The first PET scanner made in China and its clinical application*

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Abstract The structure and technical indices of PET scanner (PET-B01) are described. It is applied to do the clinical research work by using the positron ^{68}Ga-citrate and ^{68}Ga-BAT-TECH in 34 human bodies. All of them have not any symptoms or signs of chemical toxicity and radioactive hazard. ^{68}Ga-citrate PET images can be applied to make differential diagnosis on hepatoma or lung cancer, among 28 cases, the coincidence rate is 0.927; can confirm that the malignant tumor is encapsulated or divergent.

Keywords PET scanner, ^{68}Ga-citrate, Clinical application, ^{68}Ga-BAT-TECH

1 Introduction

Positron emission topography (PET) scanner is one of the highest level medical imaging equipments. It is expensive (over USD 2×10^6) and high technical so that only some developed countries can possess and use PET.

Phelps[1] had reported PET for the first time in 1975, he used computers as a tool to process the image of the isotopes emitting positrons. PET can display not only the structural images, but also the functional and metabolic images of the human body.

The first China-made PET scanner (PET-B01) was co-manufactured by Weida Company and the Institute of High Energy Physics (Prof. Zhao Yong-Jie), the Chinese Academy of Sciences. This scanner was installed in China Japan Friendship Hospital on September 17, 1992. We have used it to do the clinical research work by using ^{68}Ga labelled compounds in 34 human bodies, and obtained good results.

2 Structure and technological indices of PET-B01

PET-B01 means "the number 1 Chinese PET scanner made in Beijing" (see Fig.1). It has 2 ring-typed instruments with 608 BGO crystals. These crystals were assembled according principle of blocks and connected with coincident circuit. The data were acquired by electric collimator. The inner aperture in the gauge is 560 mm. It is large enough to get images of lung, heart, liver, brain, bone and so on. There are 3 computers to acqure and process the data, and also reconstruct the data to image simultaneously. The spacial resolution is 6 mm. Manually or by means of the computer in another room, technicians can control the movable couch up or down, into or out of the ring. The positions of the organs can be confirmed by laser projectors. When the positron nuclide with short half life (lower than 1 h) was used, its attenuation can be corrected by using a base image obtained by ^{68}Ga ring transmission. For each scanning, 3 section images can be shown, the distance between two sections is 12 mm. All pictures are coloured. We can also obtain the black and white PET pictures by using a multiframes camera (see Fig.1). PET-B01 costs about USD 350000, so it is more suitable to developing countries.

3 Clinical application of PET-B01

After the experimental PET imaging of 95 animals (dogs, rabbits and mice), ^{68}Ga-citrate was injected intravenously into 28 patients with liver tumors (14 cases), lung tumors (10 cases), lymphoma and so on. All these tumors had been pathologically diagnosed. Then, the PET images were got from the patients (see Figs.2–4). These images show the biodistribution of ^{68}Ga-citrate in the early stage (2 h after intravenous injection of human body). Citrate

*The Project Supported by National Natural Science Foundation of China, IAEA, and Research Funds of China Japan Friendship Hospital
Manuscript received date: 1995–11–20

can combine with the lysosome in tumors. The PET images are very dense in carcinoma lesion. Positron ^{68}Ga-citrate scan can be used to make differential diagnoses on some tumors to ascertain whether they are benign or malignant. PET can confirm that the malignant tumors are encapsulated or divergent. PET can demonstrate the distribution and the metastasis of the malignant cancer cells. Of the above 28 patients, 26 cases were correct, the coincident ratio was 0.927.

One healthy worker was irradiated in the nuclide ring of the PET-B01 scanner, a picture of thoracic cavity with cardiac vascular image was obtained. This picture looked like the corresponding pictures published by Washington University.

Fig.1 Outward appearance of PET-B01 scanner

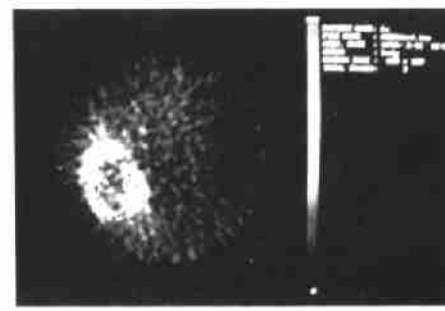

Fig.2 PET picture of encapsulated typed hapatoma

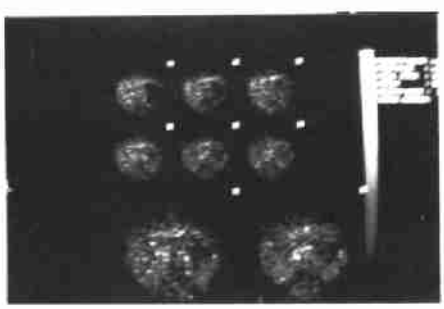

Fig.3 PET picture of divergant typed hepatoma

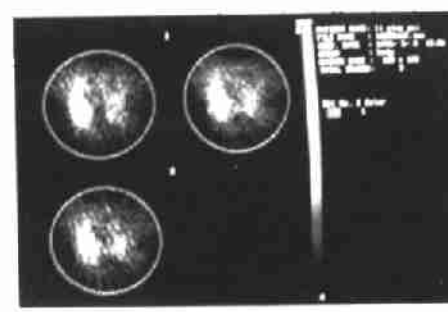

Fig.4 PET picture of lung cancer

^{68}Ga-BAT-TECH were injected i.v. into 5 normal volunteers and the PET images were obtained for analysis. ^{68}Ga-BAT-TECH is concentrated in myocardial region. The heart image is very clear, but BAT-TECH is excreted out of cardiac muscle very fast, 15 min after i.v. injection, the PET images become diffused.

All the original ^{68}Ga were eluted from the ^{68}Ge–^{68}Ga generator made in Du Pond Company. The ^{68}Ga-citrate and BAT-TECH reagents above were tested and investigated by the China Identification Institute of Pharmaceutical Products and Bioproducts and the Department of Chemistry, Beijing Normal University. Their conclusion is "these ^{68}Ga labelled reagents have no chemical toxicity and radioactive hazard to human body". The Health Ministry of China also issued a license in 1993 to permit the clinical use of ^{68}Ga-citrate and ^{68}Ga-BAT-TECH. All the 34 human bodies in this study had not any symptom and sign of chemical toxicity and radioactive hazard.

Although the first China-made PET has been set up, but the relevant techniques and equipments still have not been completed, such as the microcyclotron and the labeling synthesizers. All these limited the further application of PET in China.

Reference

1 Phelps M G. J Nucl Med, 1975; 16:210