

COMPARISON OF PLAIN X-RAY WITH MRI IN PATIENTS OF RHEUMATOID ARTHRITIS AND SERONEGATIVE ARTHRITIS

BHAGWAN YADAV, SULABH PURI*, MANOJ MATHUR

Department of Radiodiagnosis, Government Medical College and Rajindra Hospital, Patiala, Punjab, India.

*Corresponding author: Dr. Sulabh Puri; Email: dr.sulabhपुरi@gmail.com

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ABSTRACT

Objective: The aim of this study was to compare the findings of plain X-ray with magnetic resonance imaging (MRI) in patients of rheumatoid arthritis and seronegative arthritis.

Methods: A total of 35 patients who apparently fulfilled the clinical diagnostic criteria were included on the basis of serological tests for seropositive and seronegative arthritis. After fulfillment of all the inclusion and exclusion criteria, radiographic images and MRI of joints were done by various MR techniques. Findings of plain radiography and MRI in various cases were compiled and subjected to statistical analysis using IBM software SPSS v20.

Results: Twenty-one patients were diagnosed with seropositive arthritis and 14 were with seronegative arthritis. The findings showed that MRI was 100 accurate in diagnosing seropositive and seronegative arthritis while the accuracy of X-ray in detecting seropositive arthritis (in comparison to MRI) was 62.86% with sensitivity of 38.1%, specificity of 100%, positive predictive value (PPV) of 100%, and negative predictive value (NPV) of 51.85%. The accuracy of X-ray in detecting seronegative arthritis (in comparison to MRI) was 85.71% with a sensitivity of 64.29%, specificity of 100%, PPV of 100%, and NPV of 80.77%.

Conclusion: MRI of seropositive and seronegative arthritis is a highly rewarding investigation and should be undertaken in all cases where plain radiographs are positive and when there is clinical suspicion of a disease but the X-ray films are not diagnostic.

Keywords: X-ray, Magnetic resonance imaging, Seropositive, Seronegative, Arthritis.

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INTRODUCTION

Arthritis is identified as a chronic or severe inflammation of the joints that are frequently accompanied by discomfort and physical impairment [1].

Rheumatoid arthritis (RA) in this dimension is a persistent, systemic inflammatory disease marked by synovial growth and articular cartilage and bone deterioration [2]. The prevalence of RA in adults has been found to range between 0.5% and 3.8% in women and between 0.12% and 1.37% in men, with a greater prevalence in the fourth decade of life [3].

A positive test for rheumatoid factor is by no means pathognomonic of RA but is present in 70–90% of patients with the disease, as well as in 5–8% of a healthy population. Patients with a high titer of IgM-RF are more likely to have erosive joint disease, extra-articular manifestations, and greater functional disability [4].

In contrast, patients with negative rheumatoid factor in general exhibit a milder disease course. Recently, various test methods based on the principle of agglutination (Waller-Rose and Latex tests) are being applied, by which only the presence of IgM-RF is proven. The rheumatoid factor could be found in different immunoglobulin classes (G, A, D, and E) defined by enzyme-linked immunosorbent assay. The inflammation in RA causes a shift in bone metabolism toward increased osteoclast-mediated bone turnover. This dysregulation causes reduced bone mass, which is known to be an early feature in RA patients, visualized as juxta-articular bone demineralization on radiographs [4].

The diagnosis of arthritis is challenging for diagnosis of arthritis. It has been observed that plain X-ray offers high specificity in the differential diagnoses of rheumatic diseases [5]. Initial radiographic findings include bilateral and symmetric periarticular osteoporosis, early

erosions, and soft-tissue edema. Typically, where distal interphalangeal (DIP) joints are spared [6].

The radiographic hallmarks of RA are swelling of the soft-tissue, osteoporosis, narrowing of the joint spaces, and marginal erosions. The unique combination of osteoporosis, marginal erosions, and relatively minimal reactive bone formation helps distinguish RA from other inflammatory arthritis [7]. In RA, magnetic resonance imaging (MRI) permits direct observation of inflammatory soft-tissue, cartilage, and bone alterations. MRI, in this context, has the ability to evaluate both the autoimmune response and the ensuing major damage to surrounding tissue, and may thus offer quantitative information regarding the degree and activity of synovial inflammation [8].

This study thus was a prospective study on 35 patients coming to the Department of Radiodiagnosis, Rajindra Hospital, Patiala, where findings of plain X-ray radiography and MRI in various cases were compared in RA and seronegative arthritis. Few of the cases are shown in figures (Figs. 1-3) and were compared with plain X-ray radiography and MRI.

METHODS

The present, prospective, and cross-sectional study was conducted on 35 patients after the approval from the Institutional Ethical Committee. The main source of the study was patients from the Rajindra Hospital Patiala. The study included all the seropositive and seronegative arthritis patients who presented with polyarthralgia and who consented to the study. Patients with pacemakers, metallic implants, or aneurysmal clips having a history of claustrophobia or anxiety disorders exacerbated by MRI and with a history of acute trauma were excluded from the study. Depending on the radiological features a provisional diagnosis was made correlating with the clinical feature.

Patients referred to the department of radiodiagnosis with a clinical history of pain in joints (small and large joints) were subjected to conventional plain radiography and MRI evaluation with appropriate sequences with contrast administration as required. Clinical history regarding the onset of symptoms and clinical progression of the disease process was taken. Informed consent was obtained from all the subjects/guardians before.

Technique

Initially, all patients with pain in joints (small and large joints) were examined by plain radiography in the following projections:

- Posteroanterior view
- Oblique view
- Lateral view
- Additional radiographs were taken as needed.

For MRI, the following sequences were selected as required:

- MRI was performed with a 1.5-T superconducting magnet and the patients underwent imaging in a prone or supine position with the position of joints adjusted as required (FOV ranging from 80 to 150 mm with slice thickness 3–4 mm adjusted as per joint involvement). In all patients, the following imaging protocol was followed as:
 - PD transverse spin-echo in coronal, axial, and sagittal planes.
 - T1FS/PDFS/T2FS sequence in axial and sagittal planes.
 - T1-weighted axial, coronal STIR sequence.
 - T2-weighted coronal 3D sequences.
 - T2-weighted transverse spin-echo.
 - Diffusion-weighted imaging (DWI) sequences, together with T2W and STIR sequences.

3D trufi sequence was also done for joint articular cartilage imaging and post-contrast T1FS sequences were obtained in coronal, axial, and sagittal planes.

The intravenous contrast (Gadolinium in a dosage of 0.1 mmol/kg) was administered intravenously as and when necessary, based on the MRI findings, and contrast-enhanced MRI was performed on T1-weighted Coronal FSE sequence.

Study analysis

Findings of plain radiography and MRI in various cases were compiled and subjected to statistical analysis using IBM software SPSS v20. Descriptive data were presented in the form of frequency tables and mean, while categorical analysis was done using Fisher's exact test. Sensitivity and specificity data of plain X-ray versus MRI was calculated and depicted relevantly.

RESULTS

The mean age of the patients was 42.97±9.61 years. The majority of cases were females (24, 68.6%) while 11 (31.4%) patients were male.

In the serological examination, the maximum number of patients with the sum total of 21/35 (60%) of patients show RA factor positive, and 14/35 (40%) show RA factor negative values. C-reactive protein levels were found to be raised in 29 (82.9%) patients while they were in the normal range in 6 (17.1%). Erythrocyte sedimentation rate was raised in 25 (71.4%) while it was normal in 10 (28.6%) patients (Fig. 4 and Table 1).

A total of 21 patients out of 35 have seropositive arthritis while 14 patients had seronegative arthritis. Early RA was seen in 13 (37.1%) patients while late RA was seen in 8 (22.9%), ankylosing spondylitis was seen in 5 (14.3%), reactive arthritis was seen in 3 (8.6%), enteropathic arthritis, psoriatic arthritis, and systemic lupus erythematosus (SLE) were seen in 2 (5.7%), respectively (Table 2 and Fig. 5).

In seropositive RA, the X-ray showed effusion in 3 (14.30%) of patients and the majority as compared that is 20 (95.20%) picked by MRI (Table 3).

X-ray showed erosion in 16/21 (76.20%) patients in seropositive arthritis while MRI showed in 19/21 (90.50%) patients. Soft-tissue swelling was shown by 19% by X-ray while 66.70% was shown by MRI in seropositive arthritis. Osteosclerosis was shown by 28.60% by X-ray, while 47.60% cases by MRI in seropositive cases. Loss of joint space was detected in 33.30% of seropositive patients on X-ray, while 38.10% cases showed by MRI in seropositive cases. The subchondral cyst was seen in 23.60% of cases while MRI showed in 28.60% of cases. Joint subluxation was shown in 23.80% by both X-ray and MRI in seropositive patients and fusion of bone was seen by X-ray in 14.30% and on MRI in 19% in seropositive cases. X-ray for seronegative arthritis showed effusion in 28.60% of patients in comparison to 71.40% picked by MRI. X-ray showed erosion in 42.90% of cases in seronegative arthritis while MRI showed erosion in 92.90% of cases. Soft-tissue swelling was shown



Fig. 1: Reactive arthritis of hip (plain radiography findings)
Source: Image shows bilateral periarticular osteopenia (black arrows), sclerosis, joint space narrowing, and subchondral cysts. The left femoral head deformity is also seen

Table 1: Distribution of patients according to blood investigations

Blood investigation	Frequency (no. of patients)	Percentage
Ra factor		
Negative	14	40
Positive	21	60
CRP (raised)		
No	6	17.1
Yes	29	82.9
ESR (raised)		
No	10	28.6
Yes	25	71.4

CRP: C-reactive protein, ESR: Erythrocyte sedimentation rate

Table 2: Distribution of patients according to the final diagnosis

Diagnosis	Frequency	Percentage
Seropositive arthritis		
Early RA	13	37.1
Late RA	8	22.9
Seronegative arthritis		
Ankylosing spondylitis	5	14.3
Reactive arthritis	3	8.6
Enteropathic arthritis	2	5.7
Psoriatic arthritis	2	5.7
SLE	2	5.7
Total	35	100

SLE: Systemic lupus erythematosus

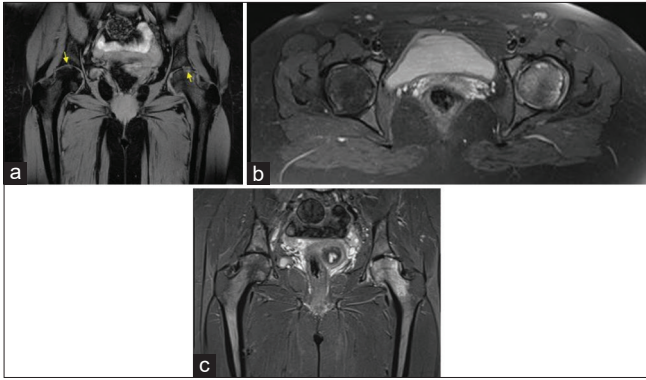


Fig. 2: Magnetic resonance imaging findings. (a) On MR T1 FSE coronal. (b) PDFS transverse. (c) T1 STIR coronal
Source: Bilateral subchondral cysts, sclerosis, subchondral erosions (yellow arrows), and synovial thickening. The left femoral head shows altered contour



Fig. 3: Early rheumatoid arthritis. (a) Plain radiography findings. (b) Magnetic resonance imaging (MRI) findings: (A) Axial T1 (left) and T1-fat-saturated post-gadolinium-enhanced (right) MRI show a focal erosion at the distal radius (arrows) (B)
Source: (a) A plain X-ray film of the hands shows no definite erosion

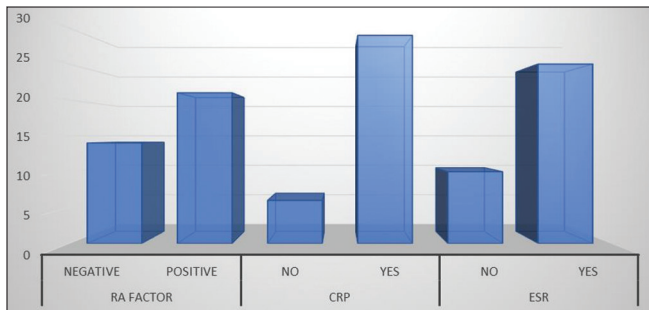


Fig. 4: Blood investigations

in 28.60% of cases by X-ray while 57.10% of cases showed by MRI in seronegative arthritis. Osteosclerosis was shown by 57.10% of cases by X-ray while 71.40% of cases were shown by MRI in seronegative arthritis. Loss of joint space was detected in 42.90% of cases while 50% of cases showed by MRI in seronegative arthritis. The subchondral cyst was shown by 21.40% of cases and MRI showed subchondral cyst in 35.70% cases in seronegative patients and joint subluxation was seen

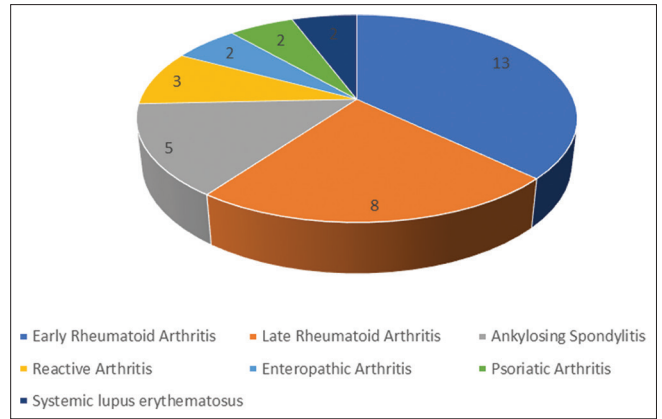


Fig. 5: Distribution of patients according to final diagnosis

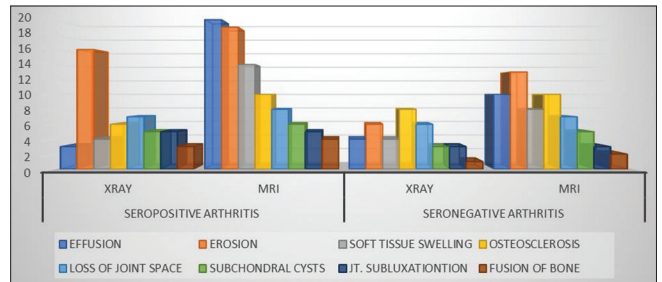


Fig. 6: Comparison between X-ray and magnetic resource imaging in detecting seropositive and negative findings

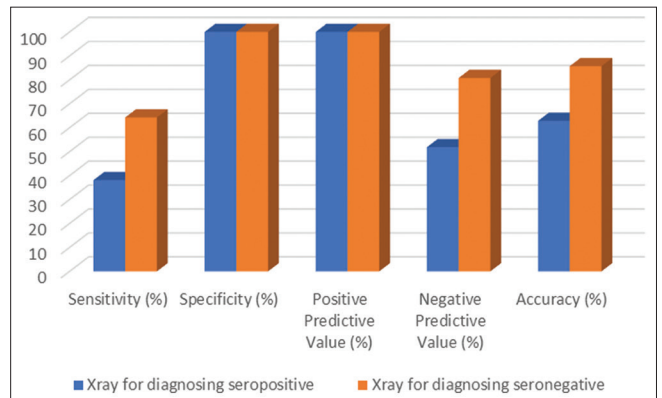


Fig. 7: Predictive value of X-ray for seronegative and seropositive arthritis in comparison to magnetic resource imaging

by both X-ray and MRI in 21.40% of cases. Fusion of bone was seen in 7.10% of cases while MRI showed 14.30% of cases in seronegative arthritis (Table 2 and Fig. 6).

(Table 4) and (Fig. 7) shows that on comparing MRI and X-ray, we observed that: X-ray shows equivalent accuracy (100%), compared to MRI for Joint subluxation and X-ray showed 94.29% accuracy for Loss of joint space, with a sensitivity of 100%, specificity of 90.91%, positive predictive value (PPV) of 86.67%, negative predictive value (NPV) of 100%. For soft-tissue swelling, X-ray showed an accuracy of 60% as compare to MRI, with a sensitivity of 100%, specificity of 48.15%, PPV of 36.36%, and NPV of 100% as there were 8 true positive, 0 false positive, 13 true negative, and 14 false negatives. The accuracy of X-ray for subchondral cyst was 97.14% with sensitivity of 90.91%, specificity of 100%, PPV of 100%, and NPV of 96%. The accuracy of X-ray with respect to MRI for osteosclerosis was 82.86% with sensitivity of 70%, specificity of 100%, PPV of 100%, and NPV of

71.43%. The accuracy of X-ray with respect to MRI for Erosion of bone was 71.43% with sensitivity of 68.75%, specificity of 100%, PPV of 100%, and NPV of 23.08%. For fusion of bone, accuracy of X-ray with respect to MRI was 94.29% with sensitivity of 66.67%, specificity of 100%, PPV of 100%, and NPV of 93.55%. For effusion, the accuracy of X-ray with respect to MRI was 28.57% with sensitivity of 20%, specificity of 80%, PPV of 85.71%, and NPV of 14.29%.

The accuracy of X-ray in detecting seropositive arthritis (in comparison to MRI) was 62.86% with sensitivity of 38.1%, specificity of 100%, PPV of 100%, and NPV of 51.85%. The accuracy of X-ray in detecting seronegative arthritis (in comparison to MRI) was 85.71% with sensitivity of 64.29%, specificity of 100%, PPV of 100%, and NPV of 80.77%.

DISCUSSION

Serological status is of paramount importance for the diagnosis, prognosis, and treatment of RA [9] which in this study was classified as seropositive or seronegative (blood RA factor positive and negative, respectively). Seronegative RA (SnRA) is a condition that is not well understood and difficult to confirm by a conventional diagnostic process, with high probabilities of its being confused with other inflammatory arthropathies [10,11] which requires consultation with an expert rheumatologist. Misdiagnosis of SnRA could be more frequent in patients in whom presumptive SnRA is negative for RF, but still positive in clinical domains.

Table 3: The comparison between X-ray and MRI findings with respect to the diagnosis of seropositive and seronegative arthritis

Findings	Seropositive arthritis				Seronegative arthritis			
	X-ray		MRI		X-ray		MRI	
	N	%	N	%	N	%	N	%
Effusion	3	14.30	20	95.20	4	28.60	10	71.40
Erosion	16	76.20	19	90.50	6	42.90	13	92.90
Soft-tissue swelling	4	19.00	14	66.70	4	28.60	8	57.10
Osteosclerosis	6	28.60	10	47.60	8	57.10	10	71.40
Loss of joint space	7	33.30	8	38.10	6	42.90	7	50.00
Subchondral cyst	5	23.80	6	28.60	3	21.40	3	21.40
JT. subluxation	5	23.80	5	23.80	3	21.40	2	14.30
Fusion of bone	3	14.30	4	19.00	1	7.10		

MRI: Magnetic resource imaging

In the present study, we found that total seropositive cases were 21 (60%) while seronegative cases were 14 (40%) (Table 5). MRI was able to detect all the cases correctly while X-ray was not able to predict all the cases correctly.

Patients with clinical features of RA, but negative rheumatoid factor present a diagnostic challenge. It has recently been suggested that a subpopulation of patients with RA, diagnosed on clinical, radiological, and pragmatic grounds, but with negative rheumatoid factor tests, represents a clinical entity quite distinct from that of seropositive RA [12]. The nature of the destructive process, as defined by radiological examination, may be different in patients with seropositive RA from that seen in individuals with so-called 'SnRA' [13]. This explains lower accuracy measures for X-ray. El-Khoury *et al.* [14] confirmed that radiograms of seronegative patients differ significantly from radiograms of seropositive patients concerning the lower rate of juxta-articular osteoporosis, relative lack of subchondral erosion, predominance of changes across the carpal part, greater number of contractures, and the asymmetry of the attacked joint.

In the present study, "erosion" was the most common finding among seropositive patients that was visible on X-ray and seen in 76.2% of patients, while among seronegative patients, osteosclerosis was the most common and erosion was seen in only 42.9% of patients. Least number of patients on X-ray presented with the fusion of bone in seropositive arthritis (14.3%) and seronegative arthritis (7.1%). To this perception contributes the study of Krahe *et al.* [15], which confirms that the extent of periarticular destruction was significantly greater amongst seropositive than seronegative patients, both at the beginning and the end of the study, but there was no significant difference in the rate at which this progressed.

In the present study on MRI findings, out of 30/35 patients with effusion, 20/21(95.2%) were seropositive while 10/14 (71.4%) were seronegative. Of 32/35 cases with erosion, 19/21 (90.5%) were seropositive while 13/14 (92.9%) were seronegative. Of 20/35 cases of osteosclerosis, 10/21 (47.6%) cases had seropositive arthritis while 10 (71.4%) had seronegative arthritis. Loss of joint space was seen in 15/35 patients of which 8 (38.1%) were seropositive while 7 (50%) were seronegative. Soft-tissue swelling was seen in 22/35 patients of which 14/21 (66.7%) were seropositive while 8/22 (57.1%) were seronegative. Of eight patients with subluxation, 5/21(23.8%) had seropositive arthritis while 3 (21.4%) were seronegative. The subchondral cyst was seen in total of 11/35 cases of which, 6/21(28.6%) and 5/14 (35.7%) were seropositive and seronegative patients, respectively.

In a study conducted by Gadeholt *et al.*, a total of 57 seropositive and 56 seronegative patients were examined. Seropositive patients had more erosions and joint space narrowing. Erosion load differed

Table 4: Predictive values for various parameters studies

Findings	True positive	False positive	True negative	False-negative	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
JT. subluxation	8	0	27	0	100	100	100	100	100
Subcondral cyst	9	0	24	1	90.9	100	100	96	97.14
Loss of joint space	13	0	20	2	100	90.91	86.67	100	94.29
Fusion of bone	4	0	29	2	66.7	100	100	93.55	94.29
Osteoscle	14	0	15	6	70	100	100	71.43	82.86
Erosion	22	0	3	10	68.8	100	100	23.08	71.43
Soft-tissue swelling	8	0	13	14	100	48.15	36.36	100	60
Effusion	6	1	4	24	20	80	85.71	14.29	28.57

PPV: Positive predictive value, NPV: Negative predictive value

Table 5: Predictive value of X-ray for seronegative and seropositive arthritis in comparison to MRI

X-ray	True positive	False positive	True negative	False-negative	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Seropositive	8	0	14	13	38.1	100	100	51.85	62.86
Seronegative	9	0	21	5	64.29	100	100	80.77	85.71

MRI: Magnetic resource imaging, PPV: Positive predictive value, NPV: Negative predictive value

significantly between seropositive and seronegative patients in the foot and metacarpophalangeal joint, but not in the wrist or proximal interphalangeal joint compartments. Intracompartmental differences were greater in seropositive patients. Carpal fusion did not differ between the groups. The qualitative comparison showed that seronegative patients displayed periarticular ossifications, carpal shortening, and sparing of the CMC joints, whereas seropositive patients had more CMC damage and less shortening [16].

Paalanen *et al.* in their study showed that long-term follow-up of seronegative patients can reveal the differences in their outcome and clarify the true nature of the disease. They observed that patients with SnRA did not develop rheumatoid-like erosions, or the extent of radiographic scores was minimal compared to the group of seropositive patients over an observation period of up to 15–20 years [17].

The findings by Moreno *et al.* revealed that X-ray assessment showed that 12/369 (3.3%) patients had bone erosion consistent with a diagnosis of SnRA. About 19% were positive for OA changes (asymmetric joint-space narrowing, osteophyte formation, and subchondral sclerosis), while the remaining 273/369 (62.3%) evidenced no joint abnormalities on normal X-ray. In the present study, however, we found no clear variation of erosion with that of serum positivity (50% of patients with erosions were RA positive while 50% were negative) [18].

Bone marrow edema, synovitis, and tendonitis/tenosynovitis were also taken into account, which showed that MRI was even more predictive of subsequent radiographic erosion. In a study by McQueen *et al.*, it offered sensitivity and specificity values of 80% and 76%, respectively, and a negative predictive value of 86% [19].

Limitation

1. Our study had a small sample size. Larger sample will produce better results.
2. Hospital-based non-probability design limits generalizability.
3. Variable duration of illness before a presentation may have impacted the results of this study.

CONCLUSION

Plain radiographs are the initial imaging modality to evaluate the pathologies affecting the joints while MRI study, due to its cost factor, is usually undertaken only to evaluate the cartilage, synovium, and soft-tissue pathologies which cannot be examined directly on X-ray films or when the plain radiographs show equivocal/suspicious findings.

The plain radiograph films in our study showed only non-specific findings in a considerable proportion of cases leaving room for proper and timely evaluation by MRI to reach a proper diagnosis. MRI was superior to plain radiography in evaluating pathologies where fibrocartilage, synovium, and soft-tissue parts were affected and the plain films were negative. Even in the initial phases of many diseases like early RA and SLE where picking up subtle erosion, effusion, synovial thickening, and bone edema changes are key to early diagnosis, MRI was found to be the radiological investigation of choice.

In a nutshell, MRI of seropositive and seronegative arthritis is a highly rewarding investigation and should be undertaken in all cases where plain radiographs are positive and also when there is clinical suspicion of a disease but the X-ray films are not diagnostic.

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PATIENT CONSENT

Patient consent statement has been taken for publishing this article.

CONFLICTS OF INTERESTS

The authors declared no conflicts of interest.

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