FDG PET/BT’de Sık Görülen Görüntüleme Artefaktları: Ortadan Kaldırılabilirler mi?

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Özet: [18F]-2-floro-2-deoksi-D-glukoz (FDG) pozitron emisyon tomografisi (PET)/bilgisayarlı tomografi (BT) görüntülerini yorumlayan hekimlerin, teknik nedenlere bağlı sıkça ortaya çıkan görüntüleme artefaktlarını tanımaları gerekir. En sık görülenleri ve en önemlileri atenüasyon düzeltme artefaktları, metalik implantlar veya yoğun kontrast maddeler gibi yüksek dansiteli materyallere bağlı artefaktlar, solunum hareket artefaktları ve trunkasyon (kesme, budama) artefaktlarından. Her bir artefakt FDG PET/BT uygulamaları ile ilgili önlemler alınarak veya hasta doğru şekilde hazırlanarak ortadan kaldırılabilir veya asgariye indirilebilir.

Anahtar Kelimeler: Fluorodeoksiglukoz F18, pozitron-emisyon tomografi/bilgisayarlı tomografi, artefaktlar

Common Imaging Artifacts on FDG PET/CT: Can They be Eliminated?

Abstract: Physicians who are in charge with interpretation of fluorine-18 fluorodeoxyglucose (FDG) positron emission tomography/computed tomography (PET/CT) images should be familiar with the imaging artifacts which occur frequently, due to technical reasons. The most common and important ones are attenuation correction artifacts, artifacts due to high-density materials such as metallic implants or concentrated contrast material, respiratory motion artifacts and truncation artifacts. Each artifact can be eliminated or minimized by taking certain measures regarding the FDG PET/CT applications or preparing the patient properly.

Keywords: Fluorodeoxyglucose F18, Positron-Emission Tomography/Computed Tomography, Artefacts

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INTRODUCTION
In today’s medical era the hospital departments taking care of oncology patients are among the most dedicated ones particularly in tertiary hospitals (1, 2). Fluorine-18 fluorodeoxyglucose (FDG) positron emission tomography/computed tomography (PET/CT), is a noninvasive imaging method which is most frequently used for staging and evaluation of response to treatment in oncology cases, giving very significant qualitative and quantitative data about metabolic activity of target tissues (3–5). Expert image interpreters who are involved with FDG PET/CT, should be familiar with the frequently seen imaging artifacts which occur mostly due to technical reasons. These artifact have a high potential to cause misinterpretation of the FDG PET/CT images. The most common and important ones are attenuation correction artifacts, artifacts due to high-density materials such as metallic implants or concentrated contrast material (CM), respiratory motion artifacts and truncation artifacts (6–8). Not only recognizing these artifacts but also having sufficient experience to eliminate them or to decrease their effects are of utmost significance in daily FDG PET/CT practice.

Common imaging artifacts on fdg pet/ct and the methods to eliminate or to minimize them
Attenuation correction artifacts result from misalignment (misregistration) between the data from PET and CT components, mostly due to change in patient position (9). Referring to PET images without attenuation correction and fusion images can help discriminate them (6). Deficiencies and errors in change over of polychromatic CT energies and the annihilation radiation (511-keV) can be another source of artifact particularly in the vicinity of metallic objects (i.e. instrumentation) or concentrated oral CM such as barium. Because of their high Hounsfield unit values, intracorporeal high density objects such as metallic bone prostheses and dentistry materials cause high PET attenuation coefficients and overestimation of the activity (7, 10). PET images without attenuation correction are particularly useful in evaluation of the patients with metallic dentistry materials (11) or smaller metallic objects such as pacemakers and chemotherapy catheters (9). As a precaution, the patient should take out all the removable metallic objects before the imaging. However, large metallic bone instrumentations such as hip prosthetics also attenuate 511-keV
photons causing photopenic region on PET images with and without attenuation correction (7). In such patients obtaining a detailed medical history and referring to other imaging data (i.e. plain radiographs) can help reveal large metallic bone instrumentations. Besides metallic objects, high concentrations of oral CM (i.e. barium) also leads to overestimation of the PET activity, whereas with lower concentrations this risk is avoided (12). Taking the oral CM which has been administered in previous days into account is also important, because water reabsorption from the intraluminal CM increases with time and causes higher CM concentrations. In such CM related false-positive findings PET images without attenuation correction are useful (7). A negative oral contrast agent solution containing 0.2% locust bean gum and 2.5% mannitol dissolved in water was reported to be successfully used to eliminate oral CM artifacts in FDG PET/CT by Antoch et al (13). Utilizing proper algorithms can also help decrease the artifacts caused by both metallic intracorporeal objects and high density oral CM (6, 10, 14).

Respiratory motion artifact which was stated to be the most common FDG PET/CT imaging artifact (15), occur because of the failure of overlapping between the images of the chest on CT component and of those on PET (7) due to the extended acquisition time of the PET component when the patient breaths liberally (16). Respiratory motion artifacts can cause a hepatic lesion to mimic a nodule at the right lower lobe of the lung (17). This artifact can also cause difficulties in PET/CT-guided biopsies (18). Additionally, a curvilinear photopenic region at the lung–diaphragm junction may be seen when the diaphragm is at lowermost position during full inspiration (9). In order to decrease this artifact, capable patients should be instructed to hold their breath at mid-expiration or mid-inspiration (7). However, shallow-breathing method can be tried in incapable patients who fail to hold their breaths. In indeterminate cases, other imaging tools such as chest radiographs, chest CT, ultrasonography or magnetic resonance imaging of upper abdomen are helpful. New respiratory motion correction methods are being proposed to overcome this artifact during PET/CT-guided biopsies such as using registered and summed phases method (18) and to make proper diagnoses on thoracic FDG PET/CT images such as cine-averaged CT combined with shallow breathing (19).
As another important artifact, the problem of truncation which occur because of the discrepancy between fields of view (FOVs) of CT and PET components can be challenging, particularly in oversized patients and/or in the patients with the arms on their sides (i.e. in malignant melanoma cases) (20). In these cases, the region of the body which extends beyond the FOV of CT is cut and can not be seen in the reconstructed CT images which causes failure in attenuation correction for these body parts (7). As the result, truncation artifacts are demonstrated as a line of increased activity (overestimation) at the side of the truncated CT image with a neighboring region of decreased activity (underestimation) peripherally (20). The simplest way to reduce these artifacts is to place the patients at the center of FOV. Holding the arms above the level of the head in all suitable patients is also an important measure. Another recommended method is the use of truncation-correction algorithms which restore the anatomy of the imaged part as much as possible, decreasing truncation artifact with little error (3, 21).

CONCLUSION
In conclusion, imaging artifacts on FDG PET/CT are not uncommon and thorough knowledge about them is necessary for their recognition. Qualified and experienced FDG PET/CT technician is necessary for patient preparation and for obtaining ideal images. Each artifact can be eliminated or minimized by taking certain measures regarding the FDG PET/CT applications or preparing the patient properly before the imaging.

Conflict of Interests
The authors declare that they have no conflict of interests.

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