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ORIGINAL ARTICLE

A novel diagnostic method (spectral computed tomography of sacroiliac joints) for axial spondyloarthritis

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KEYWORDS
axial spondyloarthritis;
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Background/Purpose: To evaluate the diagnostic value of spectral computed tomography (CT) of sacroiliac joints for axial spondyloarthritis (SpA).
Methods: We retrospectively analyzed the records of 125 patients with low back pain (LBP) suspected of having SpA. Each patient underwent sacroiliac joint spectral CT examination. Water- and calcium-based material decomposition images were reconstructed. After 3–6 months of follow-up, 76 were diagnosed with SpA, and the remaining 49 patients were diagnosed with nonspecific LBP (nLBP). The slope of sacroiliac bone marrow HU (Hounsfield unit) curve (λ_{HU}), CT value, and bone marrow to normal muscle ratios of water and calcium concentrations in the ilium and sacrum were calculated and compared between nLBP and SpA patients.
Results: The iliac λ_{HU} was 8.26 ± 3.91 for nLBP and 9.81 ± 4.92 for SpA. The mean iliac ratios of water and calcium concentrations were 1.04 ± 0.03 and 21.67 ± 4.40, respectively, for nLBP, and 1.07 ± 0.04 and 111.5 ± 358.98, respectively, for SpA. The mean iliac CT values were 311.12 ± 86.52 HU for nLBP and 423.97 ± 127.51 HU for SpA. There were statistically significant differences in iliac ratios of water and calcium concentrations, CT value, and λ_{HU} between nLBP and SpA patients ($p < 0.05$). The sensitivity of iliac λ_{HU} was the highest. The diagnostic odds ratio of ratio of iliac calcium concentration was the highest, and its negative likelihood ratio was the lowest.

Conflicts of interest: The authors have no conflicts of interest relevant to this article.

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Conclusion: Spectral CT not only shows bone erosion and sclerosis, but also shows and quantitatively measures bone marrow edema in the sacroiliac joints of SpA patients.

Introduction

Seronegative spondyloarthritis (SpA) is a chronic inflammatory rheumatologic disease. Sacroiliitis is the earliest clinical finding and is the diagnostic feature for SpA.[1] Computed tomography (CT) is sensitive in detecting the chronic changes in the sacroiliac joints (SIJs); however, magnetic resonance imaging (MRI) is more sensitive in identifying early signs of sacroiliitis including osteitis, enthesitis, and capsulitis.[2,3] With the increasing use of MRI to detect early features of SpA before identifiable radiographic features, the Assessment of Spondyloarthritis International Society (ASAS) has issued the updated criteria for the diagnosis of SpA. The presence of sacroiliitis is listed as one of the ASAS key criteria for the diagnosis of SpA.[4,5] As recommended by the ASAS criteria, the most commonly used MRI sequences for the assessment of SIJs are T1-weighted spin—echo sequences, and short tau inversion recovery (STIR) sequences.[6] Recently, the emergence of spectral CT has raised the possibility for measurements of relative water and calcium concentrations in bone via the acquisition of base material decomposition images. Spectral CT is performed by acquiring two consecutive scans with high and low energy (140 kV and 80 kV) using a single X-ray tube, a high-performance gemstone detector, and with implementation of powerful image postprocessing. By use of these techniques, accurate material decomposition images (i.e., water- and calcium-based material decomposition images) and monochromatic spectral images at energy levels ranging from 40 keV to 140 keV can be created.[7,8] The usefulness of spectral CT for musculoskeletal diseases in previous studies were primarily differential diagnosis of the osteoblastic metastases from bone islands in cancer patients, reduction of the metallic instrumentation artifacts, and detection of the uric acid depositing in tophaceous gout.[9—12] The aim of this study was to analyze whether the spectral CT sacroiliac imaging parameters could differentiate SpA and nLBP.

Methods

This study was approved by the Institutional Review Board of the Tongji hospital. Written informed consent was obtained from all participants.

Patient information

From October 2013 to May 2014, records of 125 patients (92 men and 33 women, age range 18—45 years, mean age 27.8 years) suffering from low back pain (LBP) lasting longer than 3 months and with clinical suspicion of SpA were retrospectively collected. All patients had experienced two or more of the following symptoms: insidious onset of pain/discomfort, morning stiffness, improvement of symptoms with exercise, or pain at night. None of the patients had histories of joint surgery, or intra-articular corticosteroid injections in the past 6 weeks, and none was treated with tumor necrosis factor α inhibitors or other biologic agents during the 3 months preceding the examination. Each patient underwent spectral CT and MRI examinations to evaluate the SIJs on the same day to reduce the influence of time factor in comparing the imaging finding of two methods. The spectral CT and MRI examinations were performed by the same radiologist who had $>$ 5 years of work experience.

After 3—6 months of follow-up, two fellowship-trained rheumatologists with $>$ 10 years of experience evaluated the presence of SpA based on the ASAS criteria.[4] According to ASAS criteria, a patient younger than 45 years with inflammatory back pain $>$ 3 months in duration can be diagnosed with SpA in the presence of (1) sacroiliitis on MRI or radiographic plus at least one typical clinical SpA feature or (2) the presence of positive-HLA-B27 plus at least two typical clinical SpA features. In these 125 patients, 76 patients (17 women, 59 men, age range 18—43 years, mean age 26.4 years) were diagnosed with SpA, and 49 patients (14 women, 35 men, age range 18—44 years, mean age 29.3 years) were diagnosed with nonspecific LBP (nLBP).

Equipment and scanning techniques

All CT scans were obtained using a standard spectral CT scanner (GE Discovery 750 high-definition CT; GE Healthcare, Milwaukee, WI, USA), and MRIs were performed using a 1.5-T MRI scanner (Signa HDxt; GE Healthcare).

The spectral CT scanning parameters were as follows: collimation thickness, 0.625 mm; tube current, 550 mA; rotation speed, 0.8 second; helical pitch, 0.984. Two types of images were reconstructed from the single spectral CT acquisition: conventional polychromatic images obtained at 140 kVp and monochromatic images obtained at energy of 70 keV. Slice thickness and spacing were 0.625 mm and 0.625 mm, respectively.

The MRI scanning sequences were as follows: (1) an axial fast spin echo sequence [repetition time/echo time (TR/TE) = 280/7.2 ms, slice thickness = 4 mm]; (2) an axial fast recovery fast spin—echo sequence with fat suppression (TR/TE = 2220/86 ms, slice thickness = 4 mm); and (3) an oblique coronal STIR sequence (TR/TE = 4100/71.2 ms, inversion time [TI] = 150 ms, slice thickness = 4 mm).

Image analysis and diagnosing criteria

Two musculoskeletal radiologists with $>$ 5 years of musculoskeletal imaging experience, blinded to the diagnosis and