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Biomechanical Predictors of Sacroiliac Joint Uptake on SPECT/CT

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Background

The sacroiliac (SI) joint connects the spine to the pelvis. It plays a major role in force resistance of physiologic loads. Single Photon Emission Computed Tomography/ Computed Tomography (SPECT/CT) is an emerging imaging modality that identifies sites of heightened bone metabolism in response to increased stresses. The relationship between SI radiotracer uptake and anatomic biomechanical parameters is poorly understood.

Methods

We performed a retrospective review of all SPECT/CT scans done at our institution between 2021-2023. Only adult patients with SPECT/CT of the thoracolumbar spine with a corresponding standing scoliosis film met inclusion criteria. Patient charts were reviewed for demographic factors, including age, gender, and prior thoracolumbar fusion history. Radiology reports were reviewed for evidence of adjacent segment degeneration, disc disease, facet arthropathy, or pseudoarthrosis.

Biomechanical parameters including pelvic incidence, sacral slope, pelvic tilt, lumbar lordosis, sagittal and coronal balance, pelvic incidence – lumbar lordosis mismatch, and coronal scoliosis were measured from standing scoliosis films. Two authors reviewed SPECT/CT scans at the SI joint. SI uptake greater than iliac crest uptake was designated hot. Patients were stratified by presence or absence of SI uptake. Cohen's Kappa was measured to assess interrater reliability. Statistically significant differences were determined via t-tests and chi-squared analysis for continuous and categorical variables, respectively.

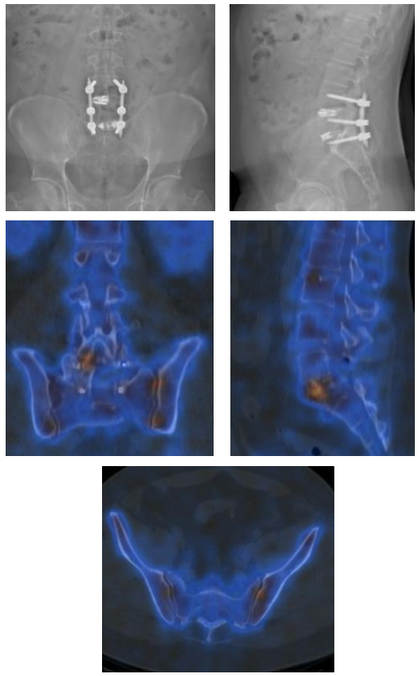
Results

115 patients met inclusion criteria. Patients were slightly more male (57%) with average age 55 ± 15 years. 50 patients (43%) had evidence of increased SI activity. Interrater reliability showed substantial agreement (kappa = 0.62). The hot cohort had greater incidence of prior thoracolumbar fusion (p = 0.02). Of those with prior fusions, the hot SI cohort trended towards longer constructs (p = 0.06). Patients were otherwise similar between cohorts (p >0.05).

Table: Demographic, spinopelvic radiographic parameters, and pathologic findings in patients stratified by sacroiliac (SI) joint uptake on SPECT/CT .

	Increased "Hot" SI Uptake (n = 50 patients)	Normal Physiologic "Cold" SI Uptake (n = 65 patients)	P-Value
Patient Demographics			
Age (years)	53.7 ± 14.8	56.6 ± 14.4	0.302
Sex: No. of Males (%)	30 (60%)	36 (55%)	0.620
No. of Patients Prior Fusion (%)	17 (34%)	10 (15%)	**0.020**
No. of Levels Fused	2.6 ± 2.1	1.4 ± 0.6	0.067
Radiographic Parameter Measured on Standing Scoliosis Films			
Pelvic Incidence (°)	53.7 ± 14.3	51.4 ± 11.8	0.361
Sacral Slope (°)	34.8 ± 8.2	33.4 ± 9.8	0.413
Pelvic Tilt (°)	18.9 ± 9.6	18.3 ± 8.8	0.753
L1 Incidence (°)	10.2 ± 7.4	10.6 ± 11.0	0.844
Lumbar Lordosis (°)	48.1 ± 10.4	46.2 ± 12.1	0.381
Sagittal Balance (mm)	34.1 ± 35.3	37.0 ± 38.1	0.681
PI – LL mismatch (°)	10.3 ± 8.2	10.0 ± 9.9	0.869
Coronal Balance (mm)	11.3 ± 9.6	13.0 ± 13.2	0.450
Coronal Cobb (°)	11.2 ± 5.4	11.0 ± 6.0	0.843
Pathologic Findings Noted in the Radiology Report			
Degenerative Disc Disease	28 (56%)	40 (62%)	0.549
Facet Arthropathy	30 (60%)	31 (48%)	0.189
Pseudoarthrosis	3 (6%)	4 (6%)	0.973
Adjacent Segment Degeneration	4 (8%)	4 (6%)	0.699

Figures: Illustrative case of patient with continued low back pain after prior L4-S1 with evidence of increased left > right sacroiliac joint radiotracer uptake on SPECT/CT.



Discussion

- Referred pain from the SI joint or hip may be misinterpreted as low back pain, especially in patients who present with back pain alone without associated lower extremity radicular pain.
- Increased uptake at the SI joint was underreported by staff radiologists reviewing SPECT/CT scans, due to lack of consensus regarding normal physiologic uptake in these joints. Greater radiotracer uptake at the SI joint relative to the iliac crest was observed in several cases.
- Patients with prior lumbar fusions, especially those undergoing multi-level constructs, demonstrated increased uptake at the SI joint
- As the fixed end of a biomechanical beam, the sacrum, and thus SI joint, plays a key role in the resistance of physiologic loads and moments.
- Prior fusions affect the loading conditions of the spine and may contribute to SI degeneration. The lumbo-sacral junction is a critical segment involved in load transfer, where there is a high percentage of non-union due to the unfavorable stress from two major lever arms of a rigid pelvis counteracting a fused spine.

Conclusions

Hybrid SPECT/CT is an emerging and valuable diagnostic tool in the workup and clinical management of low back pain. Increased radiotracer uptake on SPECT/CT is a novel finding for heightened mechanical stresses and may correlate to anatomic sites of pain generation. Thoracolumbar fusions may cause increased stresses at the SI joint. SPECT/CT may be a valuable tool to assess SI degeneration. Future studies are warranted to better characterize the clinical applications of these findings.

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