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The Usefulness of Ga-67 SPECT Imaging to Detect the Non-Hodgkin's Lymphoma: Comparison with Ga-67 Planar and SPECT Imaging

Jing Wang, M.D.*, Sang Kyun Bae, M.D. and Ha Yong Yum, M.D.

Department of Nuclear Medicine, XiJing Hospital, Xian, China, Department of Nuclear Medicine, Kosin Medical College, Pusan, Korea*

= 국문초록 =

비호지킨 림프종의 진단에서 갈륨 SPECT의 유용성: 평면영상과 SPECT영상의 비교

中國 西京醫院 核醫學科*, 고신대학교 의학부 핵의학과

汪 靜 *·배상균·염하용

갈륨스캔은 여러 종류의 염증성 질환 및 종양을 발견하기 위해 사용되고 있다. 특히 림프종은 갈륨스캔에서 양성율이 비교적 높은 종양으로 알려져 있다. 하지만 기존의 평면 영상만으로는 작은 크기의 종괴나 다른 장기에 의해 가려져 있는 경우에 위음성 결과를 보일 수 있었다. 최근 단일광자 방출 전산화 단층촬영(SPCET)을 도입하여 평면영상에 비해 더 나은 공간해상력으로 많은 정보를 얻고 있다. 저자들은 비호지킨 림프종 환자 30명을 대상으로 갈륨스캔 평면영상과 SPECT 영상을 얻어 비교하였다.

병변의 부위별로 두경부, 흉부, 복부에서 평면영상의 예민도는 각각 71%, 73%, 81%였으며, SPECT 영상의 예민도는 91%, 93%, 96%였다. CT 등 방사선학적 검사소견과 임상소견을 기준으로 하였을 때 위음성율은 평면영상의 경우 24%, SPECT 6.5%였다. 장의 방사능으로 인한 섭취와 폐문부 및 침샘의 비대칭적 섭취로 인한 위양성례가 4예있었다.

결론적으로 비호지킨 림프종의 진단 및 병기를 결정하는데 있어서 갈륨스캔이 유용하며, SPCET 영상을 얻음으로써 더 나은 해부학적 위치 및 정확한 범위를 보여 줄 수 있을 것으로 생각된다.

Key Words : Non-Hodgkin's lymphoma, Gallium scan, SPECT

INTRODUCTION

Since the introduction of imaging with gallium-67(Ga-67) citrate, this radioisotope has been used to detect inflammatory and various neoplastic conditions[1, 2]. More recently, single photon emission computed tomography (SPECT) has been widely used in clinical experiences. SPECT can separate foci of abnormal uptake from each other as well as from overlying tissue, which is thought to be a better method than planar scintigraphy to stage or follow up lymphoma patients[3, 4]. Since there have been only a few clinical reports about the same sub-group of Non-Hodgkin's lymphoma(NHL) alone, we compared SPECT with planar gallium images of 30 intermediate grade NHL patients. Our objective

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was to determine whether SPECT increases the sensitivity and evaluate the causes resulted in false negative or false positive.

MATERIALS AND METHODS

Thirty patients with histologically proven Non-Hodgkin's lymphoma (NHL, Intermediate Grade) who underwent Ga-67 planar and SPECT imaging were included in the study. There were 66 sites of involvement (including liver and spleen). We used radiologic examinations (including chest radiography, computed tomography, ultrasonography, barium studies, and so on) and pathologic examinations, and also consulted surgical findings and medical records whenever possible to confirm the presence or absence of a disease. Final diagnosis was established on the basis of clinical, radiologic, and pathologic information.

Patients were injected with 185 MBq(5 mCi) of Ga-67 citrate, and scintigraphy was performed after 72 hours with preparation to evacuate activity from the bowel. After acquiring the multiple static images the patients were positioned for tomographic (SPECT) study. The Ga-67 scintigraphy was obtained by using a triple peak energy window(93, 184 and 296KeV ± 20%, respectively) and a medium-energy collimator. The planar images (Basicam, Siemens) were obtained by collecting 350 kcounts. Ga-67 SPCET images (Sophy DS7, Sopha Medical) were obtained by using 360° rotation at 64 intervals in a 64×64 matrix. The acquisition time of each step was 40 seconds. Tomographic images were obtained in the transaxial, coronal, and sagittal planes. The results were blindly read by two nuclear medicine physicians without prior knowledge of clinical findings, CT findings, or therapy. Disagreement was resolved by discussion.

Table 1. Sensitivity According to Anatomic Site

	Planar	SPECT
Head-Neck	71%(15/21)	91%(19/21)
Chest	73%(11/15)	93%(14/15)
Abdomen	81%(21/26)	96%(25/26)
Total	76%(47/62)	94%(58/62)

RESULTS

The findings of planar and SPECT based on the location of the lesion are shown in Table 1. In 15 sites of the head-neck, both planar and SPCET images were positive. SPECT results showed an abnormal uptake in 4 sites that were not positive on planar images. The sensitivities were 71% and 91% for planar and SPECT images, respectively.

In the chest, 11 sites were correctly depicted by both modalities. However, SPECT demonstrated 3 additional sites that were equivocal on planar images. The sensitivities were 73% and 93% for planar and SPECT images, respectively.

In the abdomen (except in liver and spleen), 21 sites were positive on both images. SPECT showed additional 4 sites that were uncertain on planar images. The sensitivities were 81% and 96% for planar and SPECT images, respectively.

Both planar and SPECT study had 4 false positive uptake. One was due to bowel activity and others were due to asymmetric uptakes of Ga-67 in the salivary gland and hilum area.

DISCUSSION

The first suggestion that Ga-67 citrate might localize in tumors was based on a serendipitous finding by Edwards and Hages[5]. Numerous investigators have reported on the role of Ga-67 citrate in the detection of specific tumors (including lymphoma)[6-8]. During the last few

years, the use of gallium scintigraphy in the management of patients with lymphoma has been a subject of controversy, but when we consider recent published data, there are indications that this technique represents an important tool in the diagnosis and follow-up of this type of neoplasm. In fact, studies of gallium scanning were found to be of limited value when smaller doses of radionuclide (about 100 MBq) and outmoded technology(rectilinear scanner) were used[9]. Recently, it has been stressed that the sensitivity of Ga-67 studies can be improved by injecting larger doses of radionuclide (185-370 MBq) and by using of a triple peak gamma camera acquisition[10]. We used a larger dose of Ga-67, 185 MBq and triple peak acquisition.

The sensitivity of the Ga-67 scan in the evaluation of lymphomas is related to a number of factors. The histology of the lesion has a primary role. The varying degrees of gallium

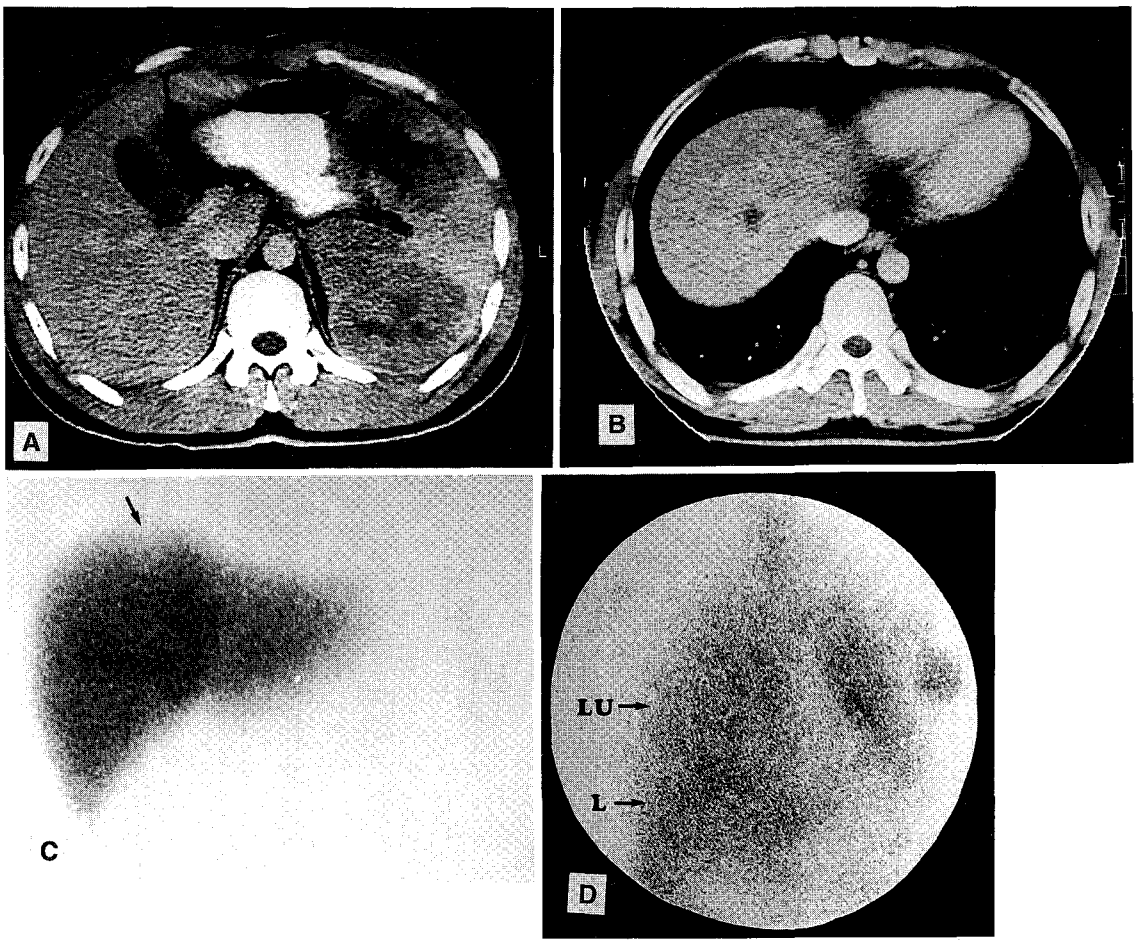

Fig. 1. Images of a 31-year-old patient with Non-Hogkin's lymphoma. (A) CT scan demonstrates the primary lesion involving the spleen. (B) Eight months later, CT scan shows early metastatic lesion in the dome of the right lobe of the liver, which is also shown in the liver scan(C). Ga-67 planar scan of chest and abdomen(D) at this time reveals no abnormal uptake in the liver(L) and spleen area due to diffuse lung uptake(LU) by pneumonitis. There is abnormal lymph node uptake in the left axillary region.

tumor avidity depend on the tumor grade in NHL. The higher the grade of the tumor, the higher gallium uptake. Gallium uptake is poor in low grade NHL[11]. Therefore, we include only the group of intermediate NHL in order to avoid the interference by the histologic grade.

Size is another important determinant of lesion detectability. The Ga-67 scan will not detect lesions that are smaller than 1 cm in diameter; and only about 25% of 2 cm lesions are visible on planar images. The overall sensitivity increases almost linearly when the lesion diameter increases from 2 to 5 cm[12]. In our study, there were 7 false negative lesions of 15 total lesions on planar images due to small sized tumor mass measuring < 2cm in diameter and 3 false negative lesions of 4 total lesions on SPECT images due to tumor diameter < 1cm. Lesions larger than 5cm in diameter are sometimes less well seen, perhaps because of central tumor necrosis. Necrotic tissue does not concentrate gallium[13]. There was one case in our study which did not show gallium uptake due to necrosis.

The anatomic site of the lymphoma can also affect the sensitivity of gallium scintigraphy, partly because of the normal distribution patterns of gallium and partly because of the characteristics of the scintigraphic instruments used for imaging[9, 11]. Turner et al.[9] have reported a high sensitivity (96%) for the detection of mediastinal disease. Its sensitivity of detection of cervical and other superficial lesions was 83%, whereas that of the disease in the abdomen and pelvis (except in the liver and spleen) was only 60%. Detection of hepatic and/or splenic involvement is difficult because of the normal gallium uptake by these organs. The rate of detection of liver involvement by gallium scanning is relatively poor (38%), but that of spleen is slightly higher (52%). CT and/or ultrasonography seems to be the method of determination[14-16]. In our study, there were 3 false negative lesions of the liver on planar images and 2 false negative lesions on the SPECT images. Both planar and SPECT images were false negative in one site of the

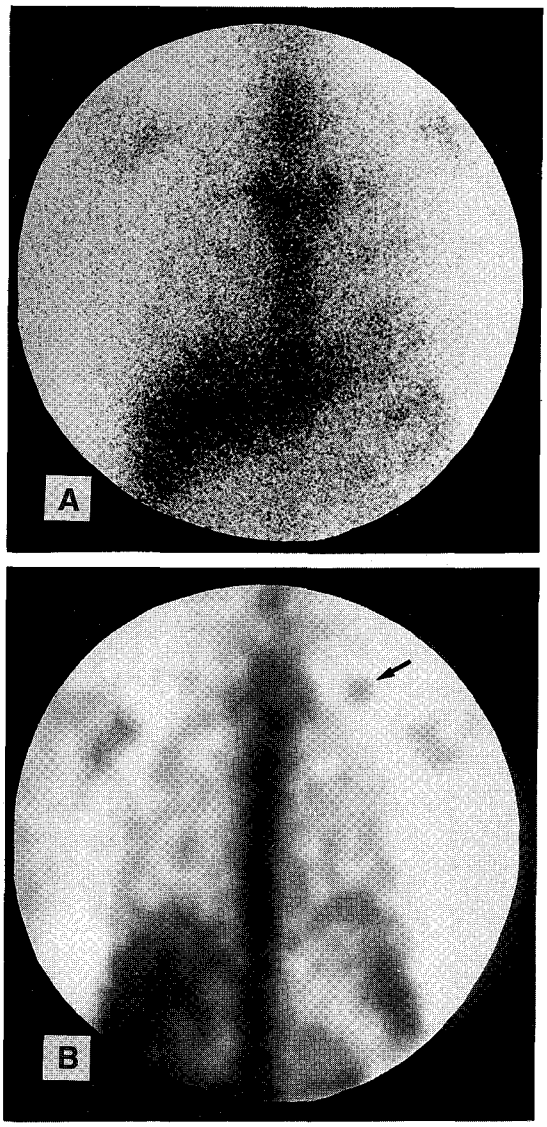

Fig. 2. A 21-year-old patient with Non-Hodgkin's lymphoma. (A) Ga-67 planar image reveals no abnormal uptake in the neck. (B) Ga-67 SPECT image(coronal section) shows a focal uptake in left lower cervical lymph node which is proved as lymphoma by biopsy(diameter about 2cm).

spleen, which was confirmed by the CT scan (Fig. 1). In the results we excluded the liver and spleen sites.

Tumeh et al.[3] studied 40 patients (33 with Hodgkin's disease and 7 with NHL) using planar and SPECT scan. The sensitivity for planar studies in the chest was only 66%, that of SPECT was 96%. They also compared planar scans with SPECT in the abdomen and found a sensitivity of 69% for planar, but 85% for SPECT studies. Front et al.[4] published a paper on the Gallium SPECT in staging for lymphoma before and after treatments. The detection rate of planar image ranged from 78% to 84%, and that of SPECT was 85% to 92%. Larcos et al.[17] found that SPECT improved lesion detection (92% vs. 74% for planar) in the thorax. The results of our study were similar to these findings.

Overall, SPECT had a superior sensitivity (94%) compared with planar imaging (76%), and lesions undetected with planar scintigraphy became obvious on SPECT studies (Fig. 2). Planar imaging has a relatively higher false negative rate (24%) than SPCET imaging (6.5%). It is hard to differentiate tumors which are located deeply in the body because of overlying organs, thus resulting a higher false negative rate. SPECT proves to be significant in this aspect, namely because of the radiopharmaceutical distribution in the body in three dimensions and the ability to extract true quantitative values non-invasively from structures deep within the body. We came up with the same false positive lesions in both modalities due to asymmetric gallium uptake in salivary glands and/or hilum area, but there was no evidence of disease.

In conclusion, Ga-67 SPECT was more accurate in depicting foci of gallium-avid lymphoma both in the extent and location of involvement. We strongly recommend that all clinical informations, (e.g. about current inflammatory lesions) and methods of improving techniques, (e.g. increasing the dose by injecting 370 MBq of Ga-67, delayed scanning after 72 hours and use of SPECT to increase contrast) be made available in order to ensure that false positive and negative interpretations are avoided.

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