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Exploring the Advantages of DWI Integrated with DCE Technology in the Diagnosis of AS-SIJ

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A**bstract:** *Objective*: To observe the diagnostic advantages of MR diffusion-weighted imaging (DWI) integrated with dynamic contrast-enhanced (DCE) technology in ankylosing spondylitis (AS) with sacroiliac joint lesions (SIJ). *Methods*: 58 patients with AS-SIJ were selected and diagnosed with conventional MRI and DWI integrated with DCE, respectively, and the diagnostic differences were compared. *Results*: During the diagnosis of patients with AS-SIJ, the disease was graded. The detection rate of grade 1 was higher with DWI integrated with DCE, while there was no difference in the detection rates of the other grades between the two techniques. The detection rates of bone marrow edema, bone cystic changes, and L5-S1 articular process lesions were higher with DWI integrated with DCE. There was no difference in adverse reactions between the two diagnostic techniques. *Conclusion*: DWI integrated with DCE technology has a high early detection rate for AS-SIJ. It is recommended to use DWI integrated with DCE technology as the preferred diagnostic scheme to improve diagnostic accuracy.

Keywords: MR diffusion-weighted imaging; Ankylosing spondylitis; Sacroiliac joint lesions; Detection rate

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1. Introduction

Ankylosing spondylitis (AS) is a clinically common rheumatic immune disease and chronic inflammatory lesion that affects various parts, including the spine, peripheral joints, and sacroiliac joints. The main pathogenic factors include genetics, immunity, and infection. Early clinical symptoms of patients mainly include pain, morning stiffness, and fatigue in the lower back, hips, sacroiliac region, and groin, accompanied by peripheral arthritis. Some patients also experience extra-articular symptoms such as intestinal, lung, and eye abnormalities, while severe cases may involve spinal deformity or rigidity [1]. Clinical studies suggest that the sacroiliac joint (SIJ) is an early lesion of AS, and early diagnosis and effective therapeutic intervention of such lesions can lead to a high detection rate of AS. Imaging techniques, especially MRI, are commonly used to diagnose sacroiliac joint lesions in AS [2]. Pathological changes such as synovitis, inflammatory cell proliferation, and bone marrow fibrosis are common in AS-SIJ patients, affecting the diffusion rate of water molecules and elevating DWI signals.

DWI technology, which does not require the use of contrast agents, can observe fine tissue structures with high precision and has a high detection rate for early inflammation or small lesions. DCE, which requires the injection of a contrast agent, can monitor signal changes in the lesion area and generate a time-signal intensity curve (TIC). The volume transfer constant of the contrast agent (K_{trans}) can reflect the vascular permeability of the lesion area and assess the degree of inflammation, while indicators such as the extracellular volume fraction (V_e) can evaluate edema and predict the progression of fibrosis. Therefore, this study selected 58 AS-SIJ patients to evaluate the advantages of applying DWI integrated with DCE technology.

2. Materials and methods

2.1. General information

Fifty-eight patients with AS-SIJ were selected from January 2022 to June 2024, including 35 males and 23 females, aged between 29 and 38 years old, with an average age of (33.19 ± 3.75) years old. The disease duration ranged from 6 months to 4 years, with an average of (2.47 ± 0.45) years.

2.2. Methods

(1) Instrumentation: A 3.0T MR scanner (750W) produced by GE was selected, using a body phased array coil.

(2) Conventional MRI: Patients were examined in a supine position, and various parameters were adjusted based on the needs of patients with AS sacroiliac joint lesions. Images of STIR sequence, T2WI sequence, T1WI sequence, FS-T1WI sequence, FS-T1WI sequence, and 3D FLASH sequence were acquired. If patients were suspected of having active lesions, enhanced scanning-related operations were performed.

(3) DWI Integrated with DCE Technique

During DWI scanning, the b-value was set at 800 s/mm^2. Gadoteridol was injected intravenously through the elbow vein, and scanning was started. A high-pressure injector was used, with an injection flow rate set at 2 mL/s and a dose of 0.1 mmol/kg. Then, 20 mL of normal saline was injected. A total of 32 phases were acquired continuously without an interval, each with a duration of 10s, resulting in a total scanning time of 320s. For the axial plane, under the FSE-T1WI sequence, the TR value was set at 787 ms, the TE value at 15 ms, the field of view at 240240 mm^2, the slice thickness at 4 mm, the matrix at 320256, and acquisition was performed twice. Under the FRFSE-T2WI sequence, the TR value was set at 5225 ms, the TE value at 68 ms, the field of view at 240240 mm^2, the slice thickness at 4 mm, the matrix at 320256, and acquisition was performed twice. Under the DWI sequence, the TR value was set at 4000 ms, the TE value at 95 ms, the field of view at 360360 mm^2, the slice thickness at 4 mm, the matrix at 128130, and acquisition was performed six times. Under the DCE sequence, the TR value was set at 3.8 ms, the TE value at 1.2 ms, the field of view at 380304 mm^2, the slice thickness at 4mm, the matrix at 256160, and acquisition was performed once. For the coronal plane, under the FSE-T1WI sequence, the parameters were set at 639 ms, 15 ms, 240240 mm^2, 3 mm, 320192, with a slice gap of 1mm and acquisition performed twice. Under the FRFSE-T2WI sequence, the parameters were set at 1575 ms, 30 ms, 240240 mm^2, 3 mm, 320256, with a slice gap of 1 mm and acquisition performed twice. After acquiring the above images, they were transferred to a workstation where parameter maps were reconstructed using professional software, and multiple data points were measured. Post-processing of DCE images included

motion correction, adjustment of image swing differences, and removal of invalid phases. The diagnostic images were comprehensively observed to detect SIJ conditions. If a definite lesion was present, a region of interest (ROI) was placed in the center of the lesion. If no lesion was found, ROIs were placed in the central regions of both sides of the sacroiliac joint (sacral and iliac sides), ensuring that the area of each ROI was 25 mm^2. The apparent diffusion coefficient (ADC) value was measured from the ADC map, and ROI perfusion parameters, including K_{trans}, V_e, and the ratio of extracellular space volume to intravascular volume (K_{ep}) were obtained.

2.3. Statistical methods

Data were analyzed using SPSS 23.0 software. Measurement data mean ± standard deviation (SD) were tested using the t-test, and enumeration data (%) were tested using the χ^2 test. A *P*-value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of detection rates of AS-SIJ at different levels by conventional MRI and DWI integrated with the DCE technique

As shown in **Table 1**, in the graded diagnosis of AS-SIJ, the detection rate of grade 1 by DWI integrated with the DCE technique was higher than that by conventional MRI ($P < 0.05$). There were no significant differences in the detection rates of other grades between the two methods ($P > 0.05$).

3.2. Comparison of detection rates of typical signs of AS-SIJ by conventional MRI and DWI integrated with DCE technique

As shown in **Table 2**, the detection rates of subchondral bone cystic changes, bone marrow edema, and L5-S1 articular process lesions by DWI integrated with DCE technique were higher than those by conventional MRI. The detection rates of joint erosion and joint surface hyperplasia and sclerosis were also higher than those by conventional MRI ($P < 0.05$).

3.3. Comparison of diagnostic results of DWI integrated with DCE technique for different disease activity levels

The Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) was used to evaluate disease activity. The stable phase was defined as a BASDAI score of no more than 4, with 22 cases; the active phase was defined as a BASDAI score of no less than 6, with 32 cases. For patients with scores exceeding 4 but below 6, if the erythrocyte sedimentation rate exceeded 20 mm/h or C-reactive protein exceeded 30 mg/L, they were considered to be in the active phase, with 3 cases. The remaining 1 case was in the stable phase.

The ADC values were $(1.16 \pm 0.53)10^{-3}$ mm^2/s for patients in the active phase and $(0.81 \pm 0.27)10^{-3}$ mm^2/s for patients in the stable phase ($t = 3.316$, $P = 0.002$). The K_{trans} values in the active phase were (0.77 ± 0.26) min^{-1}, and (0.20 ± 0.06) min^{-1} in the stable phase ($t = 12.525$, $P = 0.000$). The V_e values in the active phase were (0.47 ± 0.10), and (0.30 ± 0.05) in the stable phase ($t = 8.582$, $P = 0.000$). The K_{ep} values in the active phase were (1.08 ± 0.52) min^{-1}, and (0.54 ± 0.10) min^{-1} in the stable phase ($t = 6.003$, $P = 0.000$).

3.4. Comparison of the incidence of adverse reactions

Both groups successfully completed the examination without any intolerable adverse reactions during the process.

4. Discussion

Relevant survey data statistics show that the incidence rate of AS in China is about 0.5%, with a higher incidence in males than in females. The majority of patients are young and middle-aged, and the causes of the disease include genetics, environment, immunity, and infection. The main clinical manifestations of patients are inflammatory low back pain, peripheral arthritis, and enthesitis. Some patients have multiple extra-articular symptoms, which can have a more severe impact on daily life [3]. Based on clinical practice analysis, the pathological feature of early-stage AS is SIJ. This type of lesion occurs earlier than tendonitis and ligament attachment points, and is prone to complications such as synovitis and osteomyelitis in the early stage of the disease. Further analysis reveals that SIJ originates from the bone marrow, and during the pathological process, pannus formation occurs, which can lead to lesions in the subchondral plate, ultimately resulting in damage to the cartilage. Therefore, early qualitative analysis of sacroiliac joint lesions and improving the early detection rate of AS are extremely important to shorten the treatment time. In addition, the occurrence of AS-SIJ can cause patients to experience dull pain in the hips and lower back, with increased pain after activity and at night, while some patients experience pain relief during rest. When patients sit for long periods or wake up in the morning, they are prone to develop stiffness in the sacroiliac joint, which is relieved by appropriate activity. In severe cases, the pain radiates to the back of the thigh but does not extend beyond the knee.

The diagnostic approach for AS-SIJ primarily relies on imaging techniques, with MRI being a commonly used examination method. The main advantage of MRI is its high density resolution, which provides better visualization of soft tissues [4]. DWI (Diffusion-Weighted Imaging) can evaluate the movement of water molecules within living tissues, allowing for highly sensitive observation of pathological changes. It is particularly effective in detecting early lesions and pathological processes, and can predict the extent of lesions. In the case of AS-SIJ, the accelerated movement of water molecules in inflamed areas is characterized by enhanced diffusion, resulting in a high signal on DWI. Additionally, increased water content in diseased tissues leads to an elevation in ADC (Apparent Diffusion Coefficient) values. DCE (Dynamic Contrast-Enhanced) imaging can assess tissue perfusion and has strong diagnostic validity for various systems in the body, especially the musculoskeletal system. During the active phase of AS-SIJ, there is an increase in microvascular permeability in the bone marrow tissue below the articular surface, resulting in significant bone marrow enhancement. By utilizing these principles, pathological changes can be effectively detected.

Table 1. Compares the detection rates of AS-SIJ using conventional MRI and the integrated DWI and DCE technique (*n*/%)

Group	Grade 0	Grade 1	Grade 2	Grade 3	Grade 4
Conventional MRI (*n* = 58)	2 (3.4)	9 (15.5)	18 (31.0)	11 (19.0)	10 (17.2)
DWI integrated with DCE (*n* = 58)	0 (0.0)	19 (32.8)	22 (39.7)	13 (22.4)	12 (20.7)
χ^2 value	2.035	4.707	0.610	0.210	0.224
P-value	0.153	0.030	0.434	0.646	0.635

Table 2. Compares the detection rates of typical signs of AS-SIJ using conventional MRI and the integrated DWI and DCE technique (*n*/%)

Group	Subchondral bone cysts	Bone marrow edema	L5/S1 facet joint lesions	Joint erosion	Subchondral sclerosis
Conventional MRI (*n* = 58)	18 (31.0)	35 (60.3)	27 (46.6)	29 (50.0)	32 (55.2)
DWI integrated with DCE (*n* = 58)	32 (55.2)	46 (79.3)	41 (70.7)	40 (69.0)	44 (75.9)
χ^2 value	6.889	4.951	6.956	4.328	5.494
P-value	0.008	0.026	0.008	0.037	0.019

In this study, for the graded diagnosis of AS sacroiliac joint lesions, DWI combined with DCE technology had a higher detection rate for grade 1 lesions than conventional MRI, while there was no significant difference in the detection rates for other grades between the two methods. Relevant studies have shown that there are significant differences in pathological features among patients with AS sacroiliac joint lesions of different grades. Grade 1 and 2 AS sacroiliac joint lesions can be characterized by inflammatory cell infiltration, involving synovial adjacent tissues, increased synovial thickness, and the local generation of pannus, with some patients experiencing erosion of subchondral bone. Imaging diagnosis of such patients reveals a blurred or interrupted white line in the cortical area of the local articular surface, and a cystic structure with translucent features is observed below the articular surface of the affected limb. At this stage, the bone in the diseased area of the articular surface has been destroyed, resembling the skin of a bitter gourd, and bone cortical defects can be observed in imaging. In patients with grade 3 AS sacroiliac joint lesions, the ligamentous tissue, synovial tissue, cartilage, and subchondral bone in the diseased area are all damaged, with severe synovial damage that can easily lead to secondary bone sclerosis. Close observation of the articular surface area reveals damage to the smooth structure, gradual narrowing of the articular space, and gradual sclerosis and hyperplasia of adjacent tissues. Grade 4 patients have relatively severe disease, with lesions involving the synovium and ligaments, severe joint ankylosis, and loss of joint space [5]. Based on the above analysis, early AS-SIJ does not produce significant bone erosion, with soft tissue erosion as the main pathological feature, and pannus, increased synovial thickness, and inflammatory infiltration of bone adjacent tissues can be observed in the diseased area.

DWI combined with DCE technology has a higher detection rate for typical signs such as subarticular bone cystic degeneration and bone marrow edema than conventional MRI ($P < 0.05$). This is because DWI can detect the liquid components inside the cystic area, making it appear as a high signal. Inflammatory cells and fibrous tissues can affect the local diffusion effect, leading to changes in ADC values. DCE can detect active inflammation near the cystic area, causing leakage of the contrast agent, thus detecting bone cystic degeneration.

The activity of Ankylosing Spondylitis (AS) can be generally evaluated by disease progression, and a commonly used assessment method is the BASDAI score, which utilizes a graded scale to evaluate disease activity. However, this method has limitations in accurately and objectively capturing disease progression trends, and its role in evaluating treatment efficacy is limited. Therefore, it needs to be combined with advanced imaging techniques. Patients in the active phase of the disease have higher K_{trans}, V_e, and K_{ep} values than those in the stable phase ($P < 0.05$). Among these parameters, K_{trans} and $_{Kep}$ can predict microvascular permeability. During the active phase of AS, continuous secretion of inflammatory factors in patients can lead to increased vascular permeability, resulting in a large amount of microvascular blood leaking into the tissue space, thus increasing the aforementioned numerical levels. V_e can evaluate tissue necrosis. During the active phase of AS, patients have obvious necrotic foci in their bone marrow tissue, which can elevate V_e levels. In DWI diagnosis, the ADC value may be interfered with by the parameter b value, and is related to tissue

structure and magnetic field uniformity. The diagnostic results of DCE are affected by the accuracy of data processing, scanning procedures, and the pharmacokinetics of the contrast agent, so a single diagnosis has certain defects. Therefore, this study adopts an integrated diagnostic approach that allows quantitative analysis of diagnostic images, eliminating subjective factors of patients, and objectively and comprehensively evaluating the blood perfusion and pathophysiological processes of AS-SIJ, thereby accurately determining the condition [6]. However, it should be noted that when AS-SIJ patients undergo DWI-integrated DCE technical diagnosis, it should be clarified whether the patient has any MRI contraindications, such as severe renal insufficiency or metal implants in the body, and patients should be instructed to maintain a steady breathing rate during the examination to prevent motion artifacts. Additionally, during DWI-integrated DCE technology, examination parameters should be adjusted based on the patient's actual physiological and pathological conditions to obtain clear imaging of different sequences. After confirming AS-SIJ, patients should be advised to avoid overexertion, correct poor posture, and actively receive rehabilitation treatment.

5. Conclusion

In summary, the integration of DWI and DCE technology has a better diagnostic effect on AS-SIJ, which can determine the disease grading, detect typical signs, and thus comprehensively grasp the disease status. In addition, the integration of DWI and DCE technology can effectively identify disease activity, screen out the differences in parameters between active and stable periods, obtain quantitative and accurate diagnostic information, and rationalize the follow-up treatment measures for the disease to improve the prognosis as much as possible.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Zhai H, Yu S, Yin L, et al., 2023, Observation on the Value and Safety of CT and MRI in the Diagnosis of Sacroiliac Joint Lesions in Ankylosing Spondylitis. China Medical Device Information, 29(14): 111–113 + 132.

[2] Liang Z, Li J, Dong L, et al., 2015, Comparative Analysis of the Value of X-ray, CT, and MRI in the Diagnosis of Early Ankylosing Spondylitis Sacroiliac Joint Lesions. Chinese Journal of CT and MRI, (2): 84–87.

[3] Wang S, Zhang C, 2016, Comparative Analysis of CT and MRI in the Clinical Diagnosis of Sacroiliac Joint Lesions in Ankylosing Spondylitis. Chinese Journal of CT and MRI, 14(7): 112–114.

[4] Wang B, 2017, Comparing the Value of X-ray, CT, and MRI in the Diagnosis of Early Ankylosing Spondylitis Sacroiliac Joint Lesions. China Digital Medicine, 12(3): 30–31 + 96.

[5] Yue C, 2023, Value Analysis of CT Combined with MRI in the Diagnosis of Sacroiliac Joint Lesions in Ankylosing Spondylitis. Journal of Imaging Research and Medical Applications, 7(2): 128–130.

[6] Chen L, 2021, Comparative Observation of the Clinical Effects of X-ray, CT, and MRI in the Diagnosis of Early Ankylosing Spondylitis Sacroiliac Joint Lesions and Analysis of Their Impact on Detection Rate. Chinese Journal of CT and MRI, 19(11): 179–181 + 185.