Bone SPECT

Definition

Bone SPECT is a nuclear medicine imaging technique that combines conventional bone scintigraphy with tomographic imaging to produce three-dimensional views of skeletal structures. It uses radiotracers, most commonly Technetium-99m-labeled diphosphonates (e.g., 99mTc-MDP), which accumulate in areas of active bone metabolism.

Common Indications

Detection of bone metastases (especially in prostate, breast, or lung cancer)

Evaluation of unexplained bone pain

Detection of occult or stress fractures

Differentiation between osteomyelitis and cellulitis

Assessment of prosthetic joint complications (loosening vs. infection)

Paget's disease of bone

Avascular necrosis

Evaluation of benign or malignant bone tumors

Advantages

Higher sensitivity than X-rays for early bone changes.

Improved anatomical localization compared to planar bone scintigraphy.

Especially helpful in complex anatomical regions (e.g., spine, pelvis, joints).

Aids in differentiating active from chronic lesions.

Orecorded Procedure

Intravenous injection of 99mTc-MDP.

Uptake phase: wait 2-3 hours for radiotracer to localize in bone.

Imaging phase: a gamma camera rotates around the patient to capture tomographic slices.

Images are reconstructed in 3D for detailed analysis.

▲ Limitations

Still less specific than MRI or CT in some cases.

Uptake is non-specific: increased uptake occurs in infection, tumor, trauma, inflammation, etc.

Radiation exposure (though low).

Retrospective Observational Cohort Studies

In a Retrospective Observational Cohort Study Romera et al. from the Clínica Universidad de Navarra, Pamplona, Spain, explored the usefulness of bone SPECT/CT for providing additional information to Magnetic Resonance Imaging (MRI) in patients with axial pain, and for guiding the site of spinal injections.

They studied 194 patients with axial pain evaluated with SPECT/CT and MRI. Imaging abnormalities were classified according to location and diagnosis of pain generators. Patient outcomes after SPECT/CT guided spinal injection were evaluated during clinical follow-up. Descriptive analyses and kappa coefficient were performed for facet joint arthropathy detection and degenerative disc disease between imaging modalities.

MRI showed 44.3% more abnormalities than SPECT/CT (329 vs. 228). However, SPECT/CT detected 17% more patients with facet joint arthropathy compared to MRI (43.3% vs. 26.3% respectively). Imaging agreement for diagnosing degenerative disc disease was moderate (κ : 0.44; 95% CI, 0.32-0.56), but only fair for facet joint arthropathy (κ : 0.35; 95% CI, 0.28-0.42). The response to spinal injections guided by SPECT/CT imaging was assessed in 56 patients with facet joint arthropathy. Among these, 26 /56 had a history of previous spinal injections guided by physical examination. In this group, the response was effective or partially effective in 65.4% of patients and ineffective in 34.6%. After a second injection guided by SPECT/CT, the response rate increased to 88.4%, with only 11.6% remaining ineffective, resulting in an absolute benefit of 23.4%. In 30/56 patients with no prior history of spinal injections, the therapy was effective or partially effective in 93.3%, while 6.7% did not show any improvement in pain after SPECT/CT-guided spinal injections.

Bone SPECT/CT imaging complements MRI by providing valuable information to identify pain generators. In facet joint arthropathy, it improves the effectiveness of pain relief when used to guide spinal injections ¹⁾.

This retrospective cohort study evaluates the utility of bone SPECT/CT in identifying pain generators in patients with axial spinal pain, comparing its diagnostic value to MRI and assessing clinical outcomes of SPECT/CT-guided spinal injections, especially in facet joint arthropathy.

Strengths

Large Sample Size The inclusion of 194 patients provides a reasonably powered dataset to explore

imaging findings and therapeutic outcomes.

Clinical Relevance Axial pain and its elusive etiology are common challenges. Investigating diagnostic tools that improve localization of pain generators is directly translatable to daily practice.

Outcome Assessment The study goes beyond diagnostic agreement to assess therapeutic outcomes, offering evidence of clinical utility, not just imaging concordance.

Quantitative Agreement Measures Use of kappa coefficients adds methodological rigor to the comparison between MRI and SPECT/CT.

▲ Limitations

Retrospective Design As a retrospective analysis, the study is inherently limited by selection bias, missing data, and lack of control over confounding variables (e.g., disease chronicity, prior therapies, comorbidities).

Heterogeneity in Patient Management The intervention group is not standardized: some patients had prior injections based on physical exam, others did not. This limits the ability to attribute outcomes solely to SPECT/CT guidance.

No Gold Standard for Pain Generator Confirmation There is no independent validation (e.g., surgical findings, histopathology) of whether the identified abnormalities were true pain generators, which weakens the diagnostic conclusions.

Potential Confirmation Bias SPECT/CT-guided injections are interpreted as more effective, but lack of blinding in outcome assessment may inflate perceived benefit due to observer bias or placebo effects.

MRI Underperformance Questionable

The claim that MRI underdetects facet joint pathology is intriguing but may reflect reader variability, imaging protocol differences, or overdiagnosis by SPECT/CT rather than a true superiority.

Outcome Measures are Subjective

The effectiveness of injections is categorized (effective/partially effective/ineffective) without use of validated pain scales (e.g., VAS, ODI) or objective functional metrics.

Interpretation Caveats

While the study shows improved outcomes after SPECT/CT-guided injections, this could be partially explained by regression to the mean, patient expectation, or repeat treatment effects.

The 23.4% absolute benefit in previously injected patients is clinically promising, but lacks a control arm for robust comparison.

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Romera M, Rodrigo-Paradells V, Varela N, Guillén EF, Navarro-Astiasarán M, Domínguez-Echavarri P, Betech-Antar V, Mínguez F, Basanta A, Rosales JJ, Arbizu J. Bone SPECT/CT in the diagnosis and treatment decision making of axial pain. Eur Spine J. 2025 May 26. doi: 10.1007/s00586-025-08967-x. Epub ahead of print. PMID: 40418227.

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