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Use of Digirad 2020tc Imager™, a multi-crystal scintillation camera with solid-state detectors in one case for the imaging of autografts of parathyroid glands

Nobuyoshi FUKUMITSU,* Daisuke TSUCHIDA,* Shigeyuki OGI,* Mayuki UCHIYAMA,* Yutaka MORI,* Takashi OOSHITA,** Hiroto NARITA,** Hiroyasu YAMAMOTO*** and Hiroshi TAKEYAMA****

*Department of Radiology, The Jikei University School of Medicine
**Department of Radiology, The Jikei University School of Medicine Hospital
***Department of Internal Medicine, The Jikei University School of Medicine
****Department of Surgery, The Jikei University School of Medicine

^{99m}Tc-methoxy-isobutyl-isonitrile (^{99m}Tc-MIBI) scintigraphy with Digirad 2020tc Imager™ (2020tc), which was a multi-crystal scintillation camera with solid-state detectors was performed for patients with secondary hyperparathyroidism having autografts of parathyroid glands in the right arm. With the 2020tc camera, three abnormal accumulations were found in the right arm. The images obtained with this camera were superior in resolution to those obtained with a conventional NaI crystal gamma camera (ZLC7500, Siemens, Germany). The next day, resection of autografts of parathyroid glands was done. Four hyperplastic parathyroid glands were resected and all were hyperplastic in pathological findings.

Key words: ^{99m}Tc-MIBI, Digirad 2020tc Imager™, hyperplastic parathyroid gland, cesium iodine scintillator, autotransplantation

INTRODUCTION

Digirad 2020tc Imager™ (2020tc) is a scintillation camera with a semiconductor optical sensor combined with a multiple-crystal Cesium iodine (CsI(Tl)) scintillator,[1] and has the advantages of yielding a higher signal to noise ratio (S/N ratio) than conventional scintillation cameras, and of being easily moved.[2] We had the opportunity to use this new scintillation camera for the imaging of autografts of parathyroid glands in one case. This is a report of our experience.

CASE REPORT

The case was a 55-year-old male with secondary hyperparathyroidism. Autotransplantation of the parathyroid glands in the forearm had been carried out in 1995, because the stability of the hormones and re-operation could be done easily. Serum biochemistry on October 16, 2000 revealed intact parathyroid hormone (PTH): 280 pg/ml (normal limit; 10–65 pg/ml), Ca: 10.6 mg/dl (8.6–10.2 mg/dl), and P: 6.7 mg/dl (2.6–4.6 mg/dl). Resection of the autografts was scheduled for October 18, and parathyroid scintigraphy was performed on October 17.

^{99m}Tc-methoxy-isobutyl-isonitrile (^{99m}Tc-MIBI) (740 MBq) was injected into a vein in the left arm, and 30 minutes later the right arm was fixed in the supine position and frontal and lateral images were obtained with 2020tc. A low energy high resolution collimator was attached, the energy window was set at 140 keV ± 26%, and data collection was conducted for 5 minutes. Three abnormal accumulations were found in the right arm (Fig. 1A). We moved the point source on the surface of the body, and marking was carried out on the skin side in which the point source corresponded with the abnormal accumulations from 2 directions. After images were obtained with the 2020tc, we obtained images with a conventional NaI crystal gamma camera (ZLC7500, Siemens, Germany) in the same way. With the ZLC7500, a cluster of abnormal

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For reprint contact: Nobuyoshi Fukumitsu, M.D., Department of Radiology, Jikei University School of Medicine, 3–25–8, Nishi-shinbashi, Minato-ku, Tokyo 105–3461, JAPAN.
E-mail: GZL13162@niftyserve.ne.jp

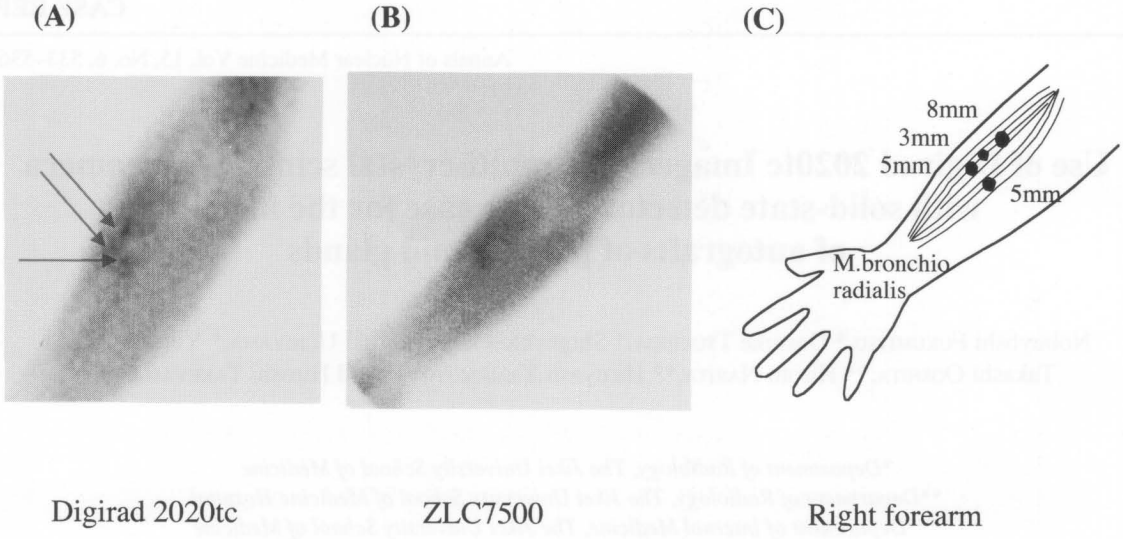

Fig. 1 Autografts of parathyroid glands. (A) ^{99m}Tc-MIBI scintigram shows three abnormal accumulations in the right arm using 2020tc. (B) ^{99m}Tc-MIBI scintigram shows a cluster of abnormal accumulations in the right arm using ZLC7500. (C) The scheme of autografts of parathyroid glands, proved by surgery.

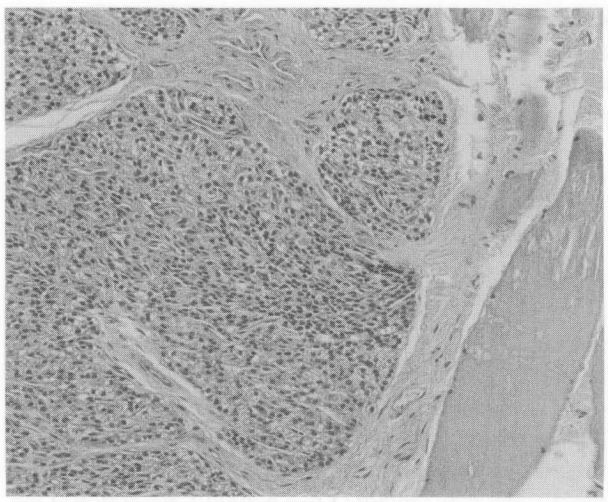

Fig. 2 The specimen of resected parathyroid glands show hyperplasia.

accumulations was found (Fig. 1B), but it was difficult to distinguish between the accumulations. The image quality with the 2020tc camera was superior to that obtained with the ZLC7500 (S/N ratio was 2.17 vs. 1.87). Resection of the autografts was carried out on October 18.

We moved the 2020tc camera into the operating room for a final confirmation of the position of abnormal accumulations, taking advantage of the movability of the camera. The image quality was inferior to that on the previous day. Discrimination between accumulations was difficult, because ^{99m}Tc-MIBI was cleared from the parathyroid glands but retained in the muscles. Four parathyroid glands were resected. The maximum diameters of the resected parathyroid glands were #8 mm, #5 mm (2 glands), #3 mm (Fig. 1C), and all were hyperplastic (Fig. 2). The serum biochemistry 1 month after the operation was PTH: 43 pg/m*l*, Ca: 9.7 mg/d*l*, and P: 4.7 mg/d*l*.

DISCUSSION

The 2020tc camera is a multi-crystal scintillation camera,[1] and has a structure in which 64 × 64 elements are arranged (the size of each element is 3.25 mm × 3.25 mm). Each matrix is separated by a septum and semiconductor elements connected to each matrix. Therefore, not only are images with a higher S/N ratio than that obtained with conventional scintillation cameras with a single crystal sodium iodine (NaI(Tl)) scintillator + photomultiplier tube obtained, but also the weight of the equipment is reduced to about 135 kg, which makes it easy to move.

Conventional scintillation cameras containing photomultiplier tubes with a NaI(Tl) scintillator have limited movability owing to their great weight. In the 2020tc camera, width is about 21 cm, thickness 7.5–9.7 cm, and the movement range from the floor is 48 cm to 133 cm, with an electromotive-style assistant. When the arm which supports the detector is extended, the distance from the body to the center of the detector is 120 cm (Fig. 3), so that it is advantageous not only because the patient can be made to stand at an optional angle for markings to be done, but also it is easily moved in the operating room. We consider that the 2020tc is useful for detecting sentinel nodes in the operating room, diagnosing renal insufficiency after a kidney transplant, pulmonary embolism, or acute myocardial infarction in an intensive care unit or coronary care unit, and for taking images of the thyroid

Fig. 3 The picture of the body of 2020tc.

gland, joints, and breasts.

The history of autotransplantation of the parathyroid glands is old, and it was reported for the first time in 1907 by Halsteds.[3,4] Total extraction of the parathyroid glands and autotransplantation have often been applied in the cases of patients with hyperparathyroidism since it was first reported in 1975 by Wells.[5] But, on the other hand, it was reported that recurrent hyperparathyroidism occurs in about 14% of patients undergoing autotransplantation.[6]

The imaging methods used to visualize the parathyroid glands are computed tomography, ultrasonography, magnetic resonance imaging, and scintigraphy, and more accurate diagnosis becomes possible when the advantages of each of these methods are adopted.[6–8] In this case, only scintigraphy was used, because of the large blood flow in the right forearm due to the arteriovenous anastomosis performed previously, and Doppler ultrasonography was difficult to use. Although the method with ^{201}Tl and ^{99m}Tc-pertechnetate has been widely used,[6,8–10] it has been reported that the method in which ^{99m}Tc-MIBI is used for detection has high sensitivity.[11–14] The difference in clearances from the thyroid and parathyroid gland are calculated, and clear detection of the parathyroid gland becomes possible especially in delayed images obtained two hours after the injection of ^{99m}Tc-MIBI. There are some reports that the detectability in early images obtained several tens of minutes after the injection is similar to that in delayed images obtained 2 hours after the injection,[7,9] and also that the detectability in early images is even clearer.[15] In the present case, the transplanted parathyroid glands could be clearly detected in the images obtained 30 minutes after injection. The images obtained with the 2020tc camera were superior in resolution to those obtained with ZLC7500 due to the higher S/N ratio obtained.

The next day, we brought the 2020tc camera into the operating room putting its movability to advantage, for final position confirmation. But retention of ^{99m}Tc-MIBI in muscle was observed and the accumulation in the transplanted parathyroid glands had cleared. We thought that ^{99m}Tc-MIBI should be injected just before the operation or re-injected just before the operation after marking is done on the previous day for more efficient diagnosis of autotransplanted parathyroid glands with the 2020tc camera.

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