COMPARISON OF IMAGING TECHNIQUES IN THE EARLY DIAGNOSIS OF SACROILIITIS*

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SUMMARY

Sacroiliitis is usually the first and main feature of seronegative spondyloarthropathies. But the sacroiliac joints present a problem to the diagnostician because of their deep seated location and lack of motion. This forces us to rely heavily on imaging modalities to diagnose diseases of this joint. Therefore, many imaging techniques such as computed tomography (CT); single photon emission computed tomography (SPECT) bone scanning, and magnetic resonance imaging (MRI) have been studied. In our study MRI was performed in 48 patients with clinical evidence of sacroiliitis. MRI findings were compared with those at CT and SPECT. Of these patients 35 had abnormal CT seans (73%), 36 had abnormal SPECT seans (75%), and 44 had abnormal MRI scans(91,6%). We concluded that MR imaging provide the best objective and complementary evidence of sacroiliitis in patients with clinical features of inflammatory spinal disease.

***Key w**ords:* Sacroiliitis, computed tomography, single photon emission computed tomography, magnetic resonance imaging

ÖZET

SAKROİLİİTİSİN ERKEN TANISINDA GÖRÜNTÜLEME YÖNTEMLERİNİN KARŞILAŞTIRILMASI

Seronegatif spondiloartropatilerin başlıca ilk görüntüsü genellikle sakroiliitistir. Fakat sakroiliak eklemlerin derin lokalizasyonları ve az hareketli oluşları, tanı açısından bir problem oluşmasına neden olmaktadır. Bu zorluklar, bu eklem hastalıklarının tanısı için görüntüleme teknikleri üzerinde yoğunlaşılmasına neden olmuştur. Bu nedenle bilgisayarlı tomografi(BT), tek foton bilgisayarlı tomografi (SPECT) ve manyetik rezonans görüntüleme(MRG) gibi çeşitli görüntüleme teknikleri üzerinde çalışılmıştır. Bizim çalışmamızda, sakroiliitisin klinik bulgularına sahip 48 hastada MRG çekildi. MRG bulguları, BT ve SPECT sonuçlarıyla karşılaştırıldı. Bu hastaların 35(%73)'inde anormal BT, 36(%75)'sında anormal SPECT ve 44(%91,6)'ünde anormal MRG görüntüleri mevcuttu. MR görüntüleme yönteminin, inflamatuvar spinal hastalığın klinik bulguları olan hastalarda, sakroiliitisin tanısında en objektif ve tanımlayıcı kanıtlar sağladığı sonucuna vardık.

Anahtar Kelimeler: Sakroiliitis, Bilgisayarlı tomografi, tek foton bilgisayarlı tomografi, manyetik rezonans görüntüleme

Sacroiliitis is an important component of spondyloarthropathies, vvhich include ankylosing spondylitis, psoriatic arthritis, and Reiter syndrome (1). The clinical diagnosis of early sacroiliitis is often difficult because of deep location and lack of motion. The symptoms of sacroiliitis may be indistinguishable from mechanical causes of low back pain (2). Also, physical findings are frequently obscured by the overlying soft tissues. For these features radiographic abnormalities are regarded as the most reliable objeetive indicator of inflammatory spondyloarthropathies. Several imaging techniques such as conventional radiography, scintigraphy, computed tomography

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(CT), and magnetic resonans imaging (MRI) have been used to examine the sacroiliac (SI) joint (3,4,5,6). Particularly, the demonstration of alteration in joint width, subchondral sclerosis, and bony erosions within one or both SI joints on conventional radiography has become cornerstone in diagnosis of inflammatory spondyloarthropathies (7). However, interpretation of conventional radiography may be difficult due to the anatomic complexity of the SI joints (8) and changes may not become apparent for up to nine years after the onset of symptoms (9). Therefore other imaging techniques have been studied (5). Of these, CT scanning reveals more bony changes such as cortical erosions and subchondral sclerosis especially in early disease (10). However CT imaging requires a large radiation dose (15-20 mGy per examination) to a group of patients who are usually young (11). In addition CT may not be accurate in assessing early sacroiliitis before the manifestation of erosions and other overt changes or in evaluating disease activity in cases with advanced sacroiliitis. The role of bone scintigraphy in evaluation of sacroiliitis is controversial. The disparity in opinion on the clinical utility of bone scintigraphy may due in part to technical problems associated with increased accumulation of radiopharmaceutical at normal bony sites in close proximity to the SI joints. SPECT scanning overcomes these difficulties by improving the 3 dimensional localization in and around the SI joints (5). SPECT scanning is superior to quantitative scintigraphy in distinguishing between inflammatory and mechanical causes of symptoms of sacroiliitis (5,12).

Recent studies have evaluated the role of MRI in diagnosis of sacroiliitis in patients with established diseases (6,13,14) and several MRI studies have been made to demonstrate the changes of cortical erosions, subchondral sclerosis, and marrow edema (5,15). The results of these studies indicate that MRI is both sensitive and specific for diagnosis of sacroiliitis and also identifies abnormalities reflecting inflammatory disease activity at the time of assessment. The purpose of our study was to compare characteristics and diagnostic sensitivity of MRI with CT and SPECT in patients had clinical evidence of sacroiliitis.

MATERIAL AND METHOD

Patients with low back pain were recruited from the outpatient and inpatient units of the Department of Physical Medicine and Rehabilitation, School of Medicine, Dicle University, Diyarbakir, Turkey. A clinical diagnosis of an inflammatory back disorder was made before MRI, SPECT and CT assessment using the characteristics of inflammatory back pain suggested by Calin, et al (16) as guideline. 48 patients were recruited whom fulfilled Calin's proposed criteria for inflammatory back pain, 4 or more of the following: age of onset of back pain, under 40 years, insidious onset, duration of at least 3 months, associated with morning stiffness, improvement with exercise. Exclusion criteria included the presence of pacemakers or intracerebral aneurysm clips; pregnancy or female patients with a history of unprotected sexual intercourse since the last menstrual period.

The clinical investigation included an evaluation of lumbar spinal mobility (Schober test), chest expansion (fourth intercostal space), and estimation of SI pain (directly by palpation of SI joint and indirectly by forced abduction of the hip in flexion with the pelvis fixed [Patrick's test]). The laboratory assessment of inflammatory activity included measurement of the peripheral blood hemoglobin, erythrocyte sedimentation rate (ESR), platelet count, and C reactive protein (CRP) levels.

SPECT, CT and MR imaging studies were performed within a 3-week interval. SPECT images was carried out 2-3 h after receiving ^{99m}Tc imidodiphosphonate intravenously. Planar and tomographic images were generated with a TOSHIBA GCA digital 601 E gamma camera. Acquisition included 64 stops, 20 s/stop over a 360 rotation on a 64 x 64 matrix. Reconstruction utilized a Hunning 2D prefilter with a 0.85 cutoff and a ramp backprojection filter. The images were displayed on transparent film in black on white.

MR imaging was performed with a superconducting imager (Magnetom; Siemens Medical-Systems, Iseline.NJ) operated at 1.0 T and an ellip-

tical surface coil (field of view, 30 cm). Images were obtained in the coronal long axis of the SI joint by prescribing an oblique plane short acquisition sagittal "scout views". For T1-weighted images (600/25 [repetition time msec/echo time msec]), eight acquisitions were averaged and obtained with use of a 256 x 256 matrix. For T2-weighted images (2,100/90), four acquisitions were averaged and a 256x128 matrix was used. For all pulse sequences 4-mm section were separated by 1-mm gaps. Patients were examined supine with their knees flexed for comfort. The MR imaging time per study averaged approximately 45 minutes (T1-weighted sequence, 20 minutes; T2-weighted sequence, 18 minutes). CT was performed with TOSHIBA TBT 600 S had 512 X 512 matrix. Patients were examined at supine position. Contiguous, 5-mm thick slices of SI joint were obtained with a tilted gantry in sagittal and coronal plane.

A quantitative and qualitative assessment of radiopharmaceutical uptake in the SI joints was derived planar films and a qualitative analysis of uptake in the SI joints was derived from SPECT scans. Findings were recorded according to the following scheme: grade 0: ilium > SI joint; grade 1 :ilium = SI joint; grade 2: ilium < SI joint. For the purpose of our study only grade 2 was considered to indicate the presence of sacroiliitis.

Results of MR imaging were considered abnormal(sacroiliitis) if any one of the following was present: *(a)* loss of normal uniform cartilage signal intensity, *(b)* erosions on T1-weighted images, or fcjincreased signal intensity in the joint or erosions on T2-weighted images. Abnormal CT findings included sacral subchondral sclerosis, joint space loss, erosions, or intraarticular osseous ankylosis.

All images of MRI, SPECT, and CT modalities were read by radiologist and MR imagings were compared with SPECT and CT scanning in sensitivity and specificity of diagnosis and detection of characteristics of sacroiliitis. Differences in proportions between groups were examined by X^2 analysis.

Table 1. Clinical and laboratory features of 40 patients with sacroiliac pain

.	Mean
Age	24.6 ± 5.3
Male: Female	40:8
Chest expansion (cm)	5.21 ± 0.27
Schober test (cm)	4.86 ± 0.41
NSAID use at time of study	32/48
Hemoglobin (g/dl)	13.5 ±0.6
Platelet (10^3/mm^3)	272 ±14
ESR (mm/h)	12.6 + 2.4
Elevated C-reactive protein	18/48

ESR: Erythrocyte sedimentation rate; NSAID:nonsteroidal antiinflammatory drugs

RESULTS

Clinical and laboratory data on the 48 patients are summarized in Table 1. Mean age was 24.6±5.3 and all patients had SI pain. There was male predominance, 32 of 48 patients (66.6 %) were using NSAID at time of study, and 18 patients had elevated C-reactive protein.

Peripheral blood hemoglobin levels, platelet counts, and ESR were in normal ranges. There were normal chest expansion, and a few diminished lomber spine movement (schober test).

All patients which had sacroiliitis that defined with CT, SPECT and MRI are summarized in Table 2.

In our 48 patients, 35 patients(73%) were determined to have sacroiliitis at CT, and 36 patients(75%) had sacroiliitis at SPECT scanning. Totally 44 patients had abnormalities indicative of sacroiliitis at MR imaging.

The comparison of MR imaging and CT results in patients with suspected sacroiliitis is summarized in Table 3.

The sensitivity of MRI when compared to CT

Table 2. MRI, SPECT, and CT imaging results inpatients with suspected sacroiliitis

	POSITIVE	
	Patients (n=48)	%
MRI	**44**	**91.6**
SPECT	**36**	**75**
CT	**35**	**72.9**

positive: patients had sacroiliitis

Table 3. Comparison of MR imaging with CT results; in patients with suspected sacroileitis

		MRI		
		Positive	Negative	Total
CT	Positive	33	2	35
	Negative	11	2	13
	Total	44	4	48

Sensitivity: 0.75 p<0.05
Specificity :0.5

images in detection of sacroiliitis was 75% and the specificity was 50%. Sacroiliitis was identified by both images when compared; there was significant difference between two groups (p<0.05).

The comparison of MR imaging and SPECT scanning in patients with suspected sacroiliitis is summarized in Table 4.

The sensitivity and specificity of MRI when compared to SPECT scans for detection of sacroiliitis was 75% and 25%, respectively (Table 4). When sacroiliitis identified by MRI and SPECT was compared; there was significant difference between two images(p<0.05).

The comparison of SPECT scanning and CT imaging in patients with suspected sacroiliitis is summarized in Table 5.

When sensitivity and specificity of SPECT scans compared to CT images in detecting of sacroiliitis was 91% and 69%, respectively (Table 5). When sacroiliitis identified by SPECT and CT scans was compared; there was non-significant difference between two images (p>0.05).

Table 4. Comparison of MR imaging with SPECT scanning results in patients with suspected sacroiliitis

		MRI		
		Positive	Negative	Total
SPECT	Positive	33	3	36
	Negative	11	1	12
	Total	44	4	48

Sensitivity: 0.75 p<0.05
Specificity :0.25

Table 5. Comparison of SPECT scanning with CT imaging results in patients with suspected sacroiliitis

		SPECT		
		Positive	Negative	Total
CT	Positive	32	3	35
	Negative	4	9	13
	Total	36	12	48

Sensitivity: 0.91 p>0.05
Specificity :0.69

Characteristics of sacroiliitis defined with MR and CT imaging are summarized in Table 6.

Cortical erosions were demonstrated in 18 (41%) of the 44 patients with sacroiliitis by MRI while 16 (45,7%) of the 35 patients with sacroiliitis by CT imaging. Subchondral sclerosis was visualised in 20(45,5%) of the 44 patients with sacroiliitis at MRI while 22 (63%) of the 35 patients with sacroiliitis at CT imaging.

Table 6. Characteristics of sacroiliitis defined with MRI and CT imaging

	patients		P
	MRI n = 44	CT n = 35	
Cortical erosions	18	16	p>0.05
%	41	45.7	
Subchondral sclerosis	20	22	p>0.05
%	45.45	63	
Joint width (narrowed or widened)	15	14	p>0.05
%	34	40	
Ankylosis	3	3	p>0.05
%	6.8	8.6	

Table 7. Features of sacroiliitis only identified by MR imaging

	Patients n=44	%
Abnormal cartilage	32	72.7
subchondral marrow edema	19	43.2
joint fluid	8	18.2

Narrowed or widened joint width was demonstrated 15(34%) of the 44 patients with sacroiliitis at MRI, whereas 14(40%) of 35 patients with sacroiliitis at CT imaging. Ankylosis was visualized only 3 (6,8%) of the 44 patients with sacroiliitis at MRI while 3 (8,6%) of 35 patients with sacroiliitis at CT imaging.

Features at sacroiliitis only identified by MRI summarized in Table 7.

Abnormalities in articular cartilage which can be visualized directly by MRI, were detected in 72,7% of patients. Increased subchondral signal intensity on T2 weighted and proton density images indicative of marrow edema (13) was present in 43,2% of patients. Fluid within the SI joint was seen only in 8(18,2%) patients.

DISCUSSION

Chronic low back pain affects up to 10% of the general population with a significant cost to affected individuals and society at large (5). Although the etiology is unknown in the majority of cases, inflammatory axial disease originating within the SI joints accounts for a small but significant proportion. This may be one component of a more generalized disease process such as spondyloarthropathy or alternatively may represent a more localized phenomenon restricted to the SI joints. Clinical assessment of early sacroiliitis is often difficult, and the diagnosis frequently depends on radiological evaluation. In the early stages of such a disease process a confident diagnosis can be elusive due to a lack of specificity of clinical manifestations and a prolonged delay prior to the emergence of unequivocal bony destruction on conventional radiographs. In our study we have assessed whether 3 imaging techniques, namely MRI, SPECT and CT bone scanning, would allow recognition of inflammatory disease within sacroiliac joints in patients with clinical evidence of sacroiliitis. The results indicated that MRI provided the best objective and complementary evidence of sacroiliitis in this patient group. And also indicated that SPECT and CT were same sensitive in diagnosis of early sacroiliitis while the CT better demonstrated characteristics of sacroiliitis such as cortical erosions and subchondral sclerosis than SPECT at early stage of inflammation.

MR imaging showed changes of sacroiliitis almost in all cases, where SPECT and CT findings were abnormal. This study agrees with the findings of Murphey et al (6).

Comparisons of MR and Cf images of patients with suspected inflammatory sacroiliitis have been performed (6,14,15,17). However in these studies direct comparisons of CT and MR images were made. In our study MRI and CT images had non significant difference in detection of cortical erosions, widened or narrowed joint width and ankylosis. Battafarano et al. reported (15) that MR images were more sensitive than CT in detecting the likely subchondral marrow change of early disease. Wittram et al. were reported in their study that the sensitivity and specificity of MRI images for detection of cortical erosions and subchondral sclerosis when compared with CT images were 100 and 94.3 %, respectively (17). In our study subchondral sclerosis rates were higher at CT images (63%) than in MR images (45.5%), but difference between two groups was statically non-significant.

In present study MRI also detected abnormalities in articular cartilage (72.7%), subchondral marrow edema (43.2%) and the presence of joint fluid (18.2%) in patients who had sacroiilitis. Subchondral bone marrow edema has previously been reported in patients with well established sacroiliitis (13,14) although usually in association with destruction of the articular cartilage. Hence it has been difficult to determine whether it represents an early or late manifestation of disease. In previous study of patients who had clinical features of sacroiliitis that characteristics were detected only by MR imaging, abnormalities of articular cartilage, subchondral marrow edema, and presence of joint fluid were 38 %, 29% and 4%, respectively (5).

SPECT scanning overcomes difficulties of bone scintigraphy in the evaluation of sacroiliitis. In a preliminary study of patients with established sacroiliitis SPECT scanning was superior to quantitative scintigraphy in distinguishing between inflammatory and mechanical axial disease (12). In our study sensitivity and specificity of MRI when compared to SPECT scanning in diagnosis of early sacroiliitis was found 75 % and was 25%, respectively. Sensitivity of SPECT scanning when compared to CT images in diagnosis of early sacroiliitis

was found 91%, and specificity was 69%, respectively. In pervious study sensitivity and specificity of MRI scanning for detection of sacroiliitis was reported 54 and 67%, respectively. And sensitivity and specificity of SPECT scanning for detection of sacroiliitis was reported 38 and 100%, respectively(5). But it should be recognized that SPECT scanning does not identify the cause of inflammatory axial disease and the characteristics of sacroiliitis. Hanly et al. reported that MRI was the most sensitive and SPECT scanning the most specific imaging techniques for the detection of sacroiliitis (5).

In conclusion MR imaging is a valuable method for evaluating the SI joint. MRI can be helpful in clarifying difficult cases in conjuction with other techniques and has a unique ability to image cartilage abnormalities directly and noninvasively. This may detect early synovitis before the occurrence of secondary osseous changes visualized with other modalities. SPECT bone scanning was more sensitive than CT imaging but less than MRI in early recognition of sacroiliitis.

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