. In a study of more than 4000 knees with various degrees of painful OA followed for 2 years, significant correlations were found between baseline KLG, body mass index (BMI), Western Ontario and McMaster Universities Arthritis Index (WOMAC) pain and total WOMAC scores, but only KLG and WOMAC-pain could predict radiological progression (JSN). However, one third of the patients did not progress radiographically and only half of the patients in the progression group had JSN, which exceeded the SDD. These results suggest that certain OA phenotypes are more prone to disease progression, raising concern whether current imaging assessment is inadequate for prediction of radiologic OA progression in many patients[23]. In approximately 600 KOA patients with KLG 2–3 who progressed to KLG 4 or underwent total knee replacement (TKR) within 8 years, it was found that certain genotypes were associated both with KOA status and progression[24]. A study of 1200 hips with KLG 0–1 showed that certain shape variants were associated with future total hip