

ROLE OF ULTRASOUND AND COLOUR DOPPLER IN SACROILIITIS AND CORRELATION WITH AGE MATCHED POPULATION

Rakhee Kumar Paruchuri¹, Shailesh Kumar Padmini², Liza Rajasekhar³

¹Associate Professor, Department of Radiology, School of Medical Science and Research, Sharda University, Greater NOIDA, Uttar Pradesh.

²Consultant Radiologist, Sahyog Imaging Center, Surat, Gujarat.

³Professor and HOD, Department of Rheumatology, Nizam's Institute of Medical Sciences, Hyderabad, Telangana.

ABSTRACT

BACKGROUND

Sacroiliitis is an important feature of several spondyloarthropathies. While findings on conventional radiographs are delayed, the cost and availability of MRI are still important negative factors.

The objectives of the study were- 1) to evaluate the role of ultrasound and colour doppler (CD) in the detection of sacroiliitis and 2) to compare these findings with those of normal age matched population.

MATERIALS AND METHODS

In this prospective study, bilateral sacroiliac joints of 25 patients with suspected sacroiliitis were studied. Radiographs were taken for all patients. MRI was performed for patients with normal or unilateral disease on radiographs. USG and CD were performed for bilateral SI joints. Presence of fluid, echogenic joint space, hypervascularity and low-resistance flow (<0.7) were considered as USG features of sacroiliitis.

RESULTS

The mean age of the test population was 30.84 years with 76% males, compared to a mean age of 31 years and 81% males in control group. The most common presenting complaint was low back ache with a mean duration of 2.997 years (S.D. 2.17). On grey scale, the width of the diseased SI joint was statistically wider than the control group with fluid seen in 44% of 50 joints evaluated. 88% of the 50 joints were hyperechoic. On CDUS vascularity was identified in 68% with RI values of ≥ 0.4 to <0.7 in 70% of joints. In the control group, vascularity (at least 2 foci) was identified in 32% joints. However, none showed RI values of <0.7.

CONCLUSION

Features of inflammation within and around the sacroiliac joints on grey scale were identified as joint widening, increased echogenicity with fluid and on CD as low resistance vascularity patterns. Radiographically negative but MRI positive cases also showed positive CDUS findings, suggesting increased sensitivity. Thus, USG with CD of the sacroiliac joints can prove to be an adjunct to the clinical examination and may be used as an alternative to MRI, when it is not available or feasible.

KEYWORDS

Sacroiliitis, colour doppler, ankylosing spondylitis.

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BACKGROUND

In humans, the sacrum supports the spine and is supported in turn by an ilium on each side. As the age progresses, changes are seen in the sacroiliac joint which are accompanied by an overgrowth of bone in the form of osteophytes, narrowing of the joint space, sclerosis or hardening of bone at the joint surface and deformity in joint.¹

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Corresponding Author:

Dr. Rakhee Kumar Paruchuri,
#J-508, 'Rajapushpa Atria', Kokapet,
Hyderabad – 500075, Telangana.
E-mail: rakheekumar@gmail.com
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Sacroiliitis is the inflammation of the sacroiliac joints and can be the manifestation / component of a wide range of diseases. It is a key and often presenting symptom in all spondyloarthropathies, with nearly a 100% occurrence in ankylosing spondylitis (AS).^{2,3} It is also an important feature in other spondyloarthropathies like psoriatic arthritis, reactive arthritis, enteropathic arthritis, and undifferentiated spondyloarthropathies.^{4,6} Sacroiliac joints may also be involved in gout, rheumatoid arthritis, pyogenic arthritis and Reiter's syndrome.^{7,8} It may be unilateral or bilateral, symmetrical or asymmetrical, which often gives a clue to the diagnosis.

The symptoms vary, with patients often presenting with inflammatory low back pain (LBP) not relieved on rest or alternating or unilateral buttock pain, to name a few. Several clinical tests like Compression test, Distraction test or

Patrick's sign may be performed to elicit the patient's pain. Several laboratory tests like HLA B 27, ESR, C reactive protein, Alkaline Phosphatase, Creatine Kinase may also help diagnose the condition.

Imaging plays an important role in the diagnostic evaluation of sacroiliitis with the choice of the imaging technique used based upon the disease duration, suspicion for inflammatory activity or infectious disease, and the patient's age. Most commonly a conventional radiograph is performed as the first investigation in patients presenting with a suspicion of sacroiliitis after evaluation of clinical and laboratory findings. The unequivocal presence of sacroiliitis on conventional radiographs in a patient with inflammatory back pain is sufficient to establish the diagnosis.⁹ However, if the radiographic findings are negative, additional imaging is performed for further confirmation.¹⁰ It should be noted that findings on conventional radiology are visible almost 3-7 years after the onset of symptoms, by which time chronic stage has already set in.^{11,12,13} On the basis of Modified New York Criteria, bilateral findings corresponding to grade 2 or unilateral findings corresponding to grade 3 or higher must be detected to diagnose sacroiliitis radiographically.^{3,14,15}

Conventional radiology has also been shown to be difficult to assess with low inter and intra-observer correlation and inability to identify active inflammation.¹⁶⁻²¹

Computed Tomography (CT) is more sensitive than conventional radiography in the assessment of the structural damage of sacroiliitis with reduced interobserver variability.²²⁻²⁵ The obvious drawbacks are the radiation exposure and the inability to assess active inflammation. It is thus not routinely performed to evaluate sacroiliitis.

Magnetic Resonance imaging (MRI) is now one of the primary tools used to evaluate sacroiliitis associated with spondyloarthropathy, especially when radiographs are negative. It allows the assessment of acute inflammatory changes which can be identified in the cartilage, subchondral bone, ligaments, synovium and capsular regions, of which bone marrow edema is the first to appear.^{24,26,27} Unlike CT, no radiation exposure is involved but it has several drawbacks like incompatibility with ferromagnetic implants and cardiac pacemakers, claustrophobia and cost. The new Assessment of Spondylo Arthritis international Society (ASAS) criteria, now includes MRI findings.

So far, ultrasound (USG) has mainly been utilized for guided interventions in the sacroiliac joints. Very few studies have been done till date to evaluate the role of ultrasound and colour Doppler in diagnosis of sacroiliitis, most of which have shown positive results in identifying disease activity.

On grey scale US (GSUS) joint space widening, fluid around and within the joint and ligament thickening are indicators suggesting sacroiliitis. Studies have shown that colour Doppler (CD) evaluation in healthy SI joints, may infrequently reveals vessels within the sacroiliac joints with high RI values. At the same time, patients with active sacroiliitis, vessels are frequently visualized in the SI joints with low mean RI values on CD evaluation, correlating with active inflammation in any anatomical region.^{28,29} These findings indicate that duplex and colour doppler sonography

may be another technique which can be used to evaluate sacroiliitis. Thus the role of ultrasound (both grey scale and colour doppler) needs to be further evaluated. Its low cost and easy availability are its other merits.

Thus the aims and objectives of this study were to (i) detect and characterize inflammatory changes in the SI joints in inflammatory low back pain; (ii) to compare these findings with a normal age matched population and (iii) to compare these findings with other radiographic methods.

MATERIALS AND METHODS

This was a prospective study conducted in our institute with prior approval from the ethics committee. 25 consecutive cases referred from department of rheumatology with suspected active sacroiliitis, were included in the study. Bilateral sacroiliac joints were evaluated after obtaining written informed consent, recording of clinical and biochemical data. Standard proformas were used for individual cases to record the data. 25 age matched healthy volunteers served as our control group and underwent USG for both SI joints as well. All patients were above 18 years of age. Radiographs (Modified Ferguson's view) and ultrasound with color doppler was performed for all patients. MRI was performed for patients with normal or unilateral disease on radiographs.

Inclusion Criteria

- Suspected cases of active sacroiliitis.
- For normal age matched population group, persons with no significant past or present history of arthropathy or other connective tissue disease or any LBP were included.

Exclusion Criteria

- Known case of sacroiliitis already on treatment.
- For age matched population
 - Patient with synchronous diseases
 - Previous history of arthropathies
 - Person with h/o LBP.

Sonography of bilateral SI joints was performed on My Lab 60 USG machine (Esaote, Genoa, Italy) with 7–10 MHz linear probe. The patient was placed in prone position. The spinous process of the fifth lumbar vertebra was identified in the midline with transducer in transverse position. The probe was first moved caudally to identify the sacral hiatus; then it was moved laterally to identify the lateral edge of the sacrum which was then followed cranially, while maintaining the transverse orientation of the probe to identify the ilium. The hypoechoic cleft between the lateral sacral margin and ilium represents the SI joint, which was then scanned in a cranio-caudal direction in both the transverse and oblique sagittal planes. The procedure was performed for both sides.³⁰ The studies were performed by two radiologists having experience of 11 and 3 years, who were blinded to the clinical and radiography findings. In case of any contention, the findings were discussed to arrive at a mutual consent.

For each subject the following parameters were recorded: 1) width of SI joint (width was measured at the posterior aspect in the midline of the joint)³¹ 2) echogenicity of the joint space 3) presence or absence of fluid on B-mode USG 4) presence or absence of color on CDUS and 5) the resistive index (RI) of vessels identified was measured. The joint space was considered to be hyperechoic when its echogenicity was greater than the normal joint space. For CDUS, standardized machine settings were used with colour box restricted to the area of the SI joints, pulse repetition frequency of 0.7- 1 kHz, a velocity scale of 3.2 cm/s and a Doppler angle ≤ 60 degree. Vascular flow voids within and around the SI joint were included. On CDUS, the area with the highest number of flow signals was selected in each SI joint and their number were counted. The RI of any visible flow signal was measured by spectral wave analysis.

Presence of fluid, echogenic joint space, hypervascularity, and low-resistance flow were considered to be USG features of sacroiliitis.

Statistical Analysis

Descriptive statistical analysis was carried out in the study. Results on continuous measurements was stated as Mean \pm SD (Min-Max) and results on categorical measurements was presented in number (%). Chi square test / Fisher Exact test was used to find the significance of association of HRUS findings with the final diagnosis. Significance was assessed at 5 %. Statistics such as sensitivity, specificity were used to correlate the HRUS findings with the final diagnosis. Charts and tables were prepared for representation and comparison of data.

RESULTS

The various causes for sacroiliitis that were identified in our study were ankylosing spondylitis, rheumatoid arthropathy, tubercular infection and undifferentiated sacroiliitis.

The patients in our study had ages ranging from 20 to 57 years with a mean of 30.84 years and maximum number of patients belonging in the 3rd - 4th decade (88%). Of the 25 patients, 19 (76%) were male and 6 (34%) were female. Among the control population, 20 (81.3%) were males and 5 (18.7%) were females with a mean of 31 years.

The most common presenting pain was low back ache, identified in 92% of our patients (n=23). Two patients also complained of fever. Peripheral arthritis was present in 14 patients (58.62%), enthesitis in 6 patients (27.6 %) and a history of uveitis and dactylitis in 1 patient each (3.448%). A positive family history was found in 2 patients (10.34%). HLA-B27 was positive in 15 patients (62.1 %) among the sample population. The ESR was elevated in 15 individuals (62.069%). The mean duration of clinical disease at the time of detection was 2.997 years (S.D. 2.17).

In our study, all 25 patients had radiographs, of which 20 patients (80%) were positive and 5 patients (20%) were negative for evidence of sacroiliitis. Of the 20 positive patients, 15 had bilateral, while 5 had unilateral sacroiliitis. According to modified NY Criteria, of the bilateral group 9 patients had grade I disease, while 6 had Grade II. Of the

unilateral group 2 patients had grade III disease and 3 patients had Grade I.

MRI evaluation was performed for patients who were either radiographically negative or had evidence of unilateral disease on radiographs (n=10). Out of these 10 patients, 2 patients showed marrow oedema on both sides, 5 patients showed unilateral involvement, while 3 were normal studies.

GSUS Findings

Average width of right SI in disease population was 2.2 mm (SD 0.6) on right, and 2.3 mm (SD 0.7) on left. These were significantly different ($P < 0.001$) from the control group which showed SI joint width measuring 1.6 mm (SD 0.1) (1.3, 1.9) on the right and 1.7 mm (0.2) (1.4, 2) on the left.

Of the 50 joints evaluated, fluid was seen in 22 joints (44%) of which 6 patients had fluid bilaterally, while 9 had unilateral fluid 9 (Image 1). No fluid was noted within or around the SI joints in 20 joints (n=10 (40%) patients). No SI joint fluid was identified in the control population.

42 of the 50 joints were hyperechoic (84%), of which 18 patients were bilateral (72%) and 3 were unilateral (12%), (1 on right and 2 on left). 3 patients showed normal echogenicity of the joint, while 1 joint was hypoechoic. None of control joints showed increased echogenicity within the joints.

CDUS Findings

Vascularity (at least 2 color foci) were identified in 17 patients (68%) bilaterally, 5 patients unilaterally (20%) (3 on right and 2 on left). No vascularity was identified in 3 patients (12%).

Vascularity within and around the SI joint was observed in 78% (n=39) of the 50 joints evaluated. Rest 22% (n=11) SI joints did not show any vascularity. 70% of joints showed RI values of ≥ 0.4 to < 0.7 (n=35) while only 8% of joints showed RI values of < 0.4 . The largest group RI values had a standard deviation of 0.057 and a mean RI value of 0.54.

In the control group, vascularity (at least 2 foci) were identified in 16 joints (32%). However, none of these showed RI values of < 0.7 .

Captions for Images

Case 1

29 year/ Female with c/o low backache and positive HLA B 27, x ray showing bilateral sacroiliitis on radiographs (a). On gray scale ultrasound imaging (b, c), fluid is identified around bilateral SIJ's. Also note the bilateral femoral head avascular necrosis on the radiographs (a).



Figure 1a. X-Ray

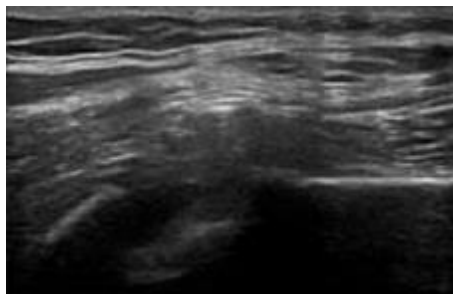


Figure 1b. USG2

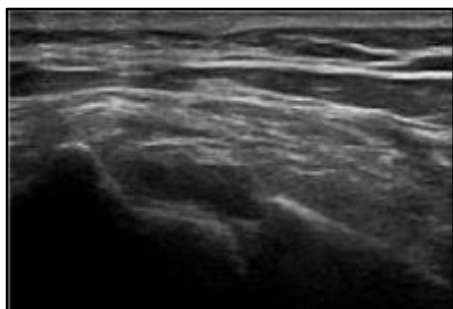


Figure 1c. USG

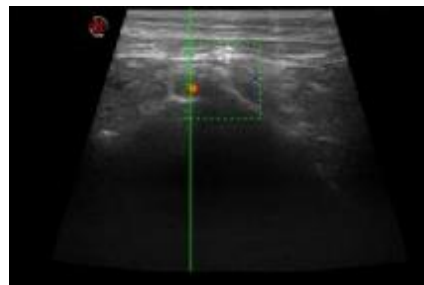


Figure 2c. DOP. 1

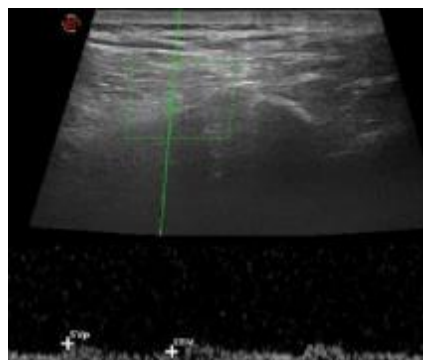


Figure 2d. DOP

Case 2

26 year / Male with c/o backache. Radiographs (a) were normal. MRI (b) showing bilateral sacroiliac marrow edema and CDUS (c, d) shows increase vascularity and RI value less than < 0.4 on either side, representing disease activity.



Figure 2a. X-Ray

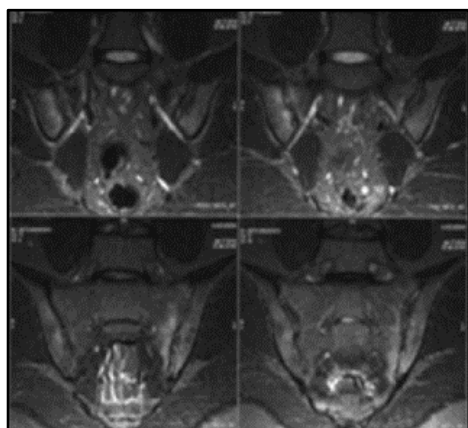


Figure 2b. MRI

Case 3

31-year old Male with c/o backache showing no marrow oedema on MRI (a). On CDUS (b) no vascularity noted within and around SI joint.

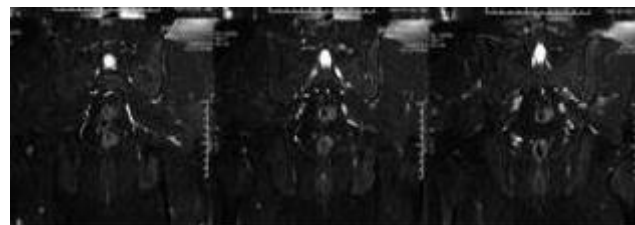


Figure 3a. MRI Negative



Figure 3b. MRI Negative

Case 4

26 year/female patient, C/o pain and low-grade fever since 1 month. (a, b) MRI showing fluid and altered marrow signal in right SI joint with adjacent collection. (c, d) USG revealed collection and low resistance vascularity around SI joint. Patient was diagnosed as infective unilateral right sacroiliitis. US guided aspiration reveals tubercular organism.

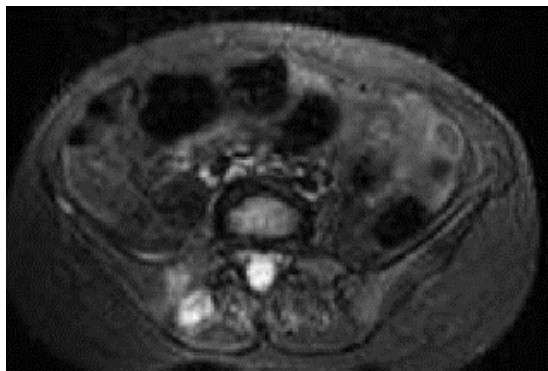


Figure 4a. MRI. Kochs

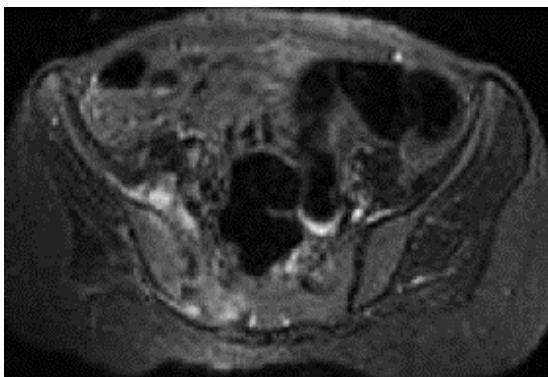


Figure 4b. MRI. Kochs

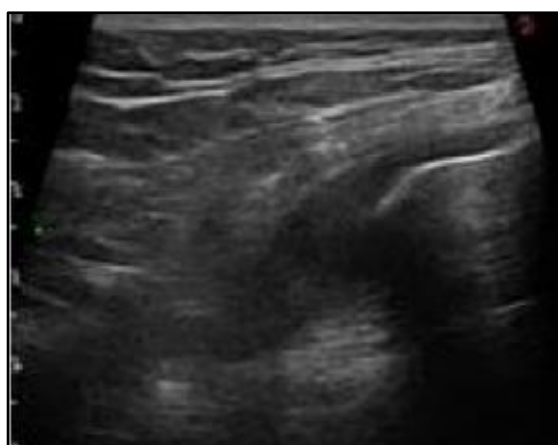


Figure 4c. USG. Kochs



Figure 4d. CD. Kochs

DISCUSSION

Pathological studies have shown that destructive synovitis and myxoid subchondral bone marrow oedema are the earliest changes identified in the sacroiliac joints in AS, with the salient features of inflammation being neovascularization, inflammatory infiltrates and intra articular fluid collections.^{32,33,34} These are identified as subtle joint irregularity, erosions and pseudo-widening on radiographs. The neovascularization may be represented as hyperaemia, identified as flow signals on CDUS.³⁵

Our descriptive study revealed widened joint spaces in the diseased population compared to the control group (1.6 vs 2.2 mm) which was similar to the findings by Bandinelli et al.³⁶ Echogenicity of the joint did not correlate with fluid within the joint space as only 50% of the 42 joints showing hyperechogenicity were accompanied by fluid within the joint space. Hence it may represent capsular thickness.

The RI is a numerical value of the amount of diastolic flow and is directly proportional to the peripheral vascular resistance.³⁵ Low RI values suggest low-resistance flow, indicating inflammation.^{37,38} In our study CDUS in sacroiliitis at least 2 foci were identified in 39 joints with 70% showing RI values between 0.4 and 0.7. These correlated well with both radiographs and MRI proven sacroiliitis. In fact, two radiographically negative but MRI positive cases for sacroiliitis showed vascularity on CDUS, suggesting the positive role in diagnosis of sacroiliitis in radiographically negative cases (Image 2, 3). This was in concordance to study done by Ghosh et al.³⁰ However, in our study RI values between the range of 0.4 – 0.7 were utilized, while they used RI values <0.605 as the cutoff for diagnosis of sacroiliitis. While the majority of patient (48%) showed at least 4 vascular foci, we set the lower limit at 2 foci as they formed 10% of the cases showing vascularity compared to those showing 5 foci (4%). Ghosh et al had used the cut off at >3 vascular foci.

Two cases were clinically and radiographically diagnosed as tubercular sacroiliitis (Image 4). Both these patients showed unilateral disease with significant fluid on ultrasound with one patient showing low level echoes within the collection and markedly increased vascularity (5 foci of color), giving clue to an infective etiology.

Our study was in concordance with study done by Arslan et al who evaluated the vascularity around the SI joint in patients of sacroiliitis and compared them to those of healthy volunteers and patients with OA and found that they had much lower RI values compared to the control group.³¹

Although we did not follow up our patients post treatment, Unlu et al demonstrated a significant change in the RI values around the sacroiliac joints post anti-TNF therapy.³⁹

Klauser et al. demonstrated unenhanced CDUS to have only a 17% sensitivity for assessing the vascularity of the SI joint compared to 94% sensitivity of contrast enhanced CDUS.⁴⁰ This low sensitivity on unenhanced CDUS may have been secondary to the fact that only vessels within the SI joints were considered in their study. However, we included vessels around and within the SI joints as Gosh et al had

suggested that vessels contributing to the inflammatory process are within the subchondral regions of both sacrum and iliac bones. Unlike, Klauser et al and Ghosh et al, we however considered 2 or more flow signals as abnormal, to increase the sensitivity of our study.

CONCLUSION

Changes in and around the sacroiliac joints like joint widening with fluid on grey scale ultrasound and increased vascularity showing low resistance wave form patterns on color doppler were noted in sacroiliitis but not in the control population. Radiographically negative but MRI positive cases also showed positive CDUS findings, suggesting increased sensitivity.

The drawbacks of our study were- Small sample size. More number of subjects could have made the statistical analysis more accurate. Role of ultrasound is very limited in obese patient in whom penetration is very poor. USG and CDUS are observer dependent and can be inter observer variable. A learning curve is associated since USG of the SI joints as it is not routinely performed.

Thus, to conclude, USG with colour doppler of the sacroiliac joints can prove to be an adjunct to the clinical examination and may be used as an alternative to MRI, when it is not available or feasible.

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