European Review for Medical and Pharmacological Sciences 2015; 19: 2781-2785

The importance of the incidental thyroid gland uptake during Tc-99m MIBI myocardial perfusion scintigraphy

S. KARACAVUS, H. EDE[1], S. SARIKAYA[1], N. DELIBAS[2], E. KAYA[3], A.R. ERBAY[1]

Department of Nuclear Medicine, Bozok University, Yozgat, Turkey
[1]Department of Cardiology, Bozok University, Yozgat, Turkey
[2]Department of Biochemistry, Bozok University, Yozgat, Turkey
[3]Department of Nuclear Medicine, Acıbadem Hospital, Kayseri, Turkey

Abstract. – OBJECTIVE: The purpose of study was to investigate whether incidental thyroid gland uptake had an important during Tc-99m sestamibi (MIBI) myocardial perfusion scintigraphy (SPECT).

PATIENTS AND METHODS: In the presented study, 968 consecutive patients were evaluated for the presence or absence of thyroid gland uptake in the raw data of the Tc-99m MIBI SPECT. All of the patients had thyroid gland uptake of the Tc-99m MIBI underwent laboratory evaluation of thyroid function, ultrasonographic imaging, and hystopathological examination.

RESULTS: The thyroid gland uptake was detected in 14 of 968 (1.4%) consecutive patients during the evaluation of raw images of Tc-99m MIBI SPECT studies. Among these 14 patients, 4 had subacute thyroiditis, 7 multinodular goiter, 3 Graves disease by ultrasonographic imaging and hystopathological examination. TSH levels of all of these patients were < 0.01 U/ml.

CONCLUSIONS: Tc-99m MIBI uptake by thyroid gland has been explained with associated clinical thyrotoxicosis. Although the primary goal of myocardial perfusion imaging is the evaluation of myocardial perfusion, the interpretation of myocardial perfusion imaging should not be limited to the heart. Because, it is possible to observe extracardiac radioactivity accumulation, which may then lead to the diagnosis of a noncardiac disease during this detailed examination.

Key Words:
Myocardial perfusion scintigraphy, Thyroid gland uptake, Tc MIBI.

Introduction

Myocardial perfusion scintigraphy by single photon emission computed tomography (SPECT) is a commonly used noninvasive cardiac test for the diagnosis of coronary artery disease[1]. The examination of the data derived from raw projection images of SPECT acquisition has importance in clinical practice since valuable data related to noncardiac abnormalities can be incidentally found [2-4].

Although technetium-99m hexakis 2-methoxy-2-methylpropylisonitrile (Tc-99m MIBI) was originally produced for myocardial perfusion scintigraphy, it has been used in many clinical settings such as a tumor-imaging agent for various malignancies and parathyroid diseases[5,6]. Tc-99m MIBI has been previously revealed to have a useful role in the differential diagnosis of cold thyroid nodules, differentiated thyroid cancer and subacute thyroiditis[7-9].

The purpose of this study was to investigate whether incidental thyroid gland uptake was an importance finding during Tc-99m MIBI myocardial perfusion SPECT.

Patients and Methods

In this study, 968 consecutively patients were evaluated for the presence or absence of thyroid gland uptake in the raw data of the Tc-99m MIBI myocardial perfusion SPECT studies.

A treadmill exercise test by Bruce protocol or adenosine infusion was used for stress testing, and 45 minutes after the intravenous administration of 555 MBq (15 mCi) Tc-99m MIBI (Sestamibi, Polatom, Poland) myocardial perfusion SPECT imaging was obtained via a double-head γ camera (Philips Medical Systems Brightview Gamma Diagnost, Eindhoven, Netherlands) equipped with a low-energy, high-resolution collimator.

The raw data of the myocardial perfusion SPECT studies were examined in all subjects,

Corresponding Author: Seyhan Karacavus, MD; e-mail: seyhankaracavus@hotmail.com

spot planar images were obtained (256 × 256 matrix, during 10 min) and the SPECT images were reconstructed in patients with thyroidal gland uptake. All these patients underwent Tc-99m pertechnetate scanning, ultrasonographic and laboratory examination for etiologic identification and either fine needle aspiration biopsy or operation followed by histopathological examination.

Results

The demographic and clinical characteristics of the patients were shown in Table I. The mean age of patients was 48.6 ± 10.7 years (range 29-72 years; 603 female). The mean TSH levels of all these patients were below 0.01 μU/ml.

The thyroid gland uptake was detected in 14 of 968 (1.4%) consecutive patients during the evaluation of raw images of Tc-99m MIBI myocardial perfusion SPECT studies (Figure 1). Later, all patients had Tc-pertecnetate scan, ultrasonographic imaging and hystopathological examination.

Among these 14 patients, 4 of them had subacute thyroiditis and 3 of them had Graves disease, whose scintigrapic imaging demonstrated persistent Tc-99m MIBI uptake and 7 of them had toxic goiter which had focal increased Tc-99m MIBI uptake (Figure 2A, B, C, respectively). These diagnoses were confirmed by ultrasonographic imaging and hystopathological examination.

Four of 14 patients (patient 1, 2, 8, 13) had subacute lymphocytic thyroiditis. The diagnosis of subacute lymphocytic thyroiditis was made on the basis of painful goiter with increased thyroid hormone levels, supressed TSH levels, systemic inflammatory signs (C-reactive protein and erythrocyte sedimentation rate). There was a lack of uptake on Tc-99m pertechnetate scanning in the thyroid glands of these patients. Ultrasonographic imaging detected hypoechoic heterogeneous echogenecity and Doppler showed an absence signal in the thyroid gland. Hystopathological examination of fine-needle aspirate showed multinucleated giant cells with histiocytes and lymphocytes, which supported the diagnosis of subacute lymphocytic thyroiditis.

Patient 3, 4 and 11 had the complaint of chest pain and manifested signs and symptoms of clinical hyperthyriodism such as weight loss, excessive sweating, palpitation, getting short of breath with walking. The TSH levels of these patients were below 0.01 μU/ml. There were heterogeneous echogenecity on ultrasonography and color Doppler revealed increased parenchymal vascularization. An increased diffuse uptake was obtained on Tc-99m pertechnetate scanning in the thyroid gland. Hystopathological examination of fine-needle aspirate revealed Graves disease.

The remaining seven patients had multinodular toxic goiter diaease. Laboratory data were consistent with hyperthyroidism (TSH: < 0.01). Tc-99m pertechnetate scanning revealed single or multiple hot nodules with the suppression of the remaining thyroid tissue in all patients. These pa-

Table I. Clinical characteristics, laboratory and scintigraphic findings of all patients.

Patient no	Gender	Age	TSH (μU/ml)	Anti-TPO (IU/mL)	Anti-Tg (IU/mL)	Tc-99m scintigraphy
1	M	29	< 0.01	157.3	96.13	RU
2	F	43	< 0.01	38.41	100.3	RU
3	F	54	< 0.01	23.74	203.3	DIU
4	M	38	< 0.01	54.71	87.5	DIU
5	M	42	< 0.01	5.61	10.0	SHN
6	M	51	< 0.01	24.87	38.9	SHN
7	F	45	< 0.01	12.35	16.42	MHN
8	F	63	< 0.01	6.23	10.0	RU
9	M	52	< 0.01	3.18	19.33	MHN
10	F	47	< 0.01	14.86	7.8	MHN
11	F	55	< 0.01	65.96	79.6	DIU
12	F	48	< 0.01	15.8	9.7	MHN
13	F	41	< 0.01	15.17	58.94	RU
14	M	72	< 0.01	6.86	12.63	SHN
Mean ± SD	F:8	48.6 ± 10.7	< 0.01	31.8 ± 40.7	53.6 ± 55.8	–

RU: Reduced uptake; DIU: Diffuse increased uptake; SHN: Single hot nodule; MHN: Multipl hot nodule.

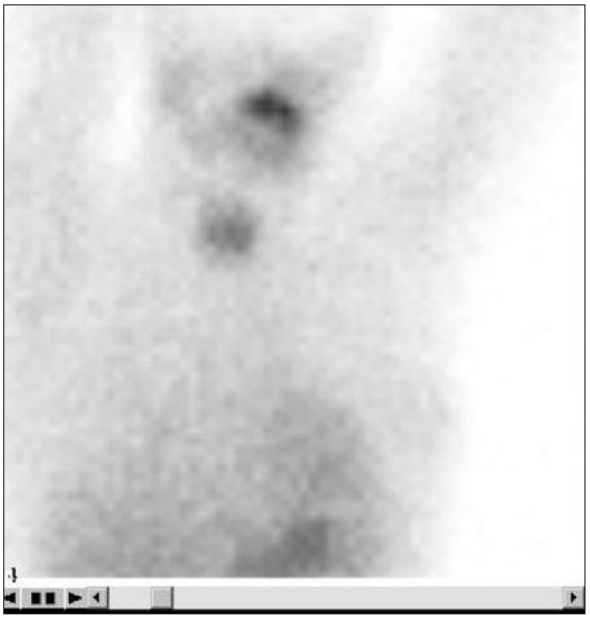

Figure 1. Coronal image from the source data of a 99mTc-MIBI myocardial scintigraphy shows a thyroid gland uptake.

tients with single/multiple toxic adenoma displayed a pattern of normal/ increased nodular vascularization within a normoechogenic normovascular parenchyma. Hystopathological examination of fine-needle aspirate confirmed the presence of benign nodular disease in all patients.

Discussion

In interpreting the myocardial perfusion single photon emission computed tomography study (SPECT), the examination of the raw data composed of the projection images is important. This observation gives exhaustive information about noncardiac accumulation of radioactivity and may lead to an early diagnosis of an unknown disease.

Technetium-99m-methoxyisobutylisonitrile (Tc-99m MIBI), a cationic complex molecule, is primarily used for myocardial perfusion imaging[10]. Tc-99m MIBI thyroid uptake is related to the mitochondria of the cells[11]. Piwinica Worms et al[12] had reported that Tc-99m MIBI uptake in thyroid cells depended on the number of mitochondria membranes because Tc-99m MIBI is held in the mitochondria. They observed that myocellular uptake mechanism of Tc-99m MIBI and its transport involves passive distribution across plasma and mitochondrial membranes. When mitochondrial and plasma membrane potentials are hyperpolarized, increased Tc-99m MIBI cellular uptake and retention happen. Metabolic changes could promptly result in decreased Tc-99m MIBI uptake. This could occur with metabolic-induced membrane polarization changes[13].

The thyroid uptake mechanism of Tc-99m MIBI is not yet clearly understood. Based on microscopic findings, more abundant mitochondria and blood flow are often described in the thyroid glands of hyperthyroidism[14]. Both the number and activity of the mitochondria are measured in thyroid glands with hyperthyroidism[15]. In addition, Tc-99m MIBI uptake increases in the thyroid gland with the acute stage of subacute lymphocytic thyroiditis. Although the intrathyroidal blood flow is increased in Graves' disease, it decreased in the acute stage of subacute lymphocytic thyroiditis[16]. Hıromatsu et al[9] reported that the accumulation of Tc-99m MIBI in the thyroid

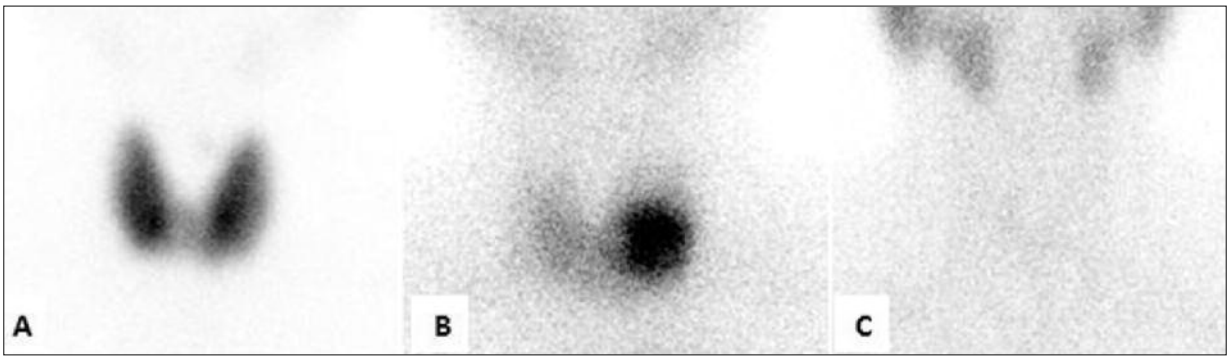

Figure 2. 99mTc-pertecnetate images show Graves Disease ***(A)***, hyperactive nodule ***(B)*** and suppressed thyroid gland of the patient with subacute thyroiditis ***(C)***. These patients have a thyroid gland uptake on their 99m Tc-MIBI myocardial scintigraphies.

gland in the acute phase may result from increased membrane permeability in the subacute thyroiditis. These studies show that Tc-99m MIBI uptake may be useful for the diagnosis of hyperthyroidism.

In a review of the literature, Tc-99m MIBI is taken up by normal thyroid tissue, Graves disease, Hashimoto thyroiditis and the metastases of thyroid carcinoma[17]. This uptake cannot be affected by exogenous thyroxine therapy[18]. The early imaging time of thyroid glands, 20-40 min after intravenous injection of Tc-99m MIBI is adequate. Kao et al[19] showed that Tc-99m MIBI were used for visualization of supressed thyroid gland without TSH stimulation.

In our study, none of 14 patients with thyroidal uptake on GSPECT had a malign thyroidal disorder. Tc-99m MIBI clearly visualized the suppressed thyroid tissue on pertechnetate scintigraphy in the patients with both subacute thyroiditis and multinodular goiter. We thought that thyroid uptake should not result from free Tc-99m pertechnetate because we did not use Tc-99m MIBI if the radiochemical purity was less than 90% in the present study.

The field of view of unprocessed SPECT data varies, in accordance with the size of the camera crystal and the size of the patient, but it usually includes the entire chest, the liver, the spleen, the kidneys and part of the bowel; occasionally, the thyroid gland is also included[20]. Therefore, the interpreting physician will have the opportunity to evaluate the other organs and should take advantage of it. When interpreting studies that involve this radiotracer, the physician must be aware of its physiologic distribution in order to recognize abnormal uptake. The unprocessed data include the physiologic or pathologic radiopharmaceutical uptake in the imaged body. It is important that the interpreting physician evaluate all the information available since the incidental findings in the other organs may lead to an earlier diagnosis of pathologic conditions that require treatment. Because the ultimate goal is the well-being of the patient, any available information should be examined and interpreted.

Conclusions

Tc-99m MIBI uptake by thyroid gland has been explained with associated clinical thyrotoxicosis. Although the primary goal of myocardial perfusion imaging is the evaluation of myocardial perfusion, the interpretation of myocardial perfusion imaging should not be limited to the heart. Finding of extracardiac radioactivity accumulation is possible while examining raw data, and this finding may then help to the diagnosis of a noncardiac disease.

Conflict of Interest

The Authors declare that there are no conflicts of interest.

References

1) Ta çı C. The evaluation criteria in diagnosing ischemia with stress and rest myocardial perfusion gated SPECT. Mol Imaging Radionucl Ther 2013; 22: 21-22.
2) Gedik GK, Ergün EL, Aslan M, Caner B. Unusual extracardiac findings detected on myocardial perfusion single photon emission computed tomography studies with Tc-99m sestamibi. Clin Nucl Med 2007; 32: 920-926.
3) Williams KA, Hill KA, Sheridan CM. Noncardiac findings on dual-isotope myocardial perfusion SPECT. J Nucl Cardiol 2003; 10: 395-402.
4) Karacavus S, Yildirim U, Okur A, Intepe YS, Tekin G. Incidental detection of thymoma during Tc-99m MIBI myocardial perfusion scintigraphy. Bozok Med J 2012; 3: 67-70.
5) Taki J, Sumiya H, Tsuchiya H, Tomita K, Nonomura A, Tonami N. Evaluating benign and malignant bone and soft-tissue lesions with technetium-99m-MIBI scintigraphy. J Nucl Med 1997; 38: 501-506.
6) Aktolun C, Bayhan H, Kir M. Clinical experiences with 99mTc-MIBI imaging in-patients with malignant tumors. Preliminary results and comparison with 201-Tl. Clin Nucl Med 1992; 17: 171-176.
7) Leidig-Bruckner G, Cichorowski G, Sattler P, Bruckner T, Sattler B. Evaluation of thyroid nodules--combined use of (99m)Tc-methylisobutylnitrile scintigraphy and aspiration cytology to assess risk of malignancy and stratify patients for surgical or nonsurgical therapy-a retrospective cohort study. Clin Endocrinol 2012; 76: 749-758.
8) Sharma R, Mondal A, Shankar LR, Sahoo M, Bhatnagar P, Sawroop K, Chopra MK, Kashyap R. Differentiation of malignant and benign solitary thyroid nodules using 30- and 120-minute Tc-99m MIBI scans. Clin Nucl Med 2004; 29: 534-537.
9) Hiromatsu Y, Ishibashi M, Nishida H, Kawamura S, Kaku H, Baba K, Kaida H, Miyake I. Tecnetium 99m sestamibi imaging in patients with subacute thyroiditis. Endoc J 2003; 50: 239-244.
10) Piwnica-Worms D, Kronauge JF, Chiu ML. Uptake and retention of hexakis (2-methoxyisobutyl isonitrile) technetium(I) in cultured chick myocardial cells. Mitochondrial and plasma membrane potential dependence. Circulation 1990; 82: 1826-1838.

11) Backus M, Piwnica-Worms D, Hockett D, Kronauge J, Lieberman M, Ingram P, LeFurgey A. Microprobe analysis of Tc-MIBI in heart cells: calculation of mitochondrial membrane potential. Am J Physiol 1993; 265: 178-187.

12) Piwnica Worms D, Chiu M, Kronauge J. Effect of mitochondrial and plasma membrane potentials on accumulation of MIBI technetium in cultured mouse fibroblasts. J Nucl Med 1990; 31: 1646-1653.

13) Belier GA, Watson DD. Physiological basis of myocardial perfusion im aging with the technetium-99m agents. Semin Nucl Med 1991; 21: 173-181.

14) Kao CH, Wang SJ, Liao SQ, Lin WY, Hsu CY. Quick diagnosis of hyperthyroidism with semiquantitative 30-minute technetium-99m-methoxy-isobutyl-isonitrile thyroid uptake. J Nucl Med 1993; 34: 71-74.

15) Als C, Listevnik M, Rösler H, Ritter EP. Separation of autonomous function from cell density in non-immunogenic hyperthyroidism. I. Quantification by double-isotope parametric scintigraphy. Nuklearmedizin 1995; 34: 215-222.

16) Donkol RH, Nada AM, Boughattas S. Role of color Doppler in differentiation of Graves' disease and thyroiditis in thyrotoxicosis. World J Radiol 2013; 5: 178-183.

17) Hiromatsu Y, Ishibashi M, Miyake I, Soyejima E, Yamashita K, Koike N, Nonaka K. Color Doppler ultrasonography in patients with subacute thyroiditis. Thyroid 1999; 9: 1189-1193.

18) Sathekge MM, Mageza RB, Muthuphei MN, Modiba MC, Clauss RC. Evaluation of thyroid nodules with technetium-99m MIBI and technetium-99m pertechnetate. Head Neck 2001; 23: 305-310.

19) Almeida-Filho P, Ravizzini GC, Almeida C, Borges-Neto S. Whole-body Tc-99m sestamibi scintigraphy in the follow-up of differentiated thyroid carcinoma. Clin Nucl Med 2000; 25: 443-446.

20) Kao CH, Lin WY, Wang SJ, Yeh SH. Visualization of supressed thyroid tissue by Tc-99m MIBI. Clin Nucl Med 1991; 16: 812-814.