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Advanced Imaging Digest

Radiology trends: Cone-beam breast computed tomography, PET-MRI, breast-specific PET and isotopes

Cone-beam breast computed tomography

Cone-beam computed tomography, a variant of computed tomography (CT) typically used in dental and extremity imaging, has recently found a new application in dedicated breast imaging. Unlike conventional CT, which uses a fan-shaped x-ray beam and one-dimensional detectors, cone-beam breast computed tomography (CBBCT) uses a cone-shaped x-ray beam and two-dimensional detectors.

CBBCT can be performed without contrast (i.e., non-contrast technique or NC-CBBCT) or after the intravenous administration of iodinated contrast media (i.e., contrast-enhanced CBBCT or CE-CBBCT). Administration of intravenous contrast has been shown to improve breast lesion detection compared to non-contrast exams. CBBCT yields a high average glandular dose, absorbing between 6–25 milligray of radiation to the breast.

Recent CE-CBBCT studies have focused on patients with dense breast tissue and/or patients with MRI contraindications. A few studies have reported superior diagnostic accuracy and sensitivity for 3D-CBBCT over ultrasound and mammography. A study of 41 patients with dense breast tissue (ACR type C or D breast density) demonstrated that the diagnostic accuracy of CE-CBBCT and MRI is superior to mammography and NC-CBBCT. Compared to MRI, CE-CBBCT has shown greater specificity, or ability to distinguish those with disease from those without, and lower sensitivity, or ability to identify true positive cases.

Magellan Healthcare clinical leaders continually review imaging trends and needs in light of current medical concerns, available literature, and society and Centers for Disease Control and Prevention recommendations and guidelines. This document is a summary of our latest findings. Please consult references for detailed information.

While accuracy was comparable in the diagnostic setting, further studies that directly compare CBBCT and breast MRI are warranted. Due to the small number of studies and patients reporting utilization of CBBCT, the ability of studies to fully detect differences in diagnostic performance are limited.

Magellan Healthcare does not recommend use of CBBCT at this time and will continue monitoring the literature.

Positron emission tomography-magnetic resonance imaging

Positron emission tomography-magnetic resonance imaging (PET-MRI) is a relatively new imaging technique. Worldwide, the number of PET-MRI systems is gradually increasing, with most systems being installed in tertiary care centers.

Although the scanning time with PET-MRI is typically longer than with PET-CT, they generally perform equally well, with PET-MRI having some advantages. PET-MRI reduces radiation exposure and has a higher soft-tissue resolution, often eliminating the need for additional dedicated MRI exams to evaluate the brain and/or liver.

One study found that PET-MRI caused management changes in eight percent of cancer patients who also underwent PET-CT. This change was primarily due to the superior performance of PET-MRI in detecting brain and liver metastases. However, PET-CT is superior in detecting lung lesions. This study also found that brain and liver metastases detected by the MRI component of PET-MRI caused management changes in 90% of patients. Additionally, lung lesions detected exclusively by PET-CT did not affect management in any patient.

Magellan will continue to monitor the literature for possible incorporation into upcoming guidelines.

Breast-specific positron emission tomography imaging

Traditional positron emission tomography (PET) imaging using supine positioning is suboptimal for detecting isolated breast lesions. Recent studies suggest that prone positioning could be used to assist in identifying breast lesions. Dedicated PET scanning modalities for the breast are in development, including positron emission mammography (PEM) and PET.

PEM uses two planar or curved detectors that scan the breasts with mild compression. The detectors have significantly improved spatial resolution, allowing functional imaging of breast cancer earlier in the disease process than whole-body PET. PEM could play a future role in classifying suspicious calcifications detected in standard mammography, potentially improving accuracy to 95%. Acquisition geometry is currently a major limitation of PEM that can affect the clear imaging of structures at the edge of the camera near the chest wall. The addition of CT helps the PEM system to scan the breast uncompressed and the lesions three-dimensionally, capturing high-resolution breast images using multiple rotating planar detectors that help overcome the limitations of PEM. Currently, PEM has not been studied in large cohorts of patients or compared to conventional modalities such as MRI which does not cause radiation exposure.

In a small study, dedicated breast PET was unable to reliably characterize MRI indeterminate lesions as suspicious for malignancy or benign.

At this time, Magellan does not recommend the use of PEM or PET for detection of isolated breast lesions and will continue to monitor the development of this technology.

Isotopes

Copper Cu 64 dotatate
Copper Cu 64 dotatate (Cu-64 dotatate), sold under the brand name Detectnet, is a radioactive diagnostic agent indicated for use with positron emission tomography (PET) for localization of somatostatin receptor positive neuroendocrine tumors (NETs).

FDA approval in September 2020 was based on two trials. The first was a single-center trial that enrolled patients with known or suspected NETs and healthy volunteers. The second reanalyzed data from a published single-center trial that included 112 patients with histories of NETs and compared Cu-64 dotatate imaging with results from other imaging and biopsies.

Cu-64 dotate has a long half-life, which helps eliminate reliance on generators at imaging sites and provides a more flexible scanning window. Its physical half-life is 12.7 hours compared to Gallium-68 dotatate (Ga-68 dotatate), which has a physical half-life of 1.1 hours. Cu-64 dotatate has traditionally had a higher radiation exposure; however, recent studies indicate the exposure is comparable to Ga-68 dotatate.

When assessed per patient, Cu-64 dotatate and Ga-68 dotatate had the same 100% sensitivity, 90% specificity, 98% positive predictive value and 100% negative predictive value. However, on a per lesion basis, Cu-64 dotatate correctly identified more true-positive discordant lesions 83% of the time, compared to 17% of the time for Ga-68 dotatate. This was attributed to the physical properties of Cu-64 dotatate compared to Ga-68 dotatate. The shorter positron range of Cu-64 dotatate resulted in better spatial resolution, improved image quality and superior detection of smaller lesions.

Considering the recent FDA approval, Cu-64 dotatate is an advantageous alternative to Ga-68 dotatate and offers a long-term economic advantage, partly due to its higher half-life, which allows for a more flexible scanning window. Additionally, Cu-64 dotatate has a lower positron range than Ga-68 dotatate, resulting in better PET spatial resolution. Overall, the greater flexibility, availability and accuracy of Cu-64 dotatate, in addition to its financial advantages, result in it being preferable over Ga-68 dotatate in most instances.

This isotope has been included as an alternate to Ga-68 dotatate in Magellan's upcoming 2022 PET guidelines.

Gallium Ga 68 prostate-specific membrane antigen-11 (Ga68-PSMA-11)
The effect of 18F-DCFPyL, a prostate-specific membrane antigen-targeted radiotracer, on patient care was assessed in the CONDOR trial and included 208 men with rising prostate-specific antigen levels after definitive treatment for prostate cancer and with negative or equivocal results on standard imaging such as computed tomography, magnetic resonance imaging or bone scintigraphy. After the 18F-DCFPyL scan, 63.9% of patients had a management change. Of these, 21.0% had their care goal changed from noncurative systemic therapy to salvage local therapy, 28.3% had a change from salvage local therapy to systemic therapy, 23.9% switched from observation to initiating therapy and 4.4% went from planned treatment to observation.

Multiple studies show superior detection rates for Ga68-PSMA-11 PET/CT when compared with 18F-fluciclovine PET/CT in patients with recurrent prostate cancer after definitive treatment. Ga68-PSMA-11 has a higher sensitivity over 18F-fluciclovine with low prostate-specific antigen (PSA) levels, even below 0.5ng/ml. When compared with current radiotracers, it is the most sensitive test for low levels of PSA. Preliminary outcome data show that PSMA PET has resulted in modification of patient treatment plans.

Magellan has incorporated this isotope into its upcoming 2022 PET guidelines.

Amyloid positron emission tomography radiotracers
Amyloid imaging utilizing positron emission tomography (PET) is developing a role in the treatment of Alzheimer's disease (AD). The imaging is based on the detection of beta amyloid plaques (Aβ) on autopsy, the hallmark of AD. Magellan is monitoring the use of several radiotracers, including ^{11}C-labeled Pittsburgh Compound-B ([^{11}C]PiB), also known as 2-(4-N-[^{11}C]methylaminophenyl)-6-hydroxybenzothiazole, and [^{18}F]Florbetapir ([^{18}F]FBP), also known as ^{18}F-AV-45 or 4-{(E)-2-[6-(2-{2-[2-(18F)Fluoroethoxy]ethoxy}ethoxy)-3-pyridinyl]vinyl}-N-methylaniline.

With an approximate half-life of twenty minutes, [^{11}C]PiB is restricted to imaging centers that have an on-site cyclotron facility. Studies have shown retention of [^{11}C]PiB in areas of the cerebral cortex that have been identified to contain fibrillar Aβ plaques in AD patients. Approved by the FDA in 2012 for subjects who are being screened for AD or other causes of cognitive decline, [^{18}F]FBP has an approximate half-life of 110 minutes, providing some flexibility in imaging duration. It has been proven to be a highly accurate method of detecting amyloid deposition in the brain and is being used in the Alzheimer's Disease Neuroimaging Initiative project and several phase III clinical trials of experimental AD drugs.

Magellan will continue to monitor the literature for future developments.

About the authors

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Dr. Khalid joined Magellan in 2014. As a board-certified diagnostic radiologist with a career spanning more than twenty years, he has a thorough understanding of the complexities of the U.S. healthcare system and current standards of care. In his current role, Dr. Khalid is involved in training new physicians, auditing, continuing education and policy development. His experience managing over 185 physicians performing utilization management reviews has afforded him the business acumen to be successful in many arenas of healthcare beyond just coverage of services.

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