New Positron-Emission Tomography/Computed Tomography Imaging for Bone Metastases

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With the increase in new therapies to treat cancer, improved diagnostic tools are needed to help determine best treatment options. Many radiopharmaceuticals used with positron-emission tomography/computed tomography have been tested to evaluate solid cancers. Two of the newer radiopharmaceuticals are 18F sodium fluoride and radiolabeled choline. This article reviews these new technologies, providing background and potential clinical use.

At a Glance
• Several new radiotracers have been developed and are being evaluated in clinical oncology practice.
• These new radiopharmaceuticals are being used with positron-emission tomography/computed tomography imaging.
• This new type of imaging may allow for earlier detection of metastases than traditional methods.

Bone is one of the most common sites for distant metastases from cancer. Metastatic disease is a more frequent cause of cancer in the bone than primary bone tumors, and bone is the third most common organ affected by cancer after the lung and liver (O’Sullivan, Carty, & Cronin, 2015). Of the primary tumors that metastasize to the bone, the most common are breast, prostate, thyroid, renal, and lung cancers (Bastawrous, Bhargava, Behnia, Djang, & Haseley, 2014). Metastatic lesions may initially cause little to no symptoms and may be diagnosed incidentally during the staging evaluation. Bony metastatic disease mainly involves the vertebral column, sacrum, pelvis, and proximal femurs. Within the vertebral column, the most common site is the lumbar spine, followed by the thoracic and cervical spine (Choi & Raghavan, 2012).

Detecting bone metastases through imaging is important for staging purposes. Imaging helps to identify the lesion and directs further care, such as a biopsy for diagnostic purposes and staging, or further imaging to identify oncologic emergencies, such as a spinal cord compression. The choice of imaging is determined based on clinical presentation and pathologic diagnosis.

Characteristics of Bone Metastases

Bone metastases are characterized as osteolytic, osteoblastic, or mixed. Osteolytic means that the tumor causes bone breakdown. On x-ray, this looks like a hole or lucency within the bone. Osteolytic disease is seen in multiple myeloma, melanoma, renal cell carcinoma, and thyroid cancers. Osteoblastic disease is characterized by the deposition of new bone formation because of activation of osteoblasts. Although these areas are harder because of the deposition of additional bony tissue, they are actually weaker than normal bone tissue. Examples of tumors that have predominantly osteoblastic bony metastases are prostate cancer, Hodgkin lymphoma, and small cell carcinoma of the lung (Fang & Xu, 2015).

Imaging

For decades, the imaging of osseous metastatic disease has been obtained by a bone scan with the most commonly used tracer, technetium 99m methylene diphosphonate. This tracer accumulates in areas of increased osteoblastic activity, providing information on the entire skeleton. The bone scan has been shown to be an effective, low-cost, and widely available test (Cuccurullo, Cascini, Tamburrini, Rotondo, & Mansi, 2013). The bone scan is useful for evaluating osteoblastic lesions found in lung and prostate cancers but is less useful for osteolytic tumors, such as multiple myeloma. The addition of single photon emission computed tomography (SPECT) to bone scans has improved diagnostic accuracy. However, SPECT does not improve the sensitivity for lytic lesions (Yang, Liu, Wang, Xu, & Deng, 2011).

Another diagnostic test, the 18F fluoro(deoxyglucose positron-emission tomography (18F-FDG-PET), is useful for diagnosing metastatic disease, including