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Comparison of apparent diffusion coefficient in spondylarthritis axial active inflammatory lesions and type 1 modic changes

Benjamin Dallaudière[a,b,c,*], Raphaël Dautry[a,c,1], Pierre-Marie Preux[d,2], Anne Perozziello[c,e,3], Julien Lincot[a,1], Elisabeth Schouman-Claeys[a,c,1], Jean-Michel Serfaty[a,b,c,1]

[a] Hôpital Bichat – Claude Bernard, Service de Radiologie, 46, rue Henri Huchard, Paris 75018, France
[b] Hôpital Bichat – Claude Bernard, Inserm U698, 46, rue Henri Huchard, Paris 75018, France
[c] Université Paris Diderot, Paris, France
[d] Faculté de Médecine de Limoges, Unité fonctionelle de recherche clinique et de biostatistique, hôpital Le Cluzeau, 23, avenue Dominique Larrey, 87042 Limges Cedex, France
[e] Hôpital Bichat – Claude Bernard, Unité de recherche clinique, 46, rue Henri Huchard, Paris 75018, France

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ABSTRACT

Objective: The goal of this study was to evaluate whether the values of ADC in spondylarthritis axial active inflammatory lesions are different from ADC values in type 1 Modic changes.
Subjects and methods: 95 patients with recent lumbar pain, including 46 patients with diagnosed or suspected spondylarthritis and 49 patients with purely degenerative history, underwent spine MRI. T1w, STIR, and diffusion-weighted images (DWI) were obtained. Two musculoskeletal radiologists interpreted the images. Axial active inflammatory lesions from the SpA group and type 1 Modic changes from the degenerative group were identified on T1w and STIR sequences. ADC values from these lesions and from healthy subchondral bone were compared.
Results: All axial active inflammatory lesions ($n=27$) and type 1 Modic changes ($n=22$) identified in T1w and STIR images were visible on DWI. ADC values were significantly higher ($p<0.05$) for axial active inflammatory lesions (median = 0.788×10^{-3} mm^2/s, IQR 25–75 [0.7×10^{-3} mm^2/s; 0.9×10^{-3} mm^2/s]) than for type 1 Modic changes (median = 0.585×10^{-3} mm^2/s, IQR 25–75 [0.55×10^{-3} mm^2/s; 0.60×10^{-3} mm^2/s]) and normal subchondral bone (median = 0.443×10^{-3} mm^2/s, IQR 25–75 [0.40×10^{-3} mm^2/s; 0.50×10^{-3} mm^2/s]). Intra-class correlation coefficients for intra- and inter-reader ADC values comparison were excellent (0.89 and 0.98 respectively).
Conclusion: DWI is a sensitive and fast sequence that offer the possibility of quantifying diffusion coefficients of the lesions, which could help to discriminate between spondylarthritis axial active inflammatory and type 1 Modic changes.

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1. Introduction

Lumbar pain is one of the most frequently reported symptoms, with a high impact on life quality [1]. When there is no evident traumatic, infectious or neoplastic context, back pain usually is of rheumatismal or degenerative cause. Most times clinical information in addition to imaging studies are sufficient to differentiate these two patterns. However the differential diagnosis can be tricky when clinical dates are scarce, and when lesions do not display a typical imaging aspect.

Inflammatory spondylarthritis (SpA) are common diseases, whose frequency is estimated to be between 0.3 and 1.9% in the general population [1,2]. Because of the young age of the SpA patients, acute lumbar pains are usually attributed to SpA axial active inflammatory lesions but degenerative lesions such as type 1 Modic changes are a frequent cause for back pain and may be overlooked

Abbreviations: ADC, apparent diffusion coefficient; DWI, diffusion weighted imaging; ROI, region of interest; SpA, spondylarthritis; T1w, T1 weighted; ASAS/OMERACT, Assessment of Spondylarthritis International Society/Outcome Measures in Rheumatoid Arthritis Clinical Trials; DCE-MRI, dynamic contrast-enhanced MRI.

* Corresponding author at: Hôpital Bichat – Claude Bernard, Service de Radiologie, 46, rue Henri Huchard, Paris 75018, France. Tel.: +33 1 40 25 80 80; fax: +33 1 40 25 88 73.
E-mail addresses: benjamin.dallaudiere@gmail.com, bendallau64@hotmail.fr (B. Dallaudière), raphael_dautry@yahoo.fr (R. Dautry), pierre-marie.preux@unilim.fr (P.-M. Preux), aperozziello@gmail.com (A. Perozziello), julienlincot@gmail.com (J. Lincot), elisabeth.schouman-claeys@bch.aphp.fr (E. Schouman-Claeys), jeanmichelserfatybch@gmail.com (J.-M. Serfaty).
[1] Tel.: +33 1 40 25 80 80; fax: +33 1 40 25 88 73.
[2] Tel.: +33 5 55 05 66 29.
[3] Tel.: + 33 1 40 25 79 31.

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in young patients. Such misdiagnosis may lead to overtreatment of patients with either 3 months corticotherapy or immunosuppressive therapy.

MRI, with T1 weighted and STIR sequences, is widely used to assess back pain patients. Differential diagnosis between axial active inflammatory lesions and Modic1 lesions can be tricky as lesion signal does not permit to discriminate between these two types of acute lesions [3,4], and anatomical topography sometimes overlap [5].

Recent works have evaluated new MRI technics for assessement and follow-up of spondylarthritis inflammatory lesion. Dynamic contrast-enhanced MRI (DCE-MRI) has been reported to be valuable in detecting early- and late-stage inflammation in the sacroiliac joints of patients with spondylarthropathy, as well as for the therapeutic follow-up of SpA [6,7]. Although in this specific clinical setting this technique has shown promising results, it is not routinely used in imaging of SpA.

Another recent study has shown that diffusion weighted MRI (DWI) might be effective to differentiate acute degenerative lesions from early inflammatory sacro-iliitis [8]. Without the need of contrast injection, this makes DWI a potentially effective tool to differentiate axial active inflammatory lesions and type 1 Modic changes. To our knowledge, the role of diffusion weighted MRI with ADC in this application has not been studied [9,10]. The goal of our study was therefore to compare ADC values of axial active inflammatory lesions in spondylarthritis patients to ADC values of type 1 Modic changes in patients with a purely degenerative disease.

2. Materials and methods

2.1. Patients

We conducted a mono-centric observational cohort study on 46 consecutive spondylarthritis patients and 49 purely degenerative patients from November 2010 to June 2012. For the spondylarthritis group, inclusion criteria were probable SpA (Amor score = 5) or confirmed SpA (Amor score $\geq$ 6) [11] presenting with a recent back pain (duration of less than a month). For the degenerative group, inclusion criteria were recent back pain with Amor score < 5 and no antecedent of personal of familial rheumatismal inflammatory disease. All patients were referred to our imaging department by the Rheumatology and Internal Medicine departments for an MRI of the spine. Exclusion criteria included contraindication to MRI (pregnancy, metallic implants, and claustrophobia) and suspicion of spine infection. Fifteen patients of the spondylarthritis group belonged to the DESIR study [12]. All patients were informed of the study procedure and gave their informed consent.

2.2. MRI

All patients underwent MRI of the either the entire spine (n = 32 in the SpA group and n = 14 in the degenerative group) or the thoraco-lumbar spine (n = 14 in the SpA group and n = 35 in the degenerative group). MRI was performed using a 1.5-Tesla MR scanner (Twin Speed HDX: GE® Healthcare) with a spine coil (CTI Array by USAI; 6 elements, 6 channels). The following sequences were obtained: sagittal fast spin-echo T1-weighted (TR/TE: 660/9.5 ms, duration 2.53 min, FOV 48 cm, 13 slices), and sagittal STIR (TR/TE: 4700/68 ms, duration 3.36 min, FOV 48 cm, 13 slices) sequences. Slice thickness was 3 mm; number of excitations, 2; and intersection gap, none.

In addition to these previous sequences, DWI (without suppression of fat signal) was performed using a single-shot spin echo-planar imaging sequence with diffusion gradient (b value) of 0 and 1000 s/mm^2 (we chose this high b-value to enhance DWI sensitivity [8]).

On the thoraco-lumbar spine, DWI parameters were: sagittal slices, TR 6000 ms, TE 1114 ms number of excitations, 2; duration 2.06 min, slice thickness, 5 mm; intersection gap, none.

On the cervico-thoracic spine, DWI parameters were: axial slices, TR 7075 ms, TE 87.4 ms number of excitations, 2; duration 4.57 min, slice thickness, 5 mm; intersection gap, none. Axial slices were used to benefit from a low acquisition time and a lesser sensitivity to motion artifacts, as electrocardiogram (EKG) gated sagittal DWI are longer to acquire.

2.3. Image interpretation

Patients' identities were removed from all images. Two musculoskeletal radiologists blindly assessed images, in random patient order, for the presence of axial active inflammatory lesions and type 1 Modic changes. T1 and STIR weighted images were looked upon first, followed immediately by DWI analysis with ADC measurements on lesions identified on T1 and STIR images. Both readers, according to the same protocol, performed a second interpretation two weeks later.

The presence of bone marrow edema (T1 hypo signal and STIR hyper signal) was considered as a marker of acute disease.

ADC maps were obtained from DWI data, on a GE Healthcare Advantage Windows, 4.2 Workstation. In order to be more reproducible, measurements were made on the Kodac PACS system® using circular ROI having an area of at least 4 pixels, or 4 mm $\times$ 4 mm (information given by the PACS system) that was positioned on active inflammatory lesions and type 1 Modic changes, as well as on 2 different locations on normal subchondral bone.

2.4. Statistical methods

Statistical analysis was performed using the SAS® software. ADC values for active inflammatory lesions, type 1 Modic changes and healthy subchondral bone were expressed as follows (median and inter quantile range (IQR)) and compared using a Wilcoxon signed rank sum test, for paired values, not normally distributed. ADC cut-off was determined using the boxplot graphic. We considered $p < 0.05$ as significant.

Intra- and inter-reader intraclass correlation coefficients for ADC value measurement were calculated.

3. Results

3.1. Population

Ninety-five patients were included in this study, 46 in the spondylarthritis group (27 women) and 49 in the degenerative group (28 women).

In the spondylarthritis group, mean age was 43 years (SD 5.3 years). Twenty-seven patients were clinically suspected of SpA and 19 patients were clinically diagnosed with SpA (including 14 patients with ankylosing spondylitis, 3 with psoriatic arthritis and 2 with spondylarthritis associated to inflammatory bowel disease). Mean back pain duration before MRI was 19 days (±3.2 days). Among the 27 patients with suspected SpA and the 19 patients with SpA, 0 and 15 respectively were receiving medical treatment (either anti-TNF or corticotherapy) at the time of imaging.

In the degenerative group, mean age was 52 years (SD 4.1 years), mean back pain duration before MRI was 21 days (±2.8 days), and none had had therapeutic spinal injection.

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