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Application and clinical application of PET/CT in disease diagnosis limitation

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Abstract

At present, the time of multi-slice CT for cardiac scanning has reached 125 ms, which is close to the scanning time of electron beam CT, but the image signal-to-noise ratio and spatial resolution are better than electron beam CT, so the diagnosis of diseases is close to or Reaching the level of electron beam CT, multi-slice spiral CT is the only way to display coronary soft plaque after reorganization, and coronary soft plaque is an important factor in coronary heart disease emergency, so multi-slice CT equipment has been widely used. Soft plaques in the coronary lining can be resolved and non-invasive coronary imaging can be performed. This article analyzes and compares the two from the perspective of their principle and temporary practical application, and summarizes and analyzes their respective characteristics and clinical limitations.

Keywords

PET/CT; coronary artery disease; coronary imaging; clinical limitations.

1. The value of PET/slice CT in the imaging diagnosis of coronary heart disease

In general, the time for 8-16-slice CT to scan the heart can reach 125 ms or less (<65 ms), which is close to the scanning time of electron beam CT (EBCT or EBT) (50ms or 100ms), but the image quality is not enough. The noise ratio and spatial resolution are better than electron beam CT, so the display of coronary arteries, cardiac chambers, valves and other structures has approached or reached the level of electron beam CT. Coronary artery soft plaque is an important factor in coronary heart disease emergency. 8-16-slice CT equipment has been able to distinguish soft plaques with a size of 0.16mm in the inner wall of coronary arteries, and non-invasive coronary imaging can be performed. . From the perspective of clinical application, multi-slice CT imaging of coronary soft plaque and non-invasive coronary imaging is as important as radionuclide myocardial perfusion and metabolic imaging, and has an important guiding role in the decision-making of coronary heart disease treatment. The examination can complete the examination of coronary soft plaque imaging, non-invasive coronary imaging, myocardial perfusion and metabolic imaging, which is the great advantage of PET/multi-slice CT in the diagnosis and treatment of coronary heart disease. Secondly, multi-slice spiral CT cardiac functional examination-myocardial perfusion and myocardial stress perfusion, myocardial blood flow reserve measurement, etc. have been further developed. PET/slice CT can be used for CT myocardial stress perfusion and radionuclide in this regard. The comparative study of myocardial perfusion imaging and the optimal combination of the two methods can truly reflect the relationship between myocardial metabolism and coronary artery disease. This new technology will provide more valuable information for the diagnosis and clinical treatment of coronary heart disease. In addition, realizing the fusion of 3D diagnostic information of anatomy, phase motion, metabolic state and receptor distribution of cardiac images will bring a new concept to the diagnosis and treatment of coronary heart disease.

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2. The diagnostic value of PET/CT in cerebrovascular disease

Spiral CT can obtain quantitative analysis parameters, curves and images such as cerebral perfusion peak time (PT), peak value (PH), mean transit time (MTT), regional cerebral blood volume (rCBV), and cerebral blood flow (rCBF). This test is mainly used in the early diagnosis of patients with acute cerebral ischemia (within 6 hours of onset) or hyperacute cerebral ischemia (within 3 hours of onset). Compared with PET cerebral perfusion and metabolic imaging, CT perfusion imaging has better spatial resolution and time resolution, and the examination is convenient and rapid, which is suitable for emergency patients; however, cerebral CT perfusion imaging can only reflect the pathophysiology of cerebral blood perfusion. It cannot reflect the metabolic status of brain tissue or neurons, especially the judgment of cerebral ischemic penumbra (recoverable ischemic focus) and infarcted area is difficult, and FDG imaging can just make up for CT perfusion imaging metabolism. The lack of information is insufficient, so that one FDG PET/CT examination can obtain cerebral perfusion and metabolic diagnostic information at the same time, which can significantly reduce the cost of examination and increase clinical operability. The clinical treatment decision-making has greater clinical research value.

3. Contribution of PET/CT to Molecular Imaging

Many specific molecular imaging agents or molecular probes labeled with positron radionuclides are the main methods and approaches for molecular imaging. Relying solely on PET equipment for molecular imaging, due to the inherent limitations of image resolution and the lack of anatomical structures As a reference for localization, actual clinical research is difficult, and PET/CT can provide high-quality localization images of anatomical structures, making positron nuclide-labeled molecular imaging techniques such as receptor imaging, antisense imaging and Gene expression or reporter gene imaging can gain greater clinical acceptance.

4. Limitations in the clinical application of PET/CT

Although PET/CT has been used clinically, we should also clearly see that PET/CT also has some limitations in actual clinical application. If these problems are not fully understood, the diagnosis of PET/CT will also be affected. Misdiagnosis or deviation will bring negative impact on the clinical application and promotion of PET/CT, which should be paid attention to.

1. Imaging of image fusion or lesion localization by respiratory motion

Due to the fast scanning speed of spiral CT, it is hardly affected by physiological motion, especially the 8-16-slice CT is also not affected by heartbeat motion. The influence of physiological motion on image quality during multi-slice CT scanning can be ignored. . However, during the PET imaging process, it takes at least a few minutes for the information acquisition of one bed, which is easily affected by physiological movements such as breathing, heartbeat, gastrointestinal motility, and swallowing movements, especially in the lower lung field, subpleural small lesions and The lesions in the liver parenchyma near the top of the diaphragm are especially affected by respiratory motion, resulting in inconsistent lesion localization on PET images and CT images. Scanning and other measures, even if the PET and CT images are collected using respiratory gating technology, but because the current PET/CT cannot achieve the same detector to collect image information at the same time, it is impossible to completely avoid the effect of respiratory motion on both PET and CT images. The effect of fusion accuracy. For example, small lesions in the lower lung field or subpleural lung are likely to have such results on PET/CT examinations. Small lesions seen on CT images have no obvious radioactivity on the corresponding PET images. Concentrated lesions, but there are obvious radioactive

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concentrated lesions on the PET images of the upper and lower adjacent layers, or there is no abnormality in the corresponding CT images of the radioactive concentrated lesions in the lower lung; Results of wrongly locating lesions in the lower lung parenchyma during CT examination; errors in PET semi-quantitative analysis. Therefore, when analyzing this type of situation, it is recommended that CT images should be used for localization diagnosis, and PET should be used for qualitative diagnosis. When quantitative analysis is required, respiratory gating technology or respiratory gating multi-phase average weighting technology can be used. Of course, when making precise radiation therapy planning, since the PET information collection process is similar to the actual process of patient radiation therapy, it is better to delineate the biological target area of the tumor or the lesion by displaying the fusion image of the lesion.

2. The effect of CT scanning artifacts on the attenuation correction of positron coincidence detection imaging

In the process of PET/CT positron coincidence imaging, X-ray CT is mostly used for attenuation correction. Compared with the traditional radionuclide exogenous attenuation correction results, the CT attenuation-corrected images show that the SUV values of various tissues in the body (except the lungs) are relatively high. The SUV value corrected by exogenous attenuation of radionuclide increases, especially in high-density tissues in vivo, such as bony structures or lesions, with significant differences in the local radioactivity distribution, which may bring the problem of overdiagnosis to PET/CT quantitative analysis and qualitative diagnosis. . High-density structures or foreign bodies in the body, such as metals in the body (cardiac pacemakers, postoperative metal clips, metal implants, etc.), high-density substances (including residual barium in the gastrointestinal tract, etc.), calcifications or cortex in the body The junction of bone and air-containing organs will produce obvious X-ray beam hardening effect or artifact. In addition to affecting the CT image itself, the local measured CT value may be completely inaccurate. The CT image or CT value is used as attenuation correction in accordance with imaging, which will inevitably lead to excessive attenuation correction or false positive results in local areas of PET or imaging. This is particularly important, and its final diagnosis should be combined with non-attenuation corrected nuclear It should be confirmed or corrected by pixel imaging to prevent misdiagnosed results, especially in the case of re-examination of lesions after tumor surgery and re-setting of radiotherapy plans.

3. The use of CT contrast agents

The use of contrast agents before routine CT examination is necessary in most cases. Intravascular and gastrointestinal contrast agents can help localization, qualitative diagnosis and differential diagnosis. Lack of contrast agents in the gastrointestinal tract can reduce the ability of CT to detect and locate intra-abdominal lesions. , In the PET/CT examination, if the gastrointestinal tract lacks contrast agent, the ability to detect and locate the lesions will also be reduced. From the current clinical application experience of PET/CT, the routine application of 1%-1.3% CT contrast agent generally does not affect the attenuation correction and quantitative analysis results of FDG imaging, but the application time of gastrointestinal contrast agent is usually in the FDG imaging should be applied in divided doses 1-2 hours before the examination, and the concentration of the contrast agent should not be too high; in order to ensure that the pelvic cavity can be fully filled with the contrast agent , whether it can be taken orally 12 hours before the PET/CT examination is still unclear. There is no relevant data to confirm or deny, but one thing is certain, patients who have undergone gastrointestinal barium meal examination in a short period of time, due to the residual high-density barium in the intestinal tract, will affect PET or conform to the attenuation correction of imaging and cause false positives results; of course, the use of negative gastrointestinal contrast agents under conditions can avoid the above results. For the use of intravascular contrast agents, it is better to perform CT enhanced scanning again after the PET acquisition is completed. There are data

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reports that due to the influence of high concentration of intravascular contrast agents in the early stage of "bolus method" enhancement, resulting in excessive attenuation correction. False-positive results of radioactive accumulation in vascular structures, for PET/CT examinations in the post-enhanced parenchymal or venous phase, the intravascular contrast agent concentration has been diluted and will not affect the FDG PET/CT attenuation correction results; of course, in order to reduce the Under the premise of X-ray dose, the information of diagnostic enhanced CT can be obtained at the same time, and different CT enhancement sequences can also be used.

4. The influence of different CT scanning parameters on the quantitative analysis of PET imaging

According to different body weights, the parameters of CT scanning are different. For obese patients, due to the obvious attenuation and absorption of low-energy X-rays, the signal-to-noise ratio of CT images is poor. The CT information with poor signal-to-noise ratio is used for PET or coincidence imaging. Attenuation correction, PET or conforming imaging quality is relatively poor or cannot be guaranteed, then it is necessary to change the conditions of CT scanning (such as increasing tube voltage and X-ray exposure dose), etc.; A variety of dose reduction measures have been introduced, such as intelligent filtering technology, automatic mA modulation, automatic A setting, etc. It is not yet known how the adoption of these CT dose reduction measures will affect PET imaging and quantitative analysis after X-ray CT attenuation correction. Further research and exploration are required.

5. Fusion images cannot fully reflect the respective diagnostic information of PET and CT

Radionuclide imaging has its own limitations, mainly false positive and false negative results. The diagnostic information of PET and CT or multi-slice CT images is complementary to each other and confirms each other. In addition to localization, CT or multi-slice CT contains rich It can play a leading role in diagnosis under certain circumstances. It is difficult for a single PET/CT fusion image to express all the diagnostic information of multi-slice CT and PET at the same time, and even mask some valuable diagnostic and differential diagnosis information. . Some data show that the supraclavicular adipose tissue can show a symmetrical increase in radioactivity distribution rather than pathological changes during FDG PET/CT imaging.

Therefore, when analyzing PET/CT results, the results of CT and PET should be analyzed separately, and the results of CT and PET should be analyzed comprehensively and the best conclusion should be drawn. Enhanced or not also has differential diagnostic value.

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