Technical Note

Humanoid Training Phantom for Positron Emission Tomography-Computed Tomography-Guided Percutaneous Biopsy

Abstract

Positron emission tomography-computed tomography (PET-CT)-guided biopsy is being increasing practiced worldwide with indications in sampling of lung, abdominal, bone lesions, and among others. Training for PET-guided Interventions at select centers is carried out under supervision of an expert on real patients, similar to training for interventional radiology procedures. Simulation center training has been shown to be useful in improving efficiency of resident trainees. We report the development of concept, design, and practical application of a simplified humanoid training phantom for PET-guided interventions.

Keywords: *Percutaneous biopsy, positron emission tomography-guided biopsy, training phantom*

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Positron emission tomography-computed tomography (PET-CT)-guided biopsy is being increasing practiced at select centers worldwide with reported indications in lung, abdominal, bone lesions, and among others.[1,2] Like other interventions, training in PET-guided interventions relies on assisting/conducting procedures under supervision of an expert on patients. Though this mode is well accepted, direct hands-on training can risk patient safety, and other methods of simulated training need to be devised to learn the complex set of skills involved in interventions. Simulation center training has been shown to be useful in CT-guided fluoroscopic procedures by decreasing procedural time, radiation dose, and improving efficiency of the resident trainees.[3] Commercially available phantoms for image-guided intervention training (ultrasonography, CT, magnetic resonance) are very costly and need replacement after multiple needle insertions. Few training centers have reported the development of in-house low cost phantoms for CT-guided procedures.[3,4]

We report the development of concept, design and practical application of a simplified humanoid training phantom for PET-guided interventions. Figure 1a shows picture of the humanoid phantom with head and torso having outer skin like layer made of silicone rubber, which allows the biopsy needle to be inserted easily. Figure 1b shows the main frame made of fiberglass with spaces cut to simulate intercostal spaces and allow insertion of needle. Figure 1c shows the interior filled with dense foam, which shows low attenuation on CT and simulates lungs. A small part of foam is cut between layers to allow for placement of lesion with radioactivity injected in it (1c, arrowhead). We simulated a lesion using semi-cooked potato (shows tissue equivalent attenuation on CT) and injected 0.1 mCi Gallium-68 radioactivity (in 0.1–0.2 ml volume) on one side. Figure 1d shows initial scout image obtained after placing the phantom on PET-CT bed. Note the intercostal spaces and nipple markings visible on the chest scout image. Thin slice CT (1.25 mm slice thickness) followed by 2 min PET acquisition for one bed position were acquired for biopsy planning. Trans-axial PET-CT and CT images [Figure 1e and f] showing tracer activity within soft-tissue attenuating lesion placed in the left side of chest phantom. Figure 1g and h shows targeting of lesion using semi-automatic biopsy needle. Targeting of the lesion can be done using lasers, skin markers, or automated robotic guidance systems. The lesion location and size is modifiable and a trainee can learn to target smaller lesions (1 cm) over time.

In addition to PET-CT, this indigenously developed phantom can also be used to simulate lesion for CT guided interventions

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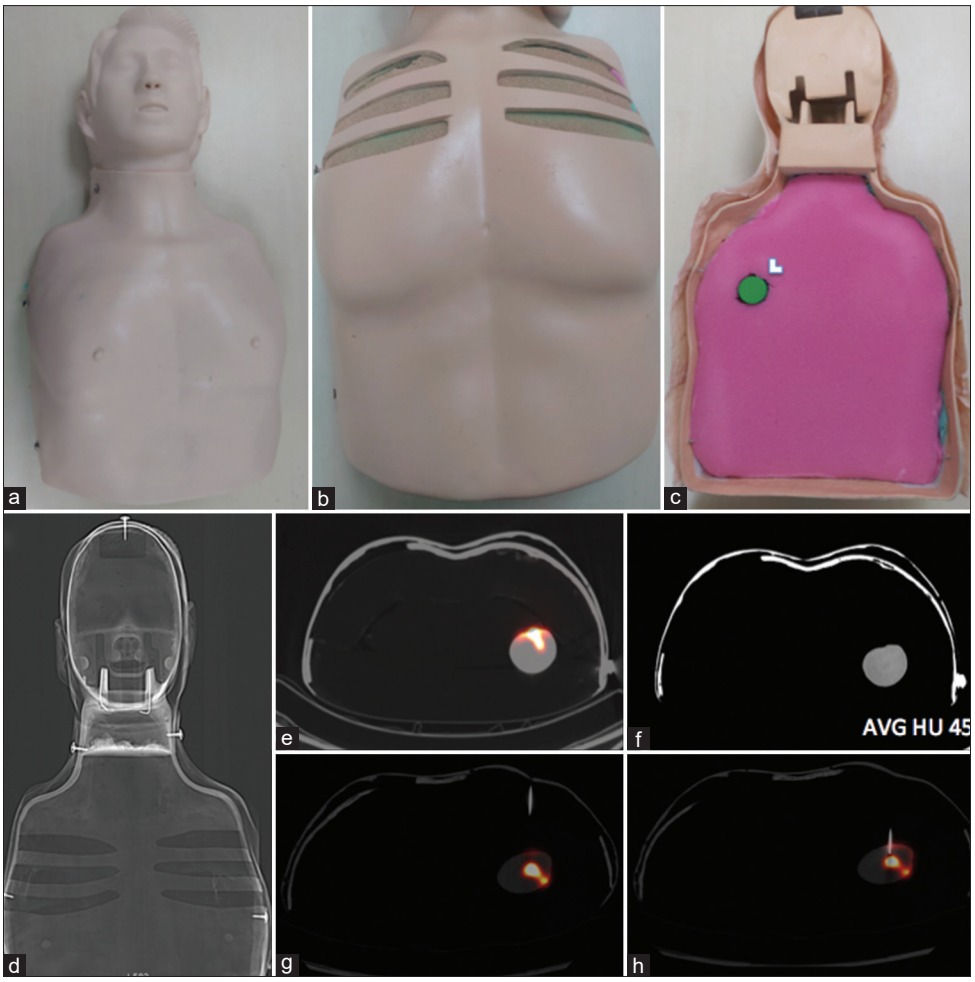

Figure 1: Showing pictures of the humanoid phantom having outer skin like layer (a), body frame with spaces cut to simulate intercostal spaces (b) and interior filled with dense foam (c), which simulates lungs with space for lesion placement (c, arrowhead). The initial scout image obtained after placing the phantom with radioactive lesion placed within (d). Trans-axial PET/CT and CT images (e-f) show tracer activity within soft tissue attenuating lesion placed in left side of chest phantom. Targeting of lesion using semi-automatic biopsy needle (g-h) can be done using lasers, skin markers or automated robotic guidance systems.

too. A limitation of this initial prototype is that it does not have inbuilt movement simulation, as lesions in lungs move with respiration and can lead to errors in sampling. The development of a more technically advanced phantom can overcome this limitation. Training and practice on phantom in a PET-CT-guided intervention training program can lead to improved performance of interventionist with possibility of reducing procedure time, radiation dose and outcomes with regard to diagnostic sampling, patient care, and safety.

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Conflicts of interest

There are no conflicts of interest.

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