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MRI FINDINGS OF SACROILIITIS IN PATIENTS WITH LOWER BACK PAIN ACCORDING TO THE "ASSESSMENT OF SPONDYLOARTHRITIS INTERNATIONAL SOCIETY" CRITERIA

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Abstract: Background: Magnetic Resonance Imaging (MRI) has become essential in detecting sacroiliac joint inflammation, identifying lesions before structural changes appear on radiography or CT. The Assessment of SpondyloArthritis International Society (ASAS) criteria introduced in 2009 provided a simple definition of active sacroiliitis for axial spondyloarthritis (axSpA) diagnosis, gaining wide acceptance in clinical practice.

Objectives: To determine the prevalence of sacroiliitis according to ASAS criteria in patients presenting with lower back pain and evaluate the diagnostic performance of the T1-weighted high-resolution isotropic volume examination (THRIVE) MRI sequence compared to the conventional T1-weighted sequence in diagnosing axial spondyloarthritis.

Patients and Methods: This prospective cross-sectional study involved 83 patients with suspected axSpA, conducted from February to November 2023 at Gazi Al-Hariri Teaching Hospital, Baghdad. Clinical history, serological tests (HLA-B27, CRP), and detailed MRI findings (osteitis, sclerosis, fat deposition, ankylosis, erosions, joint space narrowing) were collected and assessed.

Results: The mean age was 35.1 years (±9.4), with females comprising 51.8% of the sample. Inflammatory back pain was significantly more prevalent in males ($P < 0.05$). Among participants, 21 (25.3%) were classified as axSpA based on clinical criteria, while 18 (21.1%) met the imaging criteria. The THRIVE sequence was significantly superior to the conventional T1 sequence in detecting sacroiliac joint erosions ($P = 0.01$).

Conclusions: MRI-defined active sacroiliitis remains crucial for axial SpA diagnosis. The THRIVE MRI sequence demonstrates higher sensitivity and improved detection of erosions and joint-space changes compared to conventional T1-weighted imaging, highlighting its potential clinical advantage for evaluating patients with suspected axial spondyloarthritis.

Keywords: Sacroiliitis; Axial Spondyloarthritis; Lower Back Pain; ASAS Criteria; MRI; THRIVE Sequence; Sacroiliac Joint.

1. Introduction

Sacroiliitis refers to inflammation of the sacroiliac (SI) joint, situated bilaterally between the ilium and sacrum. As one of the largest axial joints, the SI joint significantly contributes to load transmission between the lumbar spine and lower extremities, making it a frequent source of lower back and gluteal pain (1). Inflammation of this joint arises from diverse causes, including osteoarthritis, pregnancy-related mechanical stress, trauma, infections, and notably, spondyloarthropathies (1,2). Among these, axial spondyloarthritis (axSpA) is particularly significant, representing a complex group of chronic inflammatory disorders that predominantly affect younger, male patients and are strongly associated with the genetic marker human leukocyte antigen B27 (HLA-B27) (3).

Patients with axSpA often present with inflammatory back pain, distinguished from mechanical low back pain by specific clinical features outlined by the Assessment of SpondyloArthritis International Society (ASAS). These include onset before age 40, insidious onset, improvement with exercise, no relief with rest, and nocturnal pain relieved upon arising (4). About 20% of chronic low back pain cases are inflammatory, and among these patients, approximately 20% progress to axSpA (5).

Historically, imaging of sacroiliitis relied primarily on radiography to detect structural joint changes, but radiography fails to visualize early inflammatory lesions, delaying the diagnosis and initiation of disease-modifying treatment (6). Magnetic resonance imaging (MRI), however, allows detection of inflammation and structural alterations much earlier than radiography or CT, significantly improving diagnostic sensitivity in early disease stages . The ASAS developed an MRI-based definition of active sacroiliitis, highlighting bone marrow edema (BME) near joint surfaces as a critical diagnostic criterion (7). Despite advances, diagnosing SI joint inflammation remains challenging due to overlapping presentations with conditions such as osteitis condensans ilii, osteoarthritis, trauma-related injuries, infections, and degenerative changes (8).

Recent MRI developments, such as the T1-weighted high-resolution isotropic volume examination (THRIVE) sequence, offer enhanced visualization of articular cartilage and structural erosions, showing potential superiority over conventional T1-weighted sequences in detecting early and subtle joint alterations (9). Despite promising preliminary findings, further comparative studies evaluating the clinical utility of THRIVE versus standard MRI sequences remain limited.

Therefore, this study aims to evaluate MRI findings of sacroiliitis in patients with lower back pain according to the ASAS criteria and compare the diagnostic performance of the THRIVE sequence with conventional T1-weighted imaging in detecting sacroiliac joint erosions and structural changes in patients with suspected axSpA.

2. Patients and Methods

A prospective cross-sectional study was conducted from February 2023 to November 2023 at the MRI unit of Gazi Al-Hariri Teaching Hospital, Baghdad. Ethical approval was obtained from the Iraqi Board of Diagnostic Radiology Committee, and informed verbal consent was secured from each participant. The study involved 83 middle-aged patients (>18 years) with chronic lower back pain persisting for more than three months, referred from the rheumatology outpatient clinic of Baghdad Teaching Hospital.

Patient demographics (age, gender), clinical symptoms (nature and characteristics of lower back pain), and serological data (HLA-B27, C-reactive protein) were collected through structured questionnaires. Associated spondyloarthropathy features, such as uveitis, arthritis, psoriasis, inflammatory bowel disease, dactylitis, and relevant family history, were assessed by rheumatologists. Imaging findings documented included bone marrow edema (osteitis), subchondral sclerosis, fat metaplasia, subchondral fat deposition, ankylosis, joint-space narrowing, and presence or absence of articular erosion on MRI sequences.

Included were patients older than 18 years with inflammatory back pain lasting more than three months. Patients with contraindications for MRI, including claustrophobia, pacemakers, prosthetic devices, recent surgery, or early pregnancy, were excluded.

MRI studies were conducted using a 1.5 Tesla MRI system (Achieva, Philips Medical Systems, Best, The Netherlands) with a phased-array surface coil. MRI sequences included oblique coronal T1-weighted turbo spin-echo (TR=510 ms, TE=11 ms), oblique coronal and axial STIR (TR=2500 ms, TE=60 ms), axial T2-weighted images, and oblique coronal 3D spoiled gradient-echo THRIVE (TR=4.7 ms, TE=2.3 ms) with fat saturation. Slice thickness was set at 3 mm, and the total scan duration was approximately 20 minutes. No gadolinium-enhanced sequences were obtained, in accordance with ASAS guidelines.

Patients were classified into clinical or imaging arms following the 2016 updated ASAS criteria. The clinical arm included patients with HLA-B27 positivity and at least two additional SpA features, whereas the imaging arm required MRI evidence of sacroiliitis and at least one additional SpA feature. Active sacroiliitis on MRI was identified primarily by bone marrow edema (BME), visualized as hyperintense lesions on STIR images and corresponding hypointense signals on T1-weighted images, typically involving subchondral bone areas visible on two or more consecutive slices or multiple areas within a single slice.

Structural changes assessed included erosions, subchondral fat deposition, fat metaplasia (backfill), sclerosis, and ankylosis, defined by specific MRI criteria based on signal intensity alterations on T1-weighted images.

Participants gave verbal consent after the study was explained, with assurances of confidentiality. Ethical approval was obtained from the Iraqi Board of Medical Sciences// Department of Radiology. Data analysis was performed using SPSS software version 25 (IBM). Quantitative variables (age) were summarized using means and standard deviations, with comparisons via Student's t-tests. Categorical variables (imaging findings) were represented using frequencies and percentages, with associations analyzed using chi-square tests and Pearson correlation coefficients.

3. Results

Eighty-three patients were enrolled in this study; the mean age was 35.1 (SD=9.4), ranged from 19-50. Forty-three patients (51.8%) were females; the rest were males. **(Figure 3-1).**

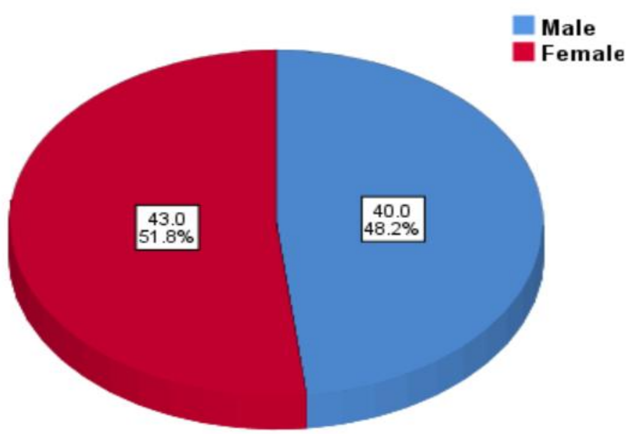

Figure 3.1: Gender distribution among study participants.

The results of serological tests revealed that 32 (38.6%) of the sample had HLA-B27 positive test, and 31 (37.3%) had positive CRP.

According to ASAS criteria, 21 (25.3%) patients were diagnosed as axSpA using the clinical arm. All (100%) had positive tests for HLA-B27, and 16 (76.2%) had inflammatory back pain. Conversely, from patients with negative axSpA on the clinical arm, 14 (22.6%) had IBP, and only 11 (17.7%) had a +ve test for HLA-B27. **(Table 3-1)** and **(Figure 3-2)** demonstrate different SpA features in both groups. There was a statistically significant correlation (p-value < 0.05) between IBP, HLA-B27, C-RP, and uveitis and having a positive diagnosis, as the percentage of these factors in positive patients is significantly higher than in negative patients.

Table 3.1: Frequency and percentage of SpA features in axSpA +ve and -ve groups according to clinical arm diagnosis. Pearson correlation coefficient, α=0.05.

SpA features	axSpA +ve n= 21	axSpA -ve n= 62	P-Value
IBP	16 (76.2) *	14 (22.6)	0.001
HLA-B27	21 (100)	11 (17.7)	0.001
C-RP	16 (76.2)	15 (24.2)	0.001
Uveitis	3 (14.3)	1 (1.6)	0.01
Arthritis	1 (4.8)	2 (3.2)	0.7
Dactylitis	1 (4.8)	0 (0)	0.08
Psoriasis	1 (4.8)	6 (9.7)	0.49
Crohn’s/Colitis	1 (4.8)	5 (8.1)	0.61
Urethritis	0 (0)	1 (1.6)	0.56
Family Hx	6 (28.6)	13 (21.0)	0.48

*Count (percentage)

Among 21 patients diagnosed positive according to the clinical arm, 16 (76.2%) were males, and the rest were females. Their mean age was 37.2 (SD = 8.7) and ranged from (20-48).

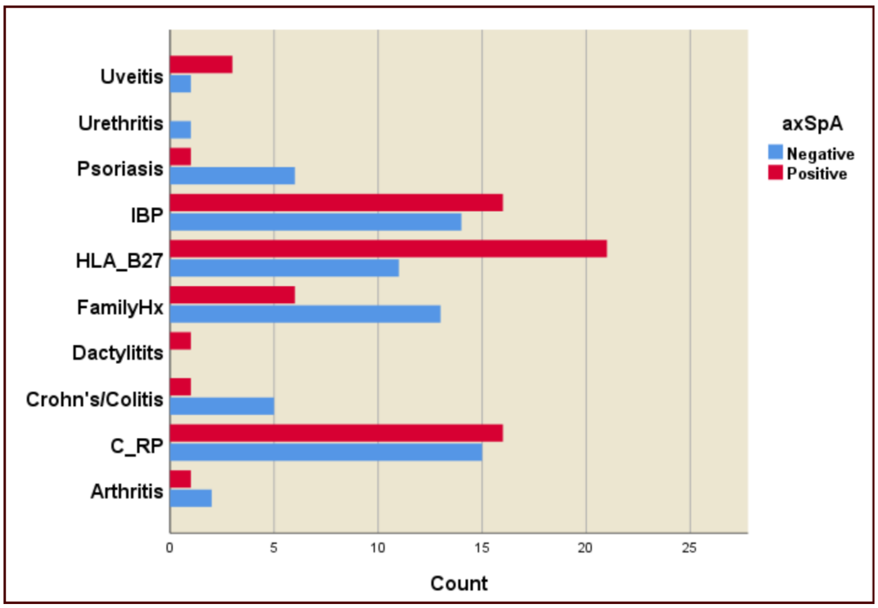

Figure 3.2: Distribution of SpA features in axSpA patients diagnosed by clinical arm.

For all participants, bone marrow edema was present in 20 (24.0 %) patients, and the highest numbers of structural changes among them were fat deposition 41 (49.4%) and erosion 39 (47.0 %) and sclerosis 34 (41.0 %). The count and percentage of structural changes among our sample are illustrated in **(Figure 3-4).**

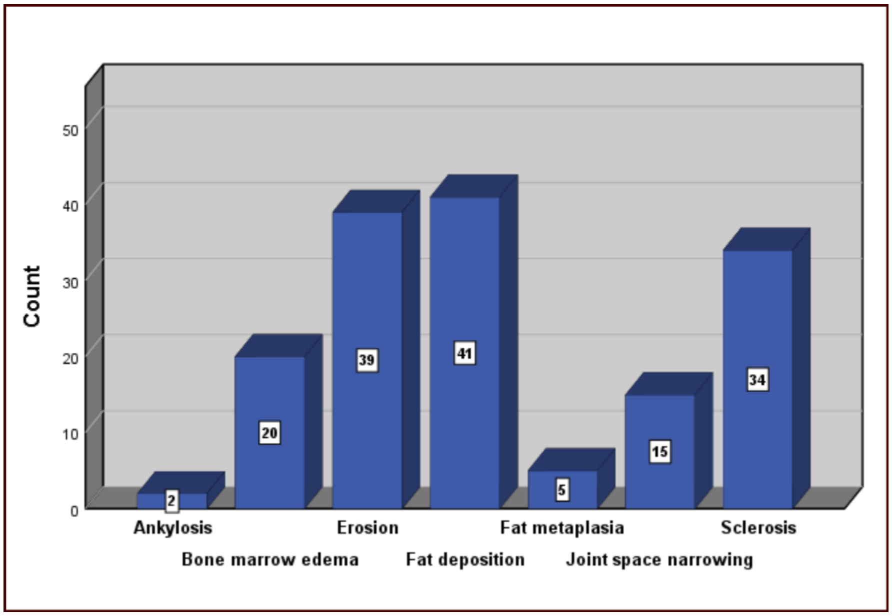

Figure 3.3: Count and percentage of structural changes in our sample (n=83).

According to ASAS definition, a diagnosis of sacroiliitis requires the presence of bone marrow edema and structural changes. On short tau inversion recovery (STIR) images (or equivalent water-sensitive sequences), a hyperintense signal represents BME; however, on T1-weighted images, it is typically represented by a hypointense signal. Signal intensity increases with the probability that an indicator of active inflammation is present. An extremely hyperintense signal resembles that of cerebrospinal fluid.

Among current study participants, 18 (21.1%) had sacroiliitis. The patient with sacroiliitis was diagnosed as axSpA +ve (by imaging arm) if the patient had one additional SpA feature. So, we had 18 (21.1%) patients diagnosed as ASAS +ve according to the imaging arm (all the patients with sacroiliitis), and all of them had bone marrow edema, 13 (72.2%) had erosion, as illustrated in **(Table 3-2).** Also, 16 (88.9%) of them had fat deposition.

Table 3.2: Distribution of structural changes according to axSpA, Pearson correlation coefficient, α= 0.05.

Imaging criteria	axSpA +ve n= 18	axSpA -ve n= 65	P-Value
BME	18 (100) *	2 (3.1)	0.001
Erosion	13 (72.2)	26 (40.0)	0.01
Sclerosis	11 (61.1)	23 (35.4)	0.3
Fat metaplasia (backfill)	1 (5.6)	4 (6.2)	0.9
Fat deposition	16 (88.9)	25 (38.5)	0.001
Ankylosis	2 (11.1)	0 (0)	0.006
Joint space narrowing	9 (50)	6 (9.2)	0.001

*Count (percentage)

The distribution of structural changes in ASAS-positive and ASAS-negative patients is demonstrated in **(Figures 3-4 and 3-5).** Among 18 patients diagnosed positive according to the ASAS imaging arm, 13 (72.2%) were males, and the rest were females. And the mean age for them was 36.8 (SD = 9.9) and ranged from (20-50) years. 11 (61.1%) had inflammatory back pain, 10 (55.6%) had positive HLA-B27, and 6 (33.3%) had positive family history.

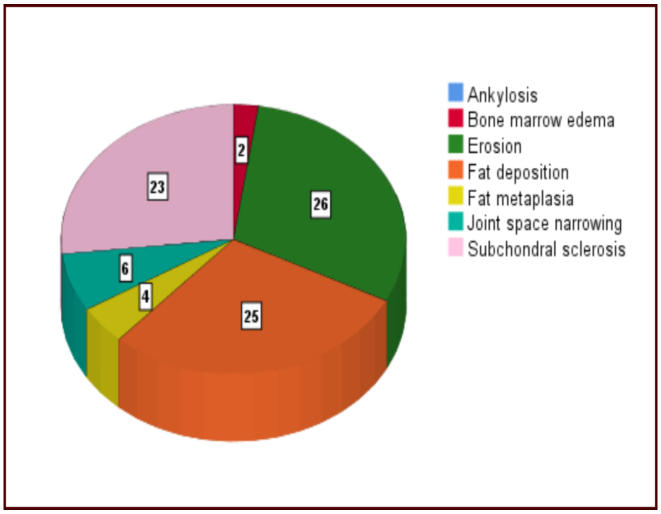

Figure 3.4: Distribution of structural changes in ASAS-negative patients.

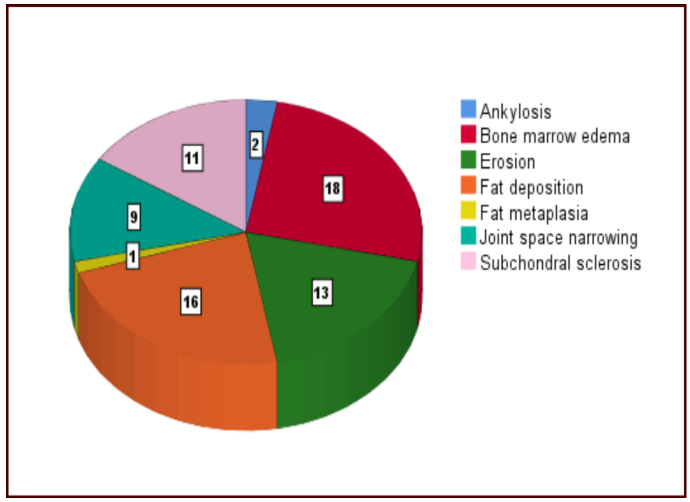

Figure 3.5: Distribution of structural changes in ASAS-positive patients.

Articular erosion appeared in 39 (47.0%) patients and was absent in 44 (53.0%). All patients with erosion were positive on the THRIVE sequence, but only 25 (30.1%) were diagnosed with by the T1 sequence. **(Table 3-3).**

Table 3.3: Frequency and percentage of articular erosion according to THRIVE and T1 sequences. Chi-square test, α=0.05.

Articular Erosion		THRIVE		Total	P-value
		Present	Absent		
T1	Present	25 (30.1) *	0 (0)	25 (30.1)	0.01
	Absent	14 (16.9)	44 (53.0)	58 (69.9)	
Total		39 (47.0)	44 (53.0)	83 (100)	

* Count (percentage)

The association between HLA-B27 and structural changes is illustrated in Table 3-4; our sample shows a significant association between HLA-B27 and articular erosion (62.5% of HLA +ve has erosion while only 37.3% of HLA -ve has erosion), and fat deposition (65.6% of HLA +ve has fat deposition while only 39.2% of HLA -ve has fat deposition), and joint space narrowing (28.1% of HLA +ve has joint narrowing while only 11.8% of HLA -ve has joint narrowing).

Table 3.4: Frequency and percentage for each structural change according to the HLA-B27, Chi-square test, α=0.05.

Structural changes	HLA-B27		P-value
	Positive N=32	Negative N=51	
Bone marrow edema	10 (31.3) *	10 (17.6)	0.12
Articular erosion	20 (62.5)	19 (37.3)	0.02
Subchondral sclerosis	13 (40.6)	21 (41.2)	0.6**
Fat metaplasia(backfill)	4 (12.5)	1 (2.0)	0.7**
Fat deposition	21 (65.6)	20 (39.2)	0.01

Ankylosis	2 (6.3)	0 (0.0)	0.1**
Joint space narrowing	9 (28.1)	6 (11.8)	0.05

*Count (percentage), **Likelihood ratio.

4. Discussion

According to the Assessment of SpondyloArthritis International Society (ASAS), active sacroiliitis on MRI necessitates the presence of bone marrow edema (BME) in subchondral bone, strongly indicative of axial SpA, even in the absence of radiographic changes (10). While CT imaging remains the gold standard for detecting erosions of the sacroiliac joint (SIJ), MRI has become widely favored for diagnosing chronic inflammatory conditions due to its lack of radiation exposure and superior capability to visualize inflammatory and structural alterations simultaneously (11).

This study compared the modern MRI three-dimensional THRIVE sequence to conventional T1-weighted imaging in detecting erosions. The results revealed a significantly higher detection rate of erosions (16.9%) using THRIVE compared to standard T1-weighted imaging ($P < 0.01$). These findings align with studies by Xie et al. (12) and Diekhoff et al. (13), who also demonstrated the superiority of THRIVE sequences in identifying joint erosions with significant statistical differences.

The superior performance of THRIVE imaging can be attributed to its high intrinsic contrast between cortical bone and adjacent joint structures, thinner slices, and reduced partial-volume effects, thereby improving the visibility of subtle joint-space alterations and small erosions (12). Further, previous studies reported greater sensitivity of MR-THRIVE than low-dose CT, as MR-THRIVE lacks radiation exposure and demonstrates higher bone-cartilage contrast (13).

The mean age of participants in our study was 35.1 years, without significant gender predominance. This demographic profile differed from Baraliakos et al. (14), where male predominance and older mean age were observed but aligned closely with Laloo et al. (15), reporting similar gender and age distribution.

Our study showed a relatively high prevalence of inflammatory back pain (IBP) (36.1%) compared to previously reported figures by Hamilton et al. (7.7%) (68) and de Oliveira et al. (15%) (16). This discrepancy suggests potential ethnic and population-specific variations that require further investigation.

The prevalence of HLA-B27 positivity in our study was 38.6%, lower than Baraliakos et al. (82%) (17), likely due to different patient selection criteria. However, our results aligned more closely with Laloo et al. (49.7%) (15). Consistent with previous research (14), HLA-B27 positivity was associated with increased structural changes and BME in the SI joints.

Regarding MRI findings, 21.1% of participants exhibited BME consistent with the ASAS definition, comparable to findings by Arnbak et al. (21%) (18) and Maksymowych et al. (31.3%) (19). Fat deposition (49.4%) was the most frequently observed structural lesion in our study, whereas Maksymowych et al. reported erosion as the predominant structural lesion (19). The presence of fatty lesions is recognized as a marker of chronicity in axSpA, correlating with disease duration and severity of joint destruction (20).

In our study, the ASAS clinical arm diagnosed a slightly higher percentage of axSpA patients (25.3%) compared to the imaging arm (21.1%), differing from Arnbak et al. (21), who reported higher diagnostic rates in the imaging arm. The relatively small sample size and shorter study duration might explain this discrepancy. Nonetheless, male predominance and similar mean ages were observed in both clinical and imaging arms, consistent with previous findings by Van den Berg et al. (22).

Certain MRI findings, such as high T1-signal intensity and ankylosis, have demonstrated high specificity for diagnosing axSpA, further emphasizing the clinical utility of advanced MRI sequences like THRIVE, which provides enhanced tissue resolution and facilitates earlier identification of joint alterations (23).

Our study had several limitations, including the absence of CT comparisons, the inability to utilize 1-mm slice thickness due to time constraints, and recruitment from a single tertiary center. Moreover, the absence of a healthy comparison group and lack of gadolinium enhancement per ASAS guidelines might have influenced diagnostic precision.

Differential diagnosis remains challenging due to overlapping imaging features. Notably, our study identified two illustrative cases: osteitis condensans ilii presenting postpartum with characteristic arcuate subchondral edema , and a case of transitional vertebra (hemisacralization of L5), underscoring the necessity for cautious interpretation of SIJ imaging in clinical practice.

5. Conclusion

MRI is an essential tool for diagnosing and classifying axial spondyloarthritis (axSpA) due to its ability to visualize both inflammatory and structural components of sacroiliitis. While bone marrow edema (BME) remains a key imaging marker, our findings suggest that evaluating periarticular and intra-articular MRI signals—particularly structural lesions—enhances diagnostic accuracy. The THRIVE sequence, with its thin 3 mm slices and rapid acquisition time, proved superior to conventional T1 TSE imaging in detecting sacroiliac joint erosions and joint-space changes. Incorporating advanced imaging techniques such as THRIVE is crucial for accurately identifying SpA, especially in cases where BME is subtle or nonspecific, thereby supporting a more comprehensive and reliable classification of sacroiliitis on MRI.

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