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Usefulness of CT based SPECT Fusion Image in the lung Disease: Preliminary Study

폐질환의 SPECT와 CT 융합영상의 유용성: 초기연구

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— Abstract—

Recently, SPECT/CT system has been applied to many diseases, however, the application is not extensively applied at pulmonary disease.Especially, in case that, the pulmonary embolisms suspect at the CT images, SPECT is performed. For the accurate diagnosis, SPECT/CT tests are subsequently undergoing.However, without SPECT/CT, there are some limitations to apply these procedures. With SPECT/CT, although, most of the examination performed after CT. Moreover, such a test procedures generate unnecessary dual irradiation problem to the patient. In this study, we evaluated the amount of unnecessary irradiation, and the usefulness of fusion images of pulmonary disease, which independently acquired from SPECT and CT. Using NEMA PhantomTM (NU2-2001), SPECT and CT scan were performed for fusion images. From June 2011 to September 2010, 10 patients who didn't have other personal history, except lung disease were selected (male: 7, female: 3, mean age: 65.3±12.7). In both clinical patient and phantom data, the fusion images scored higher than SPECT and CT images. The fusion images, which is combined with pulmonary vessel images from CT and functional images from SPECT, can increase the detection possibility in detecting pulmonary embolism in the resin of lung parenchyma. It is sure that performing SPECT and CT in integral SPECT/CT system were better. However, we believe this protocol can give more informative data to have more accurate diagnosis in the hospital without integral SPECT/CT system.

Key Words : Pulmonary embolus, SPECT, CT, Fusion Image

Ⅰ. Introduce

SPECT (Single Photon Emission Computed Tomography) can give information of the depth-distributions of the radiopharmaceutical in the body through the tomography[1]. The tomography data acquired several plane images by making a gamma camera around the object and recontructed[2]. SPECT was totally equipped and widely applicated since 10 years after

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CT was developed by Hounsfield. Recently, newly developed SPECT using over three detectors can bring high resolution and reduce an examination period, and the radiopharmaceutical applicability is tend to increase[3]. However, SPECT is a molecular imaging for a target–oriented. Therefore, if the target is highly oriented the rest of the region would be hard to see. To solve this, SPECT/CT was developed. CT of SPECT/CT not only offers an anatomical data but also physical data such as information for attenuation and a correction of scattering[4]. During the CT scan, radiopharmaceutical from patient's body will not disturb the imaging process because the amount of gamma ray is low. However, because the relatively high x–ray from CT will effect a change of SPECT data, two systems cannot acquire data at the same time[5].

The recently popularized SPECT/CT system has been applied many diseases. However, it is not used extensively in pulmonary disease[6]. Especially, it occurs to undergo SPECT for confirming the pulmonary embolism from the results of CT, it is important to do SPECT/CT for accurate diagnosis[7]. However, if the patients planned to undergo SPECT/CT, they formerly had CT scan and itmeans unnecessary radiation exposure.

In this study, we will evaluate the Usefulness of Fusion Image of SPECT/CT in Lung disease.

Through the fusion images of SPECT and CT in hospital without SPECT/CT system, and reduce the possibility of unnecessary radiation exposure.

Ⅱ. Materials and Methods

1. Phantom imaging acquisition

1–1. Phantom preparation

Using NEMA Phantom™ (NU2–2001) (Fig. 1) radiopharmaceutical were put into several spheres and background–scatter was made to the image contrast. ^{99m}Tc 1.0 mCi was put into the beaker with sterile water and stirred for 10 minutes using magnetic stirrer with magnetic bar. To put an accurate amount, air bubbles were removed by using a measuring flask, a funnel, and a syringe.

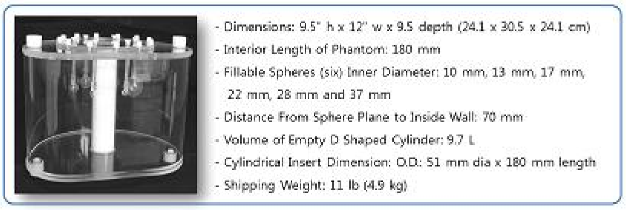

Figure 1. NEMA PhantomTM (NU2-2001)

1–2. Gamma camera image acquisition

Infinia (General Electric Healthcare, Wisconsin, MI, USA)–Detector type:mode, zoom: 1.0, Matrix size: 128 X 128, Scan type: Step and Shoot–has used as a SPECT system with 30 seconds per projection. Total angular range was 360 degrees, view angle was 6 degrees (6 degrees per sector for 180 degrees)

1–3. CT image acquisition

Using NEMA Phantom™(NU2–2001), Effective mAs 35, 120 kVp, Slice 5.0 mm, Pitch 1.15, Rotation Time 0.5 s, and FOV 500 mm CT were used as parameters.

1–4. Image analysis

The acquired SPECT and CT data were reconstructed by Multimodality Workstation (Siemens Medical Systems, CTI, Knoxville, TN, USA) to the fusion images. Three of nuclear medicine specialists evaluated the fusion images through blind test. Five–score tests were performed and ANOVA was used for a statistical test.

2. Clinical image acquisition

2–1. Subjects

From Sept. 2010 to June 2011, 10 patients who don't have other personal history except lung disease were subjected(male: 7, female: 3, mean age: 65.3±12.7). If there were some suspicious about lung disease at an initial gamma scan, the SPECT scan was added(Fig. 2). CT images were applied for fusion images from department of radiology.

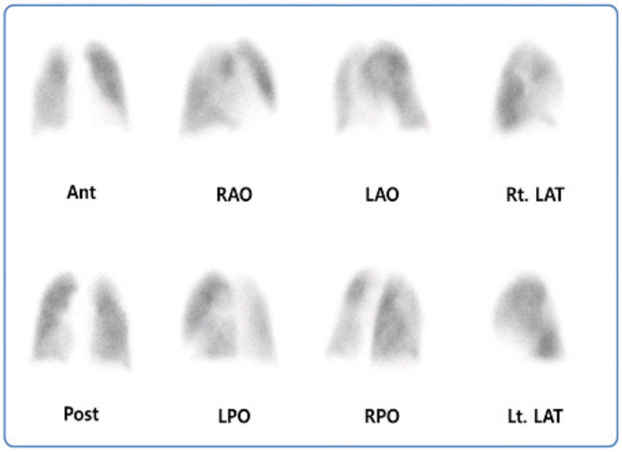

Figure 2. Lung images of gamma camera

2-2. Acquiring systems

Infinia (General Electric Healthcare, Wisconsin, MI, USA) and Biograph (Siemens

Medical Systems, CTI, Knoxville, TN, USA) have used for SPECT and CT system, respectively(Fig. 3).Total angular range was 360 degrees, view angle was 6 degrees (6 degrees per sector for 180 degrees). Both conditions were a same as the clinical one.

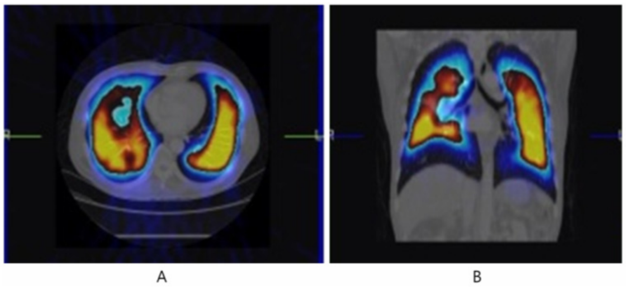

Figure 3. Lung fusion images (SPECT with CT), (A: tansaxial, B: coronal)

2-3. Image analyze

Three of nuclear medicine specialists evaluated the fusion images through blind test.

For a lesion distinction, the clinical value was scoring from SPECT, CT, and Fusion data

ANOVA was used for a statistical test.

Ⅲ. Results

1. Phantom image

Using Multimodality Workstation, SPECT and CT images have made as the Fusion images(Fig. 4). Five-score tests were performed from blind test. In SPECT, 6mm of sphere shows average 2 points, 13 mm of sphere shows 2.67 points, and as the size of spheres were large, the point scores higher(Fig. 5). In CT, 6 mm of sphereshows average 2.67 points which is higher than the score of SPECT, as the size of spheres were large, the point scores higher as well as SPECT(Fig. 6). In Fusion images, 6 mm sphere shows average 3.67 points which is higher than SPECT and CT (Fig. 7). However, over 28 mm of sphere, all the scores shows large points so that there was not much differences. Overall, there were high scores in fusion images(P〈0.005).

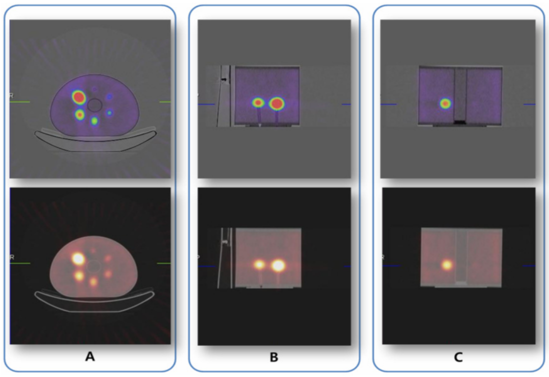

Figure 4. NEMA Phantom^{TM} (NU2-2001) 6 sphere was used for SPECT and CT scan, Multimodality Workstation was used for the Fusion images' acquisition and evaluation. (A: Transaxial images, B: Sagittal images, C: Coronal images)

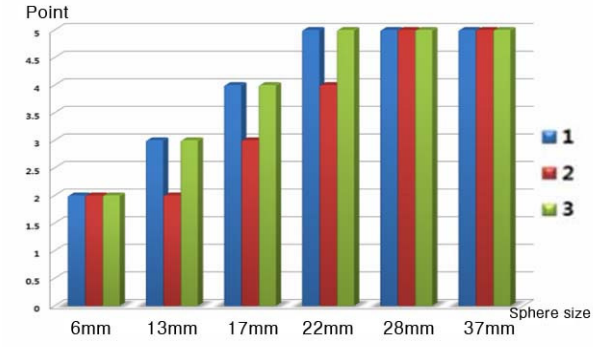

Figure 5. Results of blind test from SPECT phantom images

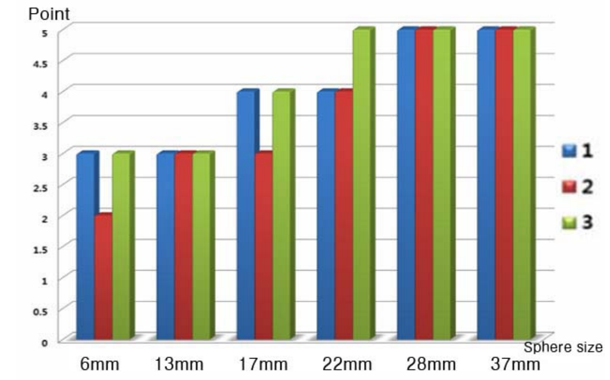

Figure 6. Results of blind test from CT phantom images

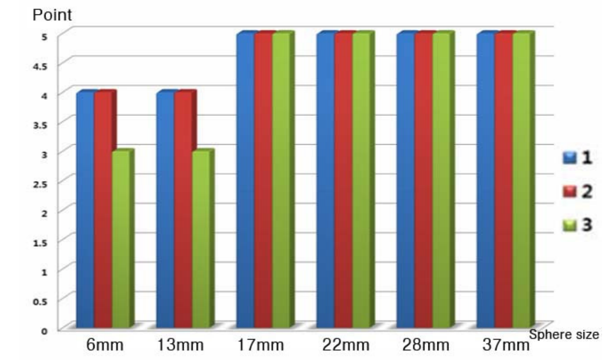

Figure 7. Results of blind test from fusion phantom images

2. Clinical image

SPECT, CT, and Fusion image were scored. SPECT shows average 3 points, CT shows average 3.67 points, and Fusion image shows average 4.67 points(Fig. 8). Individual differences for diagnosis of interpreters can occur in order to confirm the usefulness of pulmonary embolism, they found more diagnostic values on the fusion image than SPECT and CT.

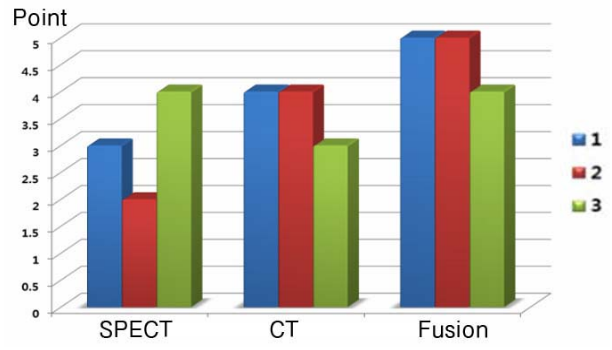

Figure 8. A score distribution of SPECT, CT, and fusion

Ⅲ. Discussion

The nuclear medicine examination of lung disease is commonly performedto diagnose for pulmonary embolism. Many cases of the pulmonary embolism show nonspecific and normal in x-ray images. Simple x-ray is commonly performed for a diagnosis by exclusion[8].

CT scan have recently used for pulmonary embolism. In the case of a central pulmonary artery embolism, a defective region can be observed by the contrast media in the enhanced CT scan. CT has a high sensitivity to evaluate a chest pain and dyspnea. However, contrast enhanced CT has a limitation to the patients who have side effect from contrast media and renal failure[9]. A pulmonary CT angiography has high specificity and is standard examination in pulmonary embolism. If blood deficiency and acute vascular occlusion were seen in CT scan, it can be diagnosed as the pulmonary embolism[10]. However, CT has limitations of diagnosing the distal pulmonary embolism and is invasive. Interventional procedure such as trombolysoangioplasty and embolectomyneeds to CT scan for guiding. Gamma camera scan and SPECT scan are non-invasive, have low patient risk, and have been proved its usefulness for decades. Gamma camera scan and SPECT scan give comparativelylow-radiation exposure than CT scan so that it can apply to pregnant patients and have no side effects from contrast media. According to several journals, CT exposure to human is 8~10 mSv and SPECT exposure to human is 2 mSv[11].

SPECT/CT for the definite diagnosis by the high quality images can be ideal system. However, if the patients planned to undergo SPECT/CT, they formerly had CT scan and it means unnecessary radiation exposure to the patients[12].

In this study, we will evaluate the clinical usefulness of fusion image of SPECT/CT through the fusion images of SPECT and CT of the phantomand the clinical patients, and nuclear medicine specialists assessed the fusion images as the highly informative data.

Ⅳ. Conclusion

In this study, the detection possibility can increaseto find pulmonary embolism in the regionof lung parenchyma through the fusion images which is combined with pulmonary vessel images from CT and functional images from SPECT. It is sure to perform SPECT and CT in integral SPECT/CT system. However, we believe this protocol can give more informative data to have more accuratediagnosis in the hospital without integral SPECT/CT system.

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• 국문초록

폐질환의 SPECT와 CT 융합영상의 유용성: 초기연구

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신구대학교 방사선과[1] · 강원대학교 방사선학과[2] · 충북대학교 의용생체공학과[3]

최근에는 SPECT/CT의 보급으로 융합영상을 여러 질환에 적용하고 있지만, 폐질환에 대한 적용은 널리 이용되고 있지 않다. 특히, CT 결과에서 폐색전증을 의심하여 SPECT를 시행하는 경우가 발생하며, 보다 정확한 진단을 위해 SPECT/CT가 중요하다. 하지만, SPECT/CT를 보유하지 않은 병원에서는 적용에 한계가 발생하며, SPECT/CT를 보유한 병원에서 검사를 시행한다 하더라도 이미 CT검사 이후 SPECT/CT를 진행하는 경우가 많다. CT검사에서 발생하는 피폭선량 외에도 추가적인 SPECT/CT는 이중으로 피폭선량을 발생하는 경우 해당되며, 불필요한 피폭이 발생하는 경우에 속한다. 그러므로 본 연구에서는 불필요한 피폭을 방지하고, SPECT/CT를 보유하지 않은 의료기관에서 SPECT와 CT의 각각 획득된 영상을 융합하고, 폐질환에서의 영상의 유용성을 평가하였다.

팬텀실험은 NEMA Phantom™ (NU2-2001)으로 SPECT와 CT에서 획득된 영상을 융합하였으며, 임상적용은 10명의 환자(남자 7명, 여자3명, 평균나이: 65.3세±12.7세)를 대상으로 각각의 영상을 융합하여 분석하였다.

팬텀실험과 임상적용에서 모두 SPECT, CT의 각각의 영상보다 fusion image에서 높은 점수를 나타내었으며, SPECT와 CT영상을 fusion하여 각각의 장점을 극대화 할 수 있었다.

CT영상으로부터 획득한 폐혈관 image가 SPECT로부터 얻은 기능적인 영상을 fusion함으로써 pulmonary embolism이 폐실질에 나타내는 영향을 더욱 잘 묘사할 수 있었다. SPECT/CT가 가장 이상적이라 할 수 있지만, 아직 보급되어 있지 않은 경우 이와 같은 프로토콜을 이용하여 진단에 사용한다면 보다 정확한 진단에 도움이 되리라 사료된다.

중심 단어 : 폐색전증, SPECT, CT, 융합영상