Nuclear Medicine Imaging in the Dentomaxillofacial Region

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KEYWORDS

• Dentomaxillofacial • Nuclear medicine • ^{99m}Tc-MDP
• ^{18}F sodium fluoride bone scan • ^{18}F-FDG • Osteomyelitis • Condylar hyperplasia
• Temporomandibular disorder

KEY POINTS

- Nuclear medicine studies evaluate the physiology on a molecular level providing earlier detection of lesions before morphologic change is evident.
- ^{99m}Tc-MDP and ^{18}F-NaF PET bone scans aid in the detection of osseous tumor, infection, condylar hyperplasia, temporomandibular disorder and osteoradionecrosis and can assess bone graft viability.
- ^{99m}Tc-MDP and ^{18}F-NaF PET bone scans detect osteomyelitis earlier than CT and 18F-FDG PET/CT can assess osteomyelitis complicated by fracture or surgery.
- ^{18}F-NaF PET/CT bone scan is more sensitive and specific than ^{99m}Tc-MDP for evaluation of osseous lesions.
- 18F-FDG PET/CT provides more accurate staging, restaging, response to treatment, and prognostic data for malignant disease than CT alone resulting in more precise patient management and improved outcomes.

NUCLEAR MEDICINE

Nuclear medicine displays physiologic processes at the molecular level. It is an imaging subspecialty that uses small amounts of radioactive material to diagnose and treat disease. Most radiopharmaceuticals administered are composed of a radioactive component (radioactive atom) bound to a physiologically active component. The choice of physiologically active component depends on the purpose of the scan. For example, if imaging of the bone is desired, technetium (^{99m}Tc) is bound to the bone-seeking agent, methylene diphosphonate (MDP),

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yielding ^{99m}Tc-MDP. Photons emitted by the ^{99m}Tc component are detected by scintillation crystals in the gamma camera. When the gamma camera rotates around the patient, three-dimensional single-photon emission computed tomography (SPECT) images are obtained, which have the advantage of improved image contrast and localization of lesions compared with planar scintigraphy. SPECT/computed tomography (CT) cameras also have the advantages of CT attenuation correction and anatomic correlation, which results in improved accuracy and diagnostic confidence.

Radiopharmaceuticals used with PET cameras emit positrons that undergo annihilation with electrons with emission of two 511-keV photons at 180°. These photons are detected by coincidence imaging when they strike the scintillation crystals. Coregistered CT data not only provide attenuation correction of the PET data but also excellent spatial resolution, helping to improve localization and characterization of lesions identified by PET. PET evaluates abnormalities on the molecular level before morphologic changes are evident on CT.[1]

BONE SCAN

Bone scans are sensitive studies of the entire skeleton. They are dependent on blood flow and adsorption on crystalline structure of hydroxyapatite. The inorganic mineral hydroxyapatite is made of calcium, phosphate, and hydroxyl ions. The most commonly used radiopharmaceutical for skeletal scintigraphy is ^{99m}Tc-MDP, which passively diffuses from the capillaries to the extravascular space. Because areas of increased tracer uptake correlate with areas of hyperemia and increased bone uptake, bone scans are well suited to evaluate osseous metastatic disease, osteomyelitis, temporomandibular joint (TMJ) disorder (TMD), inflammatory and degenerative arthritis, osteonecrosis of the mandible, condylar hyperplasia (CH), bone graft viability, and Paget disease. The anatomic changes related to these disorders are seen on radiography, whereas the activity is assessed by bone scintigraphy. A 10% increase in osteolytic or osteogenic activity is seen using nuclear imaging compared with the 40% to 50% decalcification needed to occur before changes are identified using conventional radiography.[2] Bone scans detect osseous lesions earlier and reveal more lesions than radiography. With renal excretion, high target to background ratio is reached at 2 to 3 hours. The patient is encouraged to be well hydrated to decrease the radiation dose to the bladder.[3] Images of areas of interest are obtained at 3 hours following the intravenous administration of 10 to 20 mCi of the radiopharmaceutical. Voiding before imaging is necessary because accumulation of excreted radiopharmaceutical in the bladder can obscure the pelvis. When osteomyelitis or cellulitis is suspected, radionuclide angiography followed by blood pool images are also obtained. Blood pool images in adults are obtained 5 minutes postinjection but in pediatrics are obtained immediately and no later than 4 minutes after flow because children have rapid bone metabolism.[4] Dual-head cameras can acquire anterior and posterior whole-body images simultaneously. It is important to avoid patient motion. Imaging may take 20 to 30 minutes or more. Higher resolution images are obtained with magnification views. To investigate smaller areas of interest, pinhole collimation improves spatial resolution but acquisition time is prolonged.[5]

^{18}F-FLUORIDE BONE SCAN

^{18}F-Fluoride is a highly sensitive bone-seeking PET tracer. ^{18}F-fluoride is produced in a cyclotron from ^{18}O-water. The most frequent indication for ^{18}F-fluoride PET is