

Sacroiliac Joint Index in Healthy Pakistani Population and Patients with Sacroiliitis Using Technetium-99m Methylene Diphosphonate Bone Scintigraphy

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ABSTRACT

Objective: To determine the values of the Sacroiliac Joint Index (SI Index) in normal population and patients with sacroiliitis (SI) and the correlation of normal values with age and gender.

Study Design: Prospective longitudinal study.

Place and Duration of Study: Nuclear Medical Centre, Armed Forces Institute of Pathology, Rawalpindi Pakistan, from Dec 2020 to Jul 2022.

Methodology: A total of 140 patients (Group-I consisting of 129 cancer patients having no clinical or radiological evidence of SI referred for metastatic/staging workup and Group-II consisting of 11 patients with clinical, laboratory and radiological diagnosis of ankylosing spondylitis) who underwent whole body bone scintigraphy using Technetium Perchnetate (Tc-99m) labelled Methylene Diphosphonate (MDP) were included. The SI Index was calculated for each patient using the sacroiliac joint (SIJ) to sacrum radiotracer uptake ratio using the ROI method.

Results: The mean SI Index was 1.02 ± 0.09 , (range: 0.87-1.24) in normal individuals while 1.28 ± 0.09 (range: 1.15-1.53) in patients with SI. A significant statistical difference was observed in both groups for the SI Index ($p < 0.001$). In addition, the SI Index was significantly associated with age ($p = 0.016$) in the normal population.

Conclusion: The SI Index quantification using bone scintigraphy is a sensitive and cost-effective method for detecting SI. In addition, the SI Index differs according to age, so a different cut-off value should be used for each group.

Keywords: Bone scintigraphy, Quantitative bone scintigraphy, Sacroiliac joint index, Sacroiliitis.

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INTRODUCTION

Low back pain (LBP) shares a major burden of clinical practice, with an average lifetime prevalence of 65-80% in adults. It is considered one of the major causes of years lived with disability globally.¹ Sacroiliitis (SI) is the inflammation of SIJ and is associated with many rheumatic and non-rheumatic diseases. It is one of the primary manifestations of axial spondyloarthropathies.² The diagnosis of SI may be challenging in many patients as it has diverse clinical presentations, and patients usually present with non-specific symptomatology.³

Magnetic resonance imaging (MRI) has been widely used to detect acute injuries to the sacroiliac joint over the last 2-3 decades.⁴ Bone marrow oedema (BME) is considered diagnostic for SI per the Assessment of the SpondyloArthritis International Society (ASAS) guidelines.⁵

Bone scintigraphy using technetium pertechnetate (Tc-99m) labelled methylene diphosphonate (MDP)

provides a sensitive and cost-effective diagnostic tool to evaluate bones and joints.⁶ The phosphate analogue, Tc-99m labelled MDP, is taken up by bones after being injected intravenously. The extent of radiotracer uptake depends on blood flow and osteoblastic/osteoclastic activity in the bones. Hence, it can evaluate active bone formation related to physiological or pathological processes.^{7,8}

The introduction of hybrid imaging and the addition of single photon emission computed tomography/computed tomography (SPECT/CT) has improved the specificity of bone scintigraphy by providing better anatomical details.⁹ In cases of SIJ, it is very relevant to locate radiotracer accurately uptake in SIJ (region of interest) and exclude all other elements interfering with the region of interest (ROIs). Other advantages of SPECT/CT are the volumetric analysis of joints and the differentiation of chronic changes like erosion and sclerosis using CT components.¹⁰

Although the diagnosis of SI is based on an abnormally high SI index, the normal range and threshold for detecting disease are still debatable and vary among different populations. Keeping this pers-

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pective in mind, we are conducting this study to determine the normal range of SI index in our population and to compare it with patients having Sacroiliitis.

METHODOLOGY

The prospective longitudinal study was conducted at Nuclear Medical Centre, Armed Forces Institute of Pathology Rawalpindi Pakistan, from December 2020 to July 2022 after Institutional Ethical Committee Approval (IRB certificate N0. FC-NMC19-11/READ-IRB/19/363).

Inclusion Criteria: Group-I consisting of cancer patients having no clinical or radiological evidence of SI referred for metastatic/staging workup and Group-II consisting of patients with clinical, laboratory and radiological diagnosis of ankylosing spondylitis.

Exclusion Criteria: Patients with symptoms associated with Sacroiliitis, such as backache or joint stiffness, or systemic disease, such as systemic lupus erythematosus, arthritis, diabetes mellitus, or spinal or pelvic deformity were excluded.

All patients were selected by non-probability consecutive sampling technique and informed written consent was obtained.

Clinical locomotor examination especially relevant to the sacroiliac joint (sacral compression test, pelvic compression and distraction test, FABER test) was done, followed by bone scintigraphy and an x-ray of the sacroiliac joint. Group-I consisting of 129 cancer patients having no clinical or radiological evidence of SI referred for metastatic/staging workup and Group-II consisted of 11 patients suffering from ankylosing spondylitis diagnosed according to Modified New York Criteria for classification of ankylosing spondylitis by rheumatologist.

All patients underwent whole-body bone scintigraphy. Patients were explained the procedure, appropriate preparation and radiation protection measures. All married females were asked about pregnancy status before the exam, while in doubtful cases, a pregnancy test was done. Lactating mothers were briefed to withhold breastfeeding for at least 24 hours. Technetium pertechnetate (^{99m}Tc) labelled methylene diphosphonate (MDP) was injected according to patient weight (550-740 MBq), followed by imaging 2.5 hours after injection. Imaging was done using a dual-head gamma camera (Symbia T6) with an energy high-resolution parallel hole collimator (20% energy window set at the peak of 140 keV using 256x256 matrix size). Anterior and posterior whole-body images and planar static images were acquired.

Syngo workstation software (Siemens v. 2013) was used for quantitative analysis. To calculate the SI Index, using a posterior whole-body image, an ROI was drawn on the left SIJ or joint with prominent uptake. Copied ROI were then drawn on contralateral SIJ and sacrum. Average counts were then estimated for each ROI to calculate the SI Index. SI Index for each joint was calculated as follows: SI Index (Lt)=Average Lt SIJ count/Average sacrum count, SI Index (Rt)=Average Rt SIJ count/Average sacrum count.

Statistical Package for Social Sciences (SPSS) version 23.0 was used for the data analysis. Quantitative variables were expressed as Mean \pm SD and qualitative variables were expressed as frequency and percentages. Chi-square test, Independent sample t-test and One-way analysis of variance (ANOVA) were applied to explore the inferential statistics. The p -value of ≤ 0.05 was set as the cut-off value for significance.

RESULTS

Of 140 patients, 75(53.6%) were male, while 65 (46.4%) were female, with a mean age of 49.82 \pm 17.66 years. Patients were classified into two groups. Group-I consisted of normal individuals with no clinical or radiological evidence of SI. In contrast, individuals with clinical, laboratory and radiological diagnosis of sacroiliac ankylosing spondylitis were included in Group-II (Table-I).

Table-I: Baseline characteristics and Sacroiliac Joint Index in Study Groups (n=140)

	Group-I (Normal Population) (n=129)	Group-II (Patient with Sacroiliitis) (n=11)
Age (years)	51.31 \pm 17.46	32.45 \pm 8.66
Gender		
Male n(%)	66(51.2%)	9(81.8%)
Female n(%)	63(48.8%)	2(18.2%)
SI Index [Mean\pmSD (range)]		
Rt SIJ	1.02 \pm 0.101 (0.861.25)	1.27 \pm 0.14 (1.011.56)
Lt SIJ	1.20 \pm 0.932 (0.851.23)	1.29 \pm 0.10 (1.08-1.50)

The mean SI Index in normal individuals was 1.02 \pm 0.101 on the right side and 1.20 \pm 0.932 on the left. The mean SI Index in individuals with SI was higher, i.e., 1.27 \pm 0.14 on the right side while 1.29 \pm 0.10 on the left side. A highly statistically significant difference was found between the SI Index in Group-I and Group-II, as shown in Table II.

Table-II: Comparison of Sacroiliac Joint Index between Study Groups (n=140)

Groups	Mean \pm SD	Range	p -value
Group-I	1.02 \pm 0.09	0.87-1.24	<0.001*
Group-II	1.28 \pm 0.09	1.15-1.53	

Table-III shows the association of SI Index in normal individual according to age and gender. In normal individuals, the SI Index showed a statistically significant downward trend with age (p -value 0.016).

statistically significant difference in SI Index between control and cases when compared by planar bone scintigraphy.¹⁶ However, SPECT/CT has improved the detection of radiotracer uptake in SIJ, and thus, a

Table-III: Sacroiliac Joint Index according to Age and Gender in Normal Population (n=129)

Characteristic	Number	Right Sacroiliac Joint		Left Sacroiliac Joint		p-value
		Mean±SD	Range	Mean±SD	Range	
Gender						
Male	66	1.03±0.09	0.87-1.25	1.04±0.90	0.86-1.23	0.12
Female	63	1.02±0.10	0.86-1.21	1.00±0.09	0.85-1.20	
Age (Years)						
≤29	17	1.07±0.09	0.93-1.21	1.07±0.09	0.90-1.23	0.01
30-39	15	1.05±0.06	0.93-1.17	1.04±0.08	0.91-1.19	
40-49	17	1.00±0.09	0.86-1.18	0.99±0.09	0.89-1.16	
50-59	33	1.01±0.11	0.88-1.20	1.02±0.08	0.91-1.19	
60-69	26	1.02±0.10	0.88-1.25	1.01±0.09	0.91-1.23	
≥70	21	1.00±0.10	0.87-1.18	1.00±0.09	0.85-1.18	

DISCUSSION

Sacroiliac Joint Index varies across different populations due to the physiological uptake of the radio-tracer, so every institution has established its normal range and cut-off values.¹¹ Keeping this in mind, we undertook this study to determine the normal range in our population and patients with diagnosed SI.

In our study, the mean SI Index in normal healthy individuals was 1.02±0.09, ranging from 0.87-1.24. In a similar study which recruited 100 normal individuals, the SI Index was 1.06-1.36.¹² They also found that the SI Index varies greatly according to a person's age. These findings are consistent with our findings that age is significantly associated with the SI Index and shows a downward trend with age. Bajner *et al.* observed a negative linear correlation between age and the SI Index, i.e., the SI Index decreases with advancing age, similar to our data. They, however, found a significant correlation between the SI Index and gender, which is contrary to our findings.¹³ Similarly, Kaçar *et al.* found that the SI Index is slightly higher in men than women, and the SI Index decreases with age in females, while in males, age does not have a significant effect.¹⁴

The SI Index in individuals with SI in our studied population was 1.28±0.09, with a range of 1.15-1.53. This data is consistent with the data of Abdelhai *et al.* who also reported an SI Index of 1.2-1.5 in patients with SI.⁹ They found a statistically significant difference between normal and diseased populations ($p < 0.001$), similar to our findings. Ozdogan *et al.* also had comparable results that there is a significant difference between healthy individuals and those having SI.¹⁵ According to his data, the SI Index in patients with SI was 1.47±0.20. Contrary to this, Kim *et al.* reported no

statistical difference was observed in his study. In the literature, the studies done in this regard cannot be considered statistically significant due to their small sample size.^{17,18}

LIMITATION OF STUDY

We did not compare bone scintigraphy findings with MRI, considered standard imaging modality in patients with axial spondyloarthritis.

CONCLUSION

Sacroiliac Joint Index quantification using bone scintigraphy is a sensitive and cost-effective method for detecting sacroiliitis. In addition, the SI Index differs according to age, so a different cut-off value should be used for each group.

Conflict of Interest: None.

Author's Contribution

Following authors have made substantial contributions to the manuscript as under:

MUI & FH: Conception, study design, drafting the manuscript, approval of the final version to be published.

MA & MII: Data acquisition, data analysis, data interpretation, critical review, approval of the final version to be published.

ZSD & ZS: Critical review, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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