SH49. Is there a role for bone scan in diagnosis of PJI?

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Methodology: A comprehensive literature review was conducted to identify studies on the use of bone scans for diagnosing prosthesis-related infections (PJI) in shoulder arthroplasty. Searches were performed using the terms "bone scan," "technetium Tc 99m," "scintigraphy," "prosthetic joint infection," "arthroplasty infection," "diagnostic accuracy," and "shoulder arthroplasty" in the databases PubMed, Embase, and Scopus through October 2024. Inclusion criteria for this systematic review included English-language studies (Level I-IV evidence) that reported on the diagnostic applicability and utility of technetium Tc 99m bone scans in cases of suspected PJI after shoulder arthroplasty. Exclusion criteria included non-English studies, nonhuman research, retracted publications, abstracts, case reports, and review articles. The review adhered to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The initial search yielded 22 potential articles, of which only 2 studies met the inclusion and exclusion criteria in shoulder arthroplasty.

Answer: Not recommended. There is limited supporting evidence for the routine use of bone scans in diagnosing PJI in shoulder arthroplasty.

Strength of Recommendation: Limited (Evidence is insufficient)

Rationale:

The diagnosis of shoulder PJI can be difficult to ascertain, especially in the low-grade chronic cases. Advanced imaging may provide better diagnostic utility in these cases. Bone scintigraphy is often utilized as an initial imaging modality for suspected low-grade PJIs, though its diagnostic utility remains debated.[1] For shoulder arthroplasty specifically, Falstie-Jensen et al. evaluated the diagnostic performance of WBC/BM SPECT-CT in detecting shoulder PJIs. Among 29 revision cases, the study reported a sensitivity of only 18%, a specificity of 100%, a PPV of 100%, an NPV of 67%, and an overall accuracy of 69% in detecting chronic infected shoulder arthroplasties.[2] While the technique demonstrated excellent specificity, it failed to detect infections caused by *Cutibacterium acnes,* which accounted for most cases. In contrast to its limited utility in shoulder PJIs, bone scintigraphy has shown better diagnostic performance in hip and knee arthroplasty. For example, Graute et al. investigated the use of SPECT/CT imaging as an adjunct to planar scintigraphy with 99mTc-labeled anti-granulocyte antibodies in low-grade joint infections involving hip and knee arthroplasty.[3] Among 31 patients with suspected infections, sensitivity improved from 66% with planar scintigraphy alone to 89% with the addition of SPECT imaging, and specificity increased from 60% to 73% with fused SPECT/CT imaging.[3]

Despite the advantages of nuclear medicine imaging, limitations persist. As outlined by Pinski et al. in their review, bone scintigraphy is a sensitive but non-specific modality, often showing uptake due to normal postoperative bone remodeling rather than infection.[4] This has led to the development of more targeted nuclear imaging techniques. Labeled leukocyte scintigraphy combined with bone marrow imaging has been considered the most reliable nuclear imaging test available for PJIs, offering improved specificity over bone scintigraphy alone.[4] Emerging techniques, such as [68Ga]Ga-DOTA-FAPI-04 PET/CT, have shown promise in detecting PJIs with high sensitivity and specificity.[5] Unlike FDG-PET/CT, which is prone to false positives due

to inflammation, this technique targets fibroblast activation protein, which is upregulated in chronic infections.[5] In a study by Wang et al., it demonstrated a sensitivity of 100%, specificity of 93.1%, and overall accuracy of 95% in differentiating PJIs from aseptic failures.[5] However, the diagnostic accuracy of nuclear imaging techniques can vary based on the imaging protocol used and the anatomical site of infection.

In summary, while bone scans play a role in orthopedic diagnostics, their effectiveness in diagnosing PJIs in shoulder arthroplasty is limited, particularly in cases involving low-virulence organisms which are likely to incite a less aggressive inflammatory response. Thus, bone scan would be expected to have lower diagnostic utility because low virulent organisms predominate in chronic or late shoulder PJI bone. Advanced imaging techniques may offer improved diagnostic accuracy, but further studies are needed to establish their role in shoulder PJI evaluation. Clinicians should recognize these limitations and exercise caution when deciding to include bone scans in their diagnostic approach for PJI in shoulder arthroplasty.

References:

1. Signore A, Sconfienza LM, Borens O, et al. Consensus document for the diagnosis of prosthetic joint infections: a joint paper by the EANM, EBJIS, and ESR (with ESCMID endorsement) [published correction appears in Eur J Nucl Med Mol Imaging. 2019 May;46(5):1203. doi: 10.1007/s00259-019-04281-z]. *Eur J Nucl Med Mol Imaging*. 2019;46(4):971-988. doi:10.1007/s00259-019-4263-9
2. Falstie-Jensen T, Daugaard H, Søballe K, et al. Labeled white blood cell/bone marrow single-photon emission computed tomography with computed tomography fails in diagnosing chronic periprosthetic shoulder joint infection. *J Shoulder Elbow Surg*. 2019;28(6):1040-1048. doi:10.1016/j.jse.2018.10.024
3. Graute V, Feist M, Lehner S, et al. Detection of low-grade prosthetic joint infections using 99mTc-antigranulocyte SPECT/CT: initial clinical results. *Eur J Nucl Med Mol Imaging*. 2010;37(9):1751-1759. doi:10.1007/s00259-010-1431-3
4. Pinski JM, Chen AF, Estok DM, Kavolus JJ. Nuclear Medicine Scans in Total **Joint** **Replacement**.J Bone Joint Surg Am. 2021 Feb 17;103(4):359-372. doi: 10.2106/JBJS.20.00301.PMID: 33369983 Review.
5. Wang Y, Wang R, Zhang X, Li L, Liu H, Chang Y, Li Q, Wang Y, Qi E, Hao L, Chai W, Yao S, Shi Y, Yan W, Shao W, Zhang J, Chen J, Tian J.Eur Diagnostic efficiency of [68 Ga]Ga-DOTA-FAPI-04 in differentiating periprosthetic hip joint infection and aseptic failure. J Nucl Med Mol Imaging. 2023 Jun;50(7):1919-1928. doi: 10.1007/s00259-023-06146-y. Epub 2023 Feb 23.PMID: 36813979