A COMPARISON STUDY BETWEEN DIXON SEQUENCE AND CONVENTIONAL MRI SEQUENCES IN SACROILITIS

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Abstract

Aim - The aim of this article is to compare the diagnostic efficacy of MRI-DIXON sequence to conventional MRI sequences in evaluation of sacroiliitis.

Material and Methods - MRI was performed on a 3-Tesla system for fifty-two patients diagnosed with sacroiliitis, following the specified MRI protocol.Conventional coronal oblique short tau inversion recovery, T1W sequences, and T2W multipoint Dixon sequences were performed on the subjects. Comparisons were made by two radiologists using the Syngovia Software between conventional and T2 Dixon sequences.

Results - In conventional MRI sequences Radiologist-A and Radiologist-B reveals a high level of agreement for Bone Marrow Edema, Bony Sclerosis and Joint Space Reduction. However, in the case of Fatty Infiltration there is a slight discrepancy between the interpretations of the two radiologists i.e 76.92 % agreement .Dixon MRI findings illustrates even stronger concordance between the interpretations of Radiologist-A and Radiologist-B across all observed parameters. For Fatty Infiltration, while the agreement remains high at 84.62%, there is a minor disparity in the interpretations provided by the two radiologists.

Conclusion - In the given sample size analyzed, there seemed to be some subjectivity in the assessment. However, DIXON was better at assessing some findings such as bone edema and fatty infiltration whereas Conventional sequences provided better results for bony sclerosis. The DIXON sequence demonstrated a marginal advantage over conventional MRI sequences in the assessment of sacroiliitis.

Keywords - Bone marrow edema **,** Periarticular fat deposition **,** Sacroiliitis **,** Subchondral sclerosis **,** T2 Dixon

Introduction

The sacroiliac joint can be affected by a variety of rheumatic as well as non-rheumatic disorders. The most frequent cause of sacroiliitis is seronegative spondyloarthropathies (SpA), although rheumatoid arthritis, enteropathic, gout, infection, and pyogenic arthritis can also cause it [1-4].Clinical diagnosis of sacroiliitis is often difficult, as patients present with localized or referred pain, usually below the posterior superior iliac spine, which can resemble pain from various other causes of backache[5].Only chronic diseases with changed joint space and subchondral bone alterations are detected by radiography. For early detection of acute sacroiliitis, magnetic resonance imaging (MRI) offers superior assessment of joint anatomy, bone marrow, cartilage, subchondral bone, adjacent ligaments and the joint capsule [6,7].It is one of the new criteria that the Assessment of Spondylo Arthritis International Society has established. BME/osteitis, synovitis, enthesitis, or capsulitis are examples of how acute sacroiliitis related to SpA might be visualised. It is thought that an MRI with BME or osteitis is necessary for the diagnosis.Subchondral sclerosis, periarticular fat accumulation, articular erosions, and bony ankylosis are characteristics of chronic instances. In situations of sacroiliitis, MRI is also helpful in evaluating disease activity and tracking treatment response[8-10].Two frequently used MRI sequences for evaluating the sacroiliac joints include fat-suppressed T2-weighted (T2W-FS) and T1-weighted (T1W) images, along with STIR sequences.In order to identify osteitis, contrast-enhanced fat-saturated T1-weighted (T1W-FS-PC) imaging can be used to validate short tau inversion recovery (STIR) hyperintensities [2,10].Typically, STIR is adequate for BME diagnosis. Nonetheless, the T1W-FS-PC sequence serves as a conclusive approach when STIR is equivocal or to rule out potential artefacts. Spoken bone marrow lesions, liver, kidney, and adrenal glands are all detected and characterised using fat suppression techniques like as chemical shift imaging and related Dixon-based procedures.There are four sets of post-processed and automatically reconstructed pictures produced by the T2W multipoint Dixon technique[11-13].With homogenous fat suppression, this Dixon sequence offers a superior and higher signal-to-noise ratio (SNR) in a fair amount of time. In comparison to traditional sequences used for detecting and distinguishing sacroiliac joint disorders, the Dixon method may deliver high-quality tissue contrast without prolonging the scan time [11 ,14] [IMAGE 1]. High-quality imaging combined with accurate reporting is crucial for identifying suitable patients with axial disease who are likely to benefit from biologic therapy[15] . This study assesses the effectiveness of the Dixon sequence as a standalone technique for diagnosing sacroiliitis, in comparison to the conventional multi-sequence MRI protocol.

Material and methods

This cross-sectional study was carried out over a duration of 24 months in the Department of Radiodiagnosis at a tertiary health care centre in Lucknow. All patients fulfilling the inclusion criteria and presenting to the Orthopaedics outpatient department, emergency services, or the Department of Radiodiagnosis were enrolled. A total of 52 individuals with a clinical or radiological diagnosis of sacroiliitis were included in the study. A total of 52 patients diagnosed with sacroiliitis underwent MRI on a 3-Tesla system following the specified MRI protocol. Imaging included conventional coronal oblique short tau inversion recovery (STIR), T1-weighted sequences, and T2-weighted multipoint Dixon sequences. Two radiologists compared the conventional sequences with the T2 Dixon sequences using Syngovia software. Patients were excluded if they were pregnant or had contraindications to MRI, such as ferromagnetic pacemakers, cochlear implants, or claustrophobia. The objective of the study was to assess the prevalence and imaging characteristics of sacroiliitis in this cohort, while ensuring adherence to ethical standards and maintaining patient confidentiality.

For each patient, the largest lesion within each sacroiliac joint was assessed, and a uniformly sized round region of interest was applied across all sequences to measure signal intensity. Data entry was performed in Microsoft Excel, and statistical analysis was conducted using SPSS software, version 26 (Chicago, IL, USA). Continuous variables were expressed as mean with standard deviation or as range values when appropriate, while categorical variables were presented as counts or frequencies and analyzed using the Chi-square test. Comparisons of means across more than two groups were performed using ANOVA with a 95% confidence interval, and a p-value of less than 0.05 was considered statistically significant.

Results

A total of 52 patients (35 males and 17 females) were studied. The study population comprised individuals aged between 10 and 70 years, with a mean age of 35.63 ± 19.84 years. Among these 52 cases of sacroiliitis, 41 (78.85 %) were diagnosed with inflammatory etiology and 11 cases (21.15 %) were diagnosed with infective etiology. Out of 52 cases of sacroiliitis, 17 (32.69 %)presented with lower back ache , 19 (36.54%) with lower back ache radiating to lower limbs , 7 (13.46 %)with restriction of movements and 9 (17.31 %) with early morning stiffness.

In the Conventional MRI findings, Radiologist-A identified Bone Marrow Edema in 25 patients (48.08%), while for Dixon MRI, this number slightly increased to 27 patients (51.92%). Bony Sclerosis, on the other hand, showed a higher incidence in Conventional MRI, with 29 patients (55.77%) identified, compared to 23 patients (44.23%) in Dixon MRI. Interestingly, Joint Space Reduction was observed in the same number of patients (26, 50.00%) for both Conventional MRI and Dixon MRI sequences, indicating consistency in the assessment of this feature. Fatty Infiltration, however, demonstrated a slightly higher prevalence in Dixon MRI, with 28 patients (53.85%) identified compared to 24 patients (46.15%) in Conventional MRI.

In the Conventional MRI findings, Radiologist-B identified Bone Marrow Edema in 24 patients (46.15%), whereas in Dixon MRI, this number increased to 28 patients (53.85%). Bony Sclerosis, conversely, exhibited a higher prevalence in Conventional MRI, with 29 patients (55.77%) identified, compared to 23 patients (44.23%) in Dixon MRI. Interestingly, Joint Space Reduction was observed in the same number of patients (26, 50.00%) for both Conventional MRI and Dixon MRI sequences, indicating consistent identification of this feature by Radiologist-B across the two imaging modalities. Fatty Infiltration, however,

demonstrated a slightly higher prevalence in Dixon MRI, with 30 patients (57.69%) identified compared to 22 patients (42.31%) in Conventional MRI.

Discussion

When compared to traditional approaches, the employment of Dixon sequences in diverse clinical situations has demonstrated to deliver improved fat suppression and image quality. This justification suggests that the Dixon sequence will either match or outperform traditional sacroiliac joint imaging. By reducing a multisequence technique to a single Dixon T2W sequence, this could shorten the scanning time. Additionally, better image quality is anticipated, which will boost diagnostic confidence. The study's objective was to evaluate the profile of conventional sequences and the T2W multipoint Dixon sequence in sacroiliac joint MRIs for the diagnosis of both acute and chronic sacroiliitis. There are incredibly few research that have been done on Dixon's function in sacroiliac joint examination. According to Özgen's 2017 study, the T2W multipoint Dixon sequence can be employed as a single sequence since it can better show diagnostic symptoms of both active and chronic sacroiliitis than traditional MRI sequences [2] .
In our study, the interpretation of findings in Conventional MRI by Radiologist-A and Radiologist-B reveal a high level of agreement for most findings. Specifically, for Bone Marrow Edema, there is a notable agreement of 96.15%, indicating a consistent assessment between the two radiologists. Similarly, for Bony Sclerosis and Joint Space Reduction, both radiologists exhibit a perfect agreement rate of 100.00%, suggesting a robust consensus in identifying these features [Image 2]. However, in the case of Fatty Infiltration, although the agreement remains relatively high at 76.92%, there is a slight discrepancy between the interpretations of the two radiologists [Table 1 and Graph 1]
On the other hand, Dixon MRI findings illustrates even stronger concordance between the interpretations of Radiologist-A and Radiologist-B. Across all observed features, including Bony Sclerosis, and Joint Space Reduction, both radiologists demonstrate a perfect agreement rate of 100.00% and very strong agreement of 96.4% for bone edema, indicative of a consistent assessment between the two methods. Notably, in the assessment of fatty infiltration, the agreement between the two radiologists was high at 84.62%, with only minor differences in interpretation, which were less pronounced than those observed with conventional MRI findings [Table 2 , Graph 2 and Image 3]

In 2022, R. Athira conducted a study on 37 patients (20 males and 17 females) involving a total of 63 sacroiliac joints, with bilateral involvement observed in 26 cases, right-sided involvement in 7 cases, and left-sided involvement in 4 cases. The findings indicated that T2 Dixon sequences were either superior or on par with conventional MRI sequences for detecting sacroiliitis, except in cases of ankylosis. Based on these results, Dixon imaging was suggested as a potential alternative to conventional multi-sequence protocols for acute sacroiliac joint assessment and as a valuable supplementary tool for improving the accuracy and reliability of diagnosing chronic or long-standing sacroiliac joint conditions.

The Dixon technique offers the advantage of achieving homogeneous fat suppression, owing to its reduced sensitivity to local magnetic field inhomogeneities compared with other fat saturation methods. It also facilitates quantitative assessment of fat content and is particularly useful for fat suppression in post-contrast imaging, such as in cases of inflammatory or

infectious changes near metallic implants. With proper technical optimization, Dixon imaging can be implemented in gradient-echo as well as spin-echo sequences [12] . In recent years, Dixon sequences have been extensively applied across various fields, offering superior image quality over conventional fat suppression methods [16] . Applicable to both T1-weighted and T2-weighted sequences, Dixon imaging is regarded as equivalent or superior to various conventional techniques and is widely utilized in the evaluation of neck, breast, abdominal, and female pelvic pathologies [12 , 16-20] . Dixon sequencing has been widely utilized in musculoskeletal imaging to enhance the detection of bone marrow replacement lesions and fractures, and its applications have also been explored in specialized areas such as kidney perfusion MRI and cardiovascular system imaging [11, 21-25] . The majority of these studies indicate that Dixon, when used as a standalone sequence, has the potential to replace the conventional combination of morphologic sequences traditionally employed in these regions.

Conclusion

In this study, the Dixon sequence demonstrated superior performance in detecting certain sacroiliitis features, particularly bone marrow edema and fatty infiltration, while conventional MRI sequences were more effective in identifying bony sclerosis. Overall, Dixon imaging was found to be marginally better than conventional sequences for sacroiliitis evaluation. However, its diagnostic performance for ankylosis was limited, likely due to the small number of cases with this finding. The study's relatively small sample size, inclusion of cases with varied etiologies (both inflammatory and infectious), reliance solely on imaging-based diagnosis without laboratory or clinical follow-up confirmation, and lack of longitudinal Dixon imaging to monitor treatment response were notable limitations.

Future large-scale studies are recommended to validate Dixon sequences as a primary screening tool for sacroiliac joint assessment, with particular emphasis on recruiting more cases of ankylosis. Incorporating matched controls, blinded interpretation, and laboratory correlation can help minimize bias and enhance diagnostic accuracy. Additionally, the potential role of Dixon imaging in follow-up evaluations warrants further exploration to determine its utility in monitoring disease progression and therapeutic response.

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Figures:

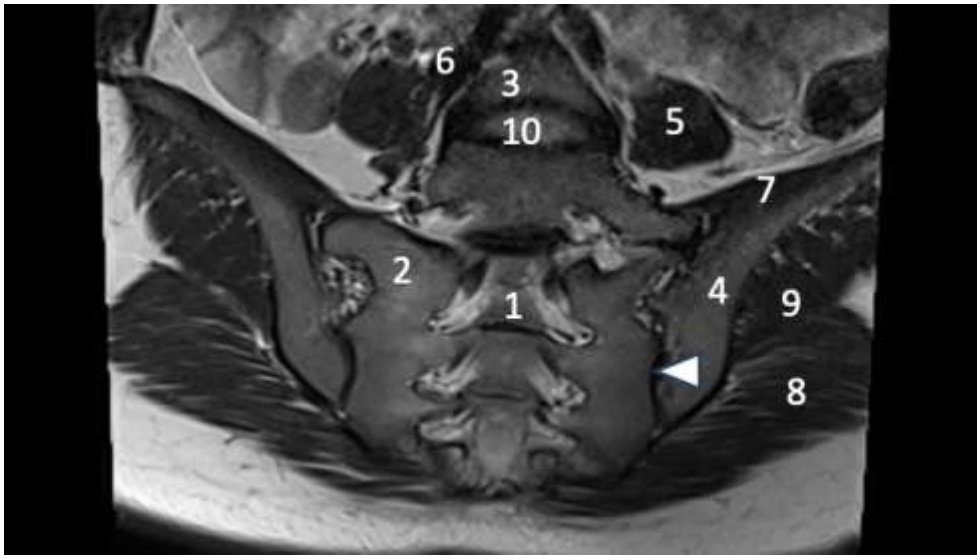

Figure 1 - Normal anatomy of sacroiliac joint on dixon imaging showing (1) sacrum With sacral elements , (2) sacral lateral mass , (3) lumbar vertebra , (4) ilium , (5) psoas muscle , (6) common iliac artery , (7) iliacus muscle , (8) gluteus maximus , (9) gluteus medius , (10) inter-vertebral disc and (arrow Head) left sacro-iliac joint

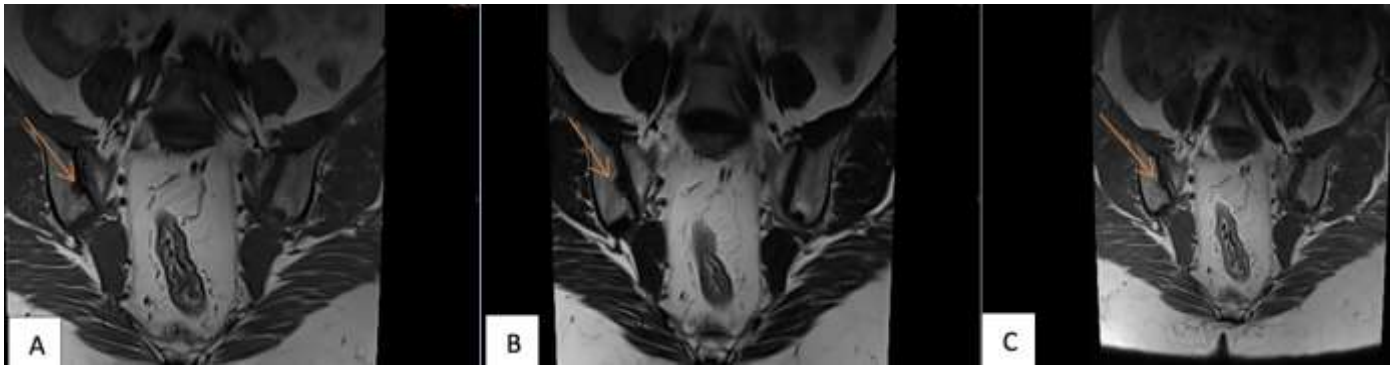

Figure 2 - MRI sacroiliac joint of a 32 year old female with complaints of morning stiffness reveal tiny globular hypointensity (orange arrows) in the right ilium bone on all the above sequences (a - T1wi, b - T2wi and c - dixon) indicative of bony sclerosis. Bony sclerosis is better identified on the conventional MR images compared to dixon.

Figure 3 - MRI sacroiliac joint of a 20 year old male patient with complaints of chronic lower back ach and morning
Stiffness reveal hyperintensity involving bilateral sacroiliac joints(left > right) denoting bone marrow edema (yellow arrow heads), which is a feature of acute sacroiliitis on dixon (water) oblique coronal
Images [a and b] and shows markedly reduced joint space (yellow arrowhead) of the left sacroiliac joint,which is a feature of chronic sacroiliitis on T1 oblique coronal images [c].

Figure 4 - MRI sacroiliac joint of a 18 year old male with backache radiating to bilateral lower limbs reveal linear high signal intensity (arrows) involving the right sacroiliac joint (predominantly ilium) indicating fatty
Infiltration of the bones, a feature seen in both active and chronic sacroiliitis. However, fatty infiltration can be appreciated better on the above dixon (fat) image [a] as compared to the T1 weighted image [b].

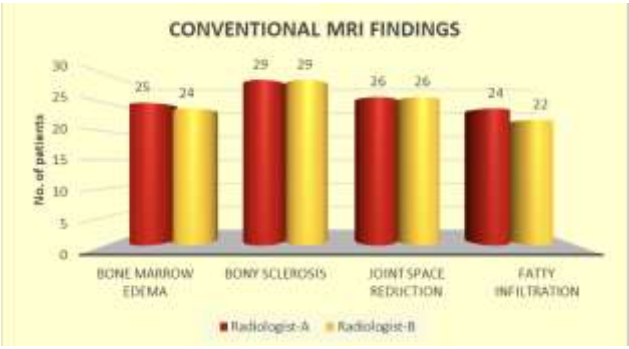

Figure 5 - Graph 1 - Conventional MRI findings

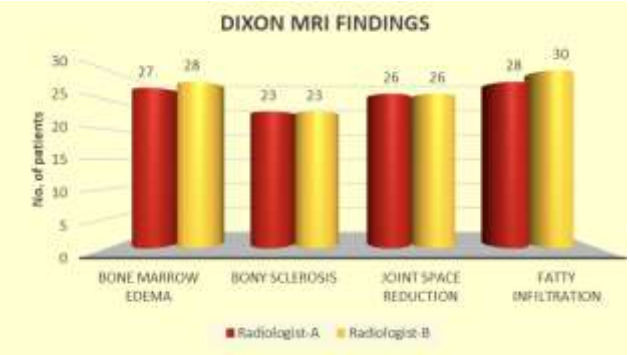

Figure 6 - Graph 2 - Dixon MRI findings

Tables:

Conventional MRI	Bone Marrow Edema	Bony Sclerosis	Joint Space Reduction	Fatty Infiltration
Radiologist-A	25	29	26	24
Radiologist-B	24	29	26	22
Agreement (%)	96.15%	100.00%	100.00%	76.92%
k value	0.96	1.00	1.00	0.76

Table 1a : Conventional MRI findings

DIXON MRI	Bone Marrow Edema	Bony Sclerosis	Joint Space Reduction	Fatty Infiltration
Radiologist-A	27	23	26	28
Radiologist-B	28	23	26	30
Agreement (%)	96.4%	100.00%	100.00%	84.62%
k value	0.96	1.00	1.00	0.84

Table 1b : Dixon MRI findings