

xSPECT Bone used to delineate cervical vertebral screw loosening

By Dr. Iain Duncan, MD
Data courtesy of Garran Medical Imaging, Canberra, Australia

History

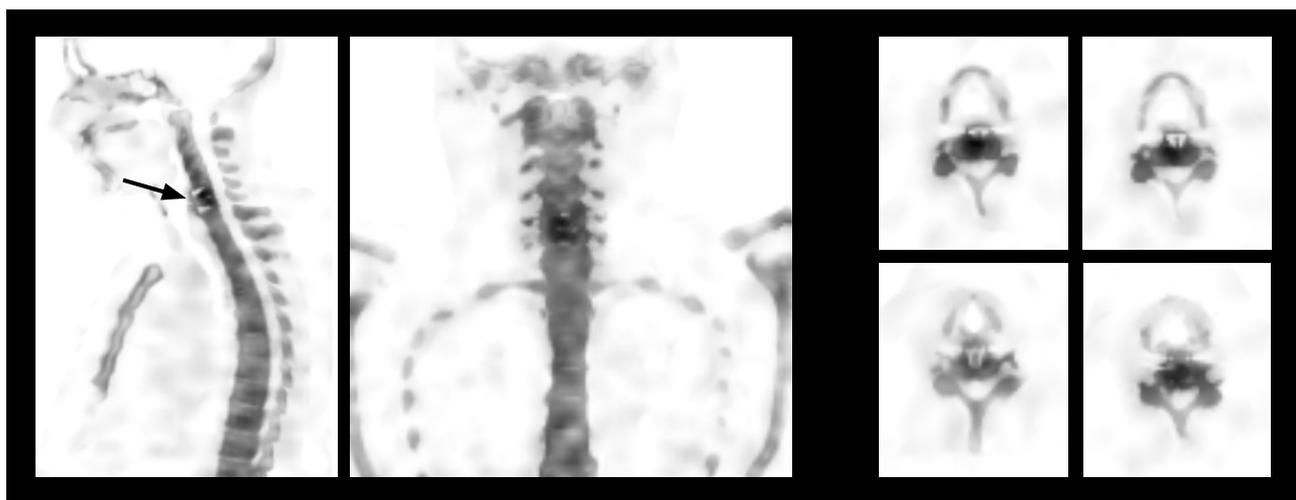
A 60-year-old woman with a history of anterior fixation and fusion of the C5-C6 vertebrae presented with chronic, dull neck pain. Cervical facet arthropathy was initially suspected to be the cause of the pain. The patient underwent a bone SPECT/CT scan using xSPECT Bone™.

The study was performed on a Symbia Intevo™ 2 system 3 hours following an intravenous injection of 23 mCi (850 MBq) of ^{99m}Tc-hydroxydiphosphonate (HDP). A diagnostic CT scan (110 kV, 49 eff mAs, 2 x 1.5 mm collimation) was followed by a SPECT acquisition (30 stops per detector, 18

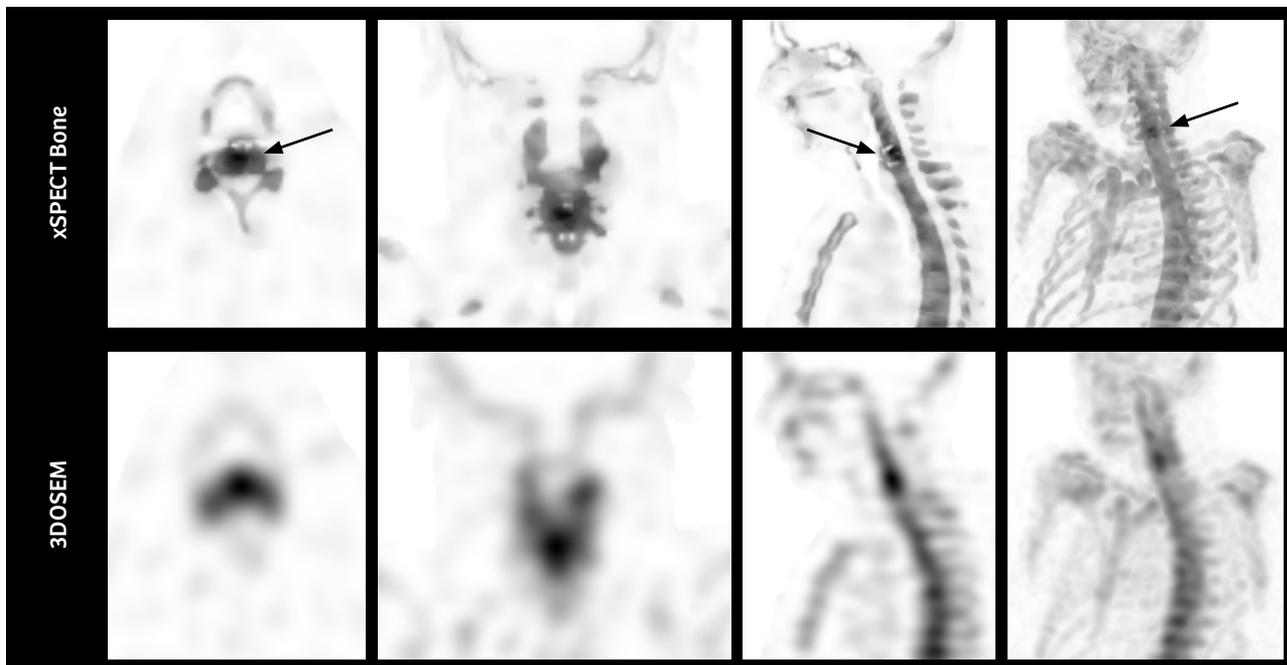
seconds per stop). xSPECT Bone reconstruction was performed using CT-based zone maps. Reconstructed xSPECT Bone data was subsequently fused with the CT for final interpretation. Standard 3DOSEM reconstruction was also performed and compared with the xSPECT Bone data. Quantitative estimation of tracer uptake from xSPECT Bone and xSPECT Quant™ acquisitions enabled determination of SUV within lesions and normal bone.

Diagnosis

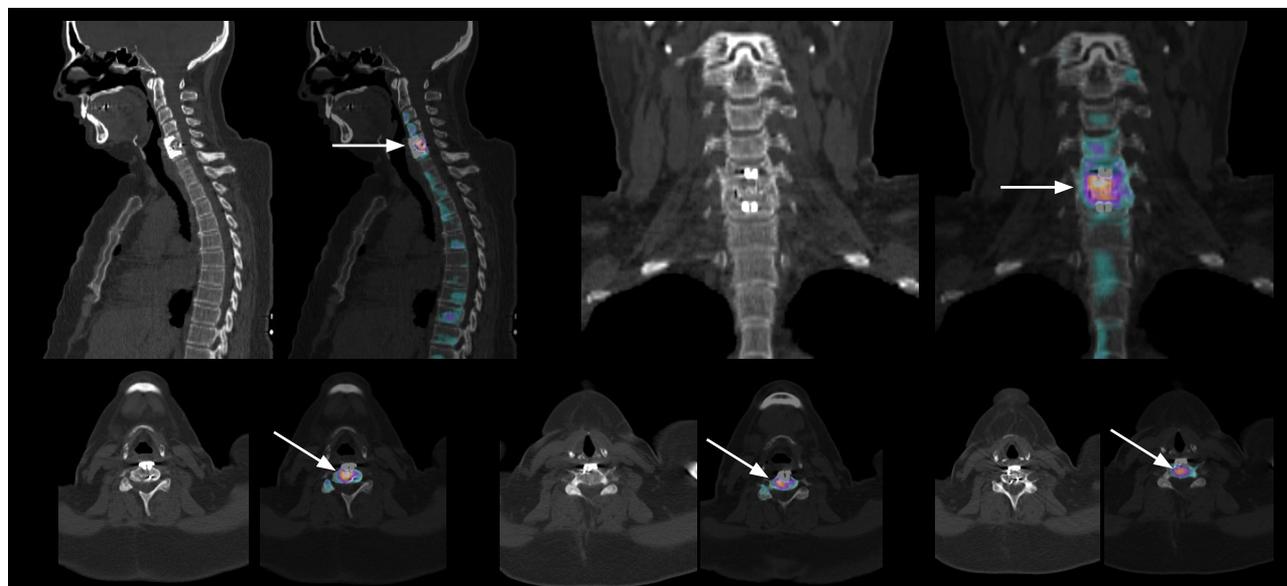
The CT, xSPECT Bone, and fused images in Figures 1-4 indicate there is focal hypermetabolism in C5-C6 disc space and adjacent vertebral end plates, which is



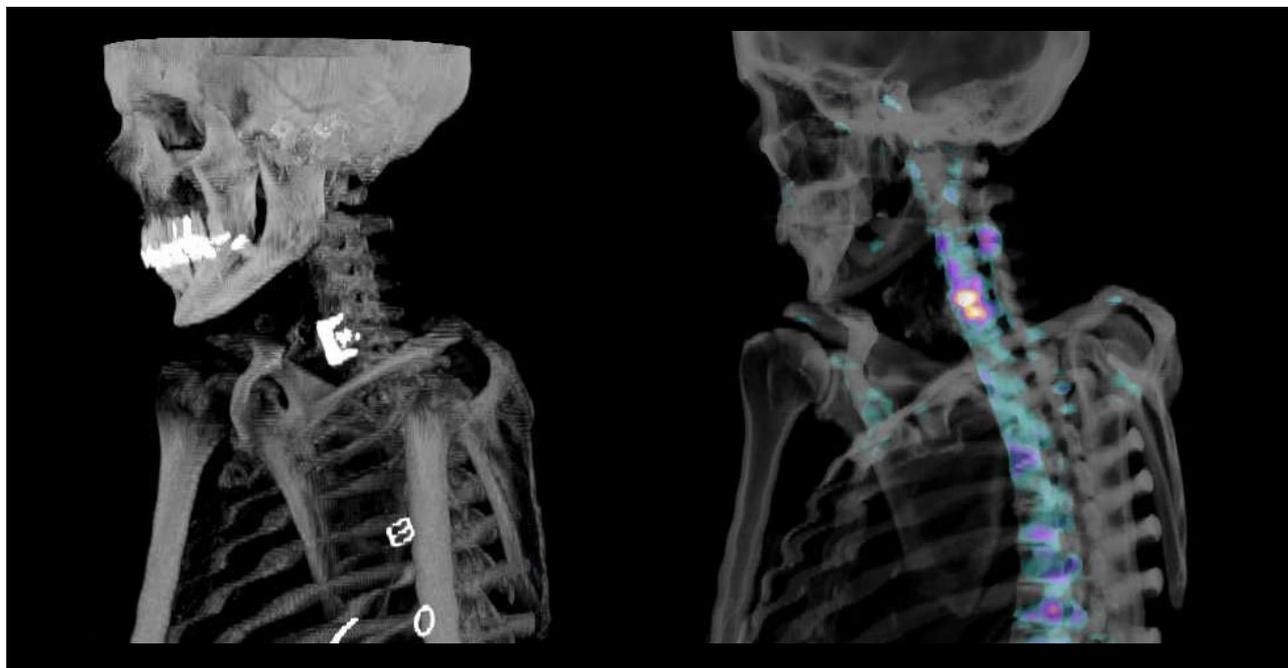
- 1 Sagittal, coronal, and transverse multiplanar reconstruction (MPR) views of xSPECT Bone reconstruction show significantly increased uptake within the C5-C6 disc space ($SUV_{max} = 13.3$); consistent with ongoing stress across the disc despite the previous anterior fixation. Bone stress of such magnitude suggests possibility of failure of fusion, most likely secondary to loosening of a fixation screw. There is also increased uptake in the left C3-C4 and right C5-C6 facets ($SUV_{max} = 9.6$), which reflects facet arthropathy secondary to fixation screw related bone stress. The right C4-C5 and left C5-C6 facet joints also show mildly increased uptake, which also reflects shear stress secondary to fixation screw loosening.



2 Comparison of transverse, coronal, and sagittal as well as maximum-intensity-projection (MIP) images of 3DOSEM and xSPECT Bone reconstructions at the level of C5-C6 vertebrae shows sharp delineation of edges of metallic prosthesis used for fixation of the 5th and 6th cervical vertebral bodies (see arrows). Additionally, the edges of vertebral bodies and facet joints, lamina, spinous and transverse processes compared to 3DOSEM are shown. The focal increase in uptake in the C5-C6 disc space and adjacent vertebral end plates and facet joints is delineated with improved clarity with xSPECT Bone compared to 3DOSEM.



3 CT and fused xSPECT and CT images show focal increase in uptake in the C5-C6 disc space and adjacent vertebral end plates with highest intensity of uptake adjacent to the upper fixation screw (see arrows), suggesting possibility of failure of fusion with loosening of the upper fixation screw.



- 4 MIP of CT and volume rendering of CT and xSPECT Bone fusion data show the orientation of the cervical vertebral fixation prosthesis and the focal increased uptake in the vertebral body and disc space between the fixation screws.

consistent with bone stress, despite anterior fixation. The intensity of uptake and the significantly increased SUV (Figure 1) compared to normal cervical bone reflect avid bone stress, which is excessive considering the fusion was performed 2 years prior. Such excessive bone stress 2 years following anterior fixation with the highest focal hypermetabolism (just adjacent to the upper fixation screw) appears to be related to possibility of failure of fusion with loosening of the upper fixation screw. The severe facet arthropathy of the right C5-C6 facet joint is secondary to shear stress caused by loosening of a fixation screw.

In the present study, xSPECT Bone was instrumental in the accurate localization of the focal hypermetabolism within the vertebral disc space close to the upper cervical fixation screw, which suggests that it may be the site of loosening with possible failure of fusion and secondary cervical facet arthropathy. A comparison of xSPECT Bone and standard 3DOSEM reconstructions

clearly demonstrate the visual improvement in delineation of prosthetic margins, vertebral hypermetabolic foci, and vertebral body and facet edge definition, which significantly improve the visual localization of the pathology. The use of SUV in the hypermetabolic foci and comparison to normal vertebral SUV is a new benchmark enabled by xSPECT Quant™ to determine the degree of hypermetabolism related to shear stress and act as a baseline for subsequent post-therapy comparisons.

Comments

Anterior interbody fusion of the cervical vertebrae is a common treatment for cervical disc herniation or instability secondary to trauma. A discectomy is performed followed by the interbody fusion, which usually involves a bone graft placed between 2 vertebrae to replace the removed disc along with insertion of fixation screws above and below the bone graft with anterior plate fixation of the upper and lower cervical vertebral

screws. A successful fixation usually leads to incorporation of the bone graft with the adjacent vertebral end plates creating a solid piece of bone out of the 2 vertebrae. The aim of the fixation screws and the anterior plate to hold them together is to create a rigid structure involving the adjacent vertebrae and bone graft in order to avoid motion between the vertebrae. Common complications following anterior cervical spine fixation include loosening of fixation screws, which may create shear stress and motion at the level of bone graft within the disc space, which may delay fusion or lead to failure of fusion. Additional complications include fracture of spinal screws as well as implant migration and psuedoarthrosis secondary to failure of fusion.

^{99m}Tc-MDP bone SPECT scans accurately reflect focal hypermetabolism within the cervical vertebral bodies, disc space, and facet joints and pedicles, which are secondary to shear stress caused by screw loosening, vertebral body

instability, implant fracture, or failure of fusion. SPECT/CT is useful in exact localization of the focal hypermetabolism in relation to bone and prosthesis, which further improves interpretation of the pattern of hypermetabolism and helps define its cause. Bone SPECT/CT has been shown to be very sensitive in localizing sites of facet arthropathy that cause neck pain.¹

Conclusion

xSPECT Bone sharply defined focal hypermetabolism in C5-C6 disc space adjacent to the upper cervical fixation screw, thereby suggesting failure of fusion due to loosening of the upper fixation screw with secondary cervical facet arthropathy. ●

References

¹ Ravindra et al World Neurosurg. 2016 Dec;96:390-395

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Examination protocol

Scanner: Symbia Intevo 2

SPECT	
Injected dose	23 mCi (850 MBq) ^{99m} Tc-HDP
Scan delay	3 hour post-injection delay
Acquisition	30 stops per detector 18 seconds/stop xSPECT Bone reconstruction
CT	
Tube voltage	110 kV
Tube current	40 eff mAs
Slice collimation	2 x 1.5 mm

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