

Comparison of Tl-201 Chloride and Ga-67 Citrate Scintigraphy in the Diagnosis of Thyroid Tumor: Concise Communication

Osamu Senga, Makoto Miyakawa, Hiroshi Shirota, Masao Makiuchi, Kesato Yano, Masanori Miyazawa, and Masaomi Takizawa

Shinshu University and Shinshu University Hospital, Matsumoto, Nagano, Japan

Twenty-five patients with thyroid tumors were scintigraphed with both Tl-201 chloride and Ga-67 citrate. All cases showed a focal area of decreased activity with I-131 or pertechnetate (Tc-99m), and each had a histological diagnosis after surgery or excisional biopsy. From the data we conclude the following: (1) Tumors giving a positive scan with Tl-201 chloride but negative results using Ga-67 citrate prove to be differentiated carcinoma or poorly differentiated adenoma. (2) All tumors that are positive with Ga-67 are highly malignant types, and if these tumors are negative by Tl-201, undifferentiated carcinoma is suggested. (3) Ga-67 citrate scintigraphy is a useful procedure in locating distant metastases, in determining the area to be irradiated, and in judging the effect of therapy on undifferentiated carcinoma.

J Nucl Med 23: 225-228, 1982

Thyroid scintigraphy is one of the most important procedures in the diagnosis of thyroid tumors. Up to this time I-131, I-123, pertechnetate (Tc-99m), and other radionuclides have been used as scanning agents. Recently, tumor-seeking agents such as [⁷⁵Se] selenomethionine (1), Tc-99m bleomycin (2), Cs-131 (3), and Hg-197 chloride (4) have been used in some clinical investigations. Thallium-201 chloride was also developed as a tumor-seeking agent and has been used for thyroid tumors in some laboratory and clinical investigations (5,6). In our previous study of Tl-201 chloride scintigraphy for thyroid tumors (7), we found that it has an affinity not only for malignant tumors, but also for tumors of a benign nature that were relatively poorly differentiated types such as tubular (fetal) or trabecular (embryonal) adenomas. Accordingly, Tl-201 chloride may be a very useful tracer in determining whether surgery is indicated.

On the other hand, gallium-67 citrate is also well known as a tumor-seeking agent and has been used in cases of thyroid tumor (8). It is reported that Ga-67 shows little affinity for differentiated carcinoma but a strong affinity for the undifferentiated type, although the results have not always been gratifying.

In our study we used Tl-201 chloride and Ga-67 citrate for thyroid scintigraphy and compared these two agents. This joint use of thyroid scintigraphy permitted a qualitative diagnosis of thyroid tumor.

MATERIALS AND METHODS

Twenty-five patients with thyroid tumors were scanned at various times with both Tl-201 chloride and Ga-67 citrate scintigraphy. Each patient showed a focal area of decreased activity with I-131 or pertechnetate (Tc-99m), and all had a histological diagnosis after surgery or excisional biopsy. A dose of 1.0-2.0 mCi Tl-201 chloride was administered intravenously, and after 10-20 min (early scan) and 2 hr (delayed scan) the patient was scanned. For Ga-67 citrate a dose of 2.0 mCi was administered intravenously and after 24 to 48 hr

Received Aug. 7, 1981; revision accepted Oct. 12, 1981.

For reprints contact: Osamu Senga, Dept. of Surgery, Faculty of Medicine, Shinshu University, 3-1-1, Asahi, Matsumoto, Nagano 390, Japan.

TABLE 1. SCINTIGRAPHIC RESULTS IN THYROID TUMORS

	No. of patients	Tl-201 chloride scintigram		Ga-67 citrate scintigram	
		positive	negative	positive	negative
Thyroid cancer	15	12 (80%)	3 (20%)	4 (26.7%)	11 (73.3%)
Papillary carcinoma	9	8	1	0	9
Follicular carcinoma	2	2	0	1*	1
Medullary carcinoma	1	1	0	0	1
Undifferentiated ca.	3	1	2	3	0
Thyroid adenoma	10	3 (30%)	7 (70%)	0 (0%)	10 (100%)
Colloid adenoma	6	0	6	0	6
Fetal adenoma	3	3	0	0	3
Cyst	1	0	1	0	1

* Oxyphilic-cell carcinoma.

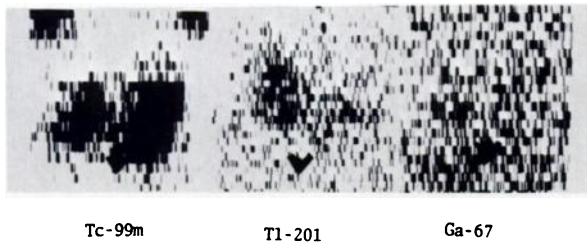


FIG. 1. Sixty-two-year-old female with papillary carcinoma. Left: thyroid scan with pertechnetate (Tc-99m) reveals nodule with decreased activity in upper part of right lobe. Center: Tl-201 chloride scintigram reveals intense concentration in the nodule. Right: scintigram with Ga-67 citrate shows no accumulation.

scanning was performed with a whole body scanner. For the thallium scans, a window covering 60–110 keV caught the mercury x ray; for gallium-67 the 93 keV gamma was used.

RESULTS

The thyroid tumors scanned with Tl-201 and Ga-67 were analyzed histologically as shown in Table 1. In 15 patients with thyroid carcinoma, 12 (80%) were positive by Tl-201, but only four cases (26.7%) were positive by Ga-67. By histological type, in nine cases of papillary carcinoma, eight (88.9%) were positive with Tl-201. In one negative case the tumor was almost completely en-

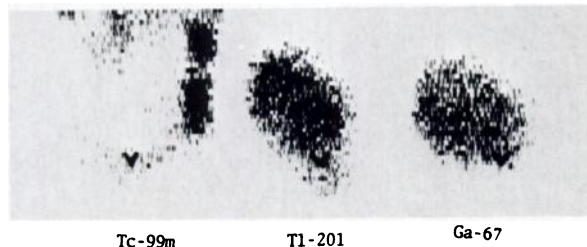


FIG. 2. Sixty-seven-year-old female with fist-sized oxyphilic-cell carcinoma of right thyroid lobe. Left: Tc-99m shows nodule with decreased activity in right lobe. Center and right: both Tl-201 and Ga-67 give intense concentration corresponding to nodule in right lobe.



FIG. 3. Fifty-eight-year-old male with medullary carcinoma. Left: Tc-99m suggests nodule with decreased activity in right lobe. Thallium-201 (center) shows slight accumulation, but Ga-67 (right) does not accumulate in nodule.

cysted. All were negative by Ga-67. In two cases of follicular carcinoma, both gave a positive scan by Tl-201 and one of them (an oxyphilic-cell carcinoma) showed positive with Ga-67. In one patient with medullary carcinoma, a weakly positive scan was found using Tl-201, but it was negative with Ga-67. In three cases of undifferentiated carcinoma, two small-cell carcinomas gave negative scans with Tl-201, and one case with pleomorphic-cell carcinoma gave a positive Tl-201 scan. With Ga-67 they all gave strongly positive scans. Of the thyroid adenomas, three of ten cases (30%) showed positive scans with Tl-201. Histologically, all were fetal adenomas. Every case of thyroid adenoma, however, gave a negative scan with Ga-67.

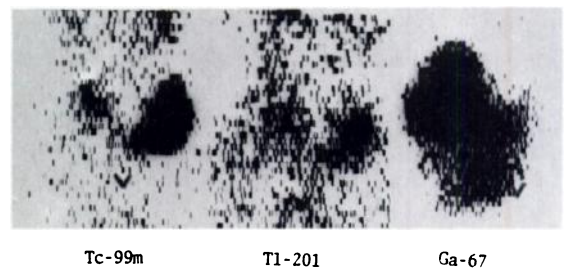


FIG. 4. Seventy-three-year-old male with undifferentiated (small-cell) carcinoma. Tc-99m (left) shows nodule with decreased activity in right lobe. Thallium-201 (center) does not accumulate in nodule, but does in normal thyroid tissue. Gallium-67 (right) gives heavy accumulation in nodule.

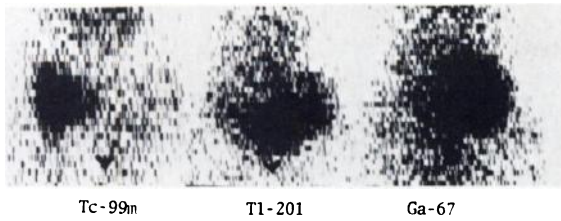


FIG. 5. Sixty-year-old female with undifferentiated (pleomorphic-cell) carcinoma. Pertechnetate (left) shows nodule with decreased activity in left lobe. Both Tl-201 (center) and Ga-67 (right) give heavy accumulation in nodule.

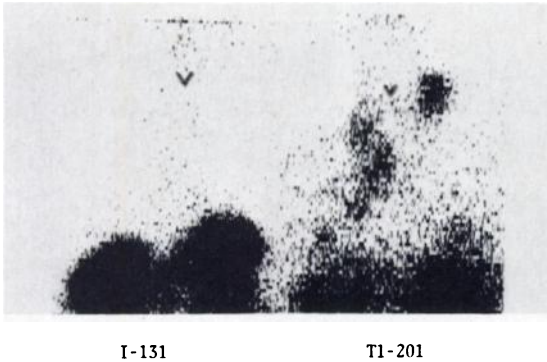


FIG. 6. Fifty-five-year-old male with papillary carcinoma. After total thyroidectomy, metastases appeared in lymph nodes in left supraclavicular region and mediastinum. Thyroid scan with I-131 (left) does not show accumulation in metastatic lymph nodes, but the Tl-201 (right) shows intense uptake at these sites.

Thallium-201 chloride and Ga-67 citrate scintigrams of each histological type of thyroid tumor are presented in Figs. 1 through 7.

DISCUSSION

Thallium-201 chloride was originally used as a myocardial (9) and renal medullary scanning agent (10). Recently some researchers have reported that Tl-201 chloride has an affinity for various malignant tumors, and it is being used in the detection of thyroid tumors. Tonami et al. (5) and Takeuchi et al. (6) reported positive scanning results in 94% and 90%, respectively, of thyroid carcinomas; they also reported accumulation of the tracers in the metastatic lymph nodes. In our previous study (7), 78.6% of thyroid carcinomas gave positive scans, with differentiated carcinoma showing 84% strongly positive. On the other hand, undifferentiated carcinomas were all negative. In adenoma, some cases gave positive scans, but all of them were relatively poorly differentiated types such as fetal adenoma and embryonal adenoma. It is difficult to distinguish some of these adenomas histologically from follicular carcinoma. Therefore, we concluded that Tl-201 chloride has no specific affinity for malignant tumors, but surgery is indicated for nodules that show positive scans by Tl-201 chloride.

Recently it was reported that delayed scans with Tl-201 chloride are effective in discriminating between benign and malignant tumors (11).

In the present study we scanned with Tl-201 chloride twice: the early scan began 10–20 min after intravenous injection and the delayed scan began at 120 min. Both gave almost the same results. It was suggested that differentiated carcinoma and adenoma, which were positive with Tl-201, produced a clear early scintigram more often than after a delay. Also, medullary carcinoma and

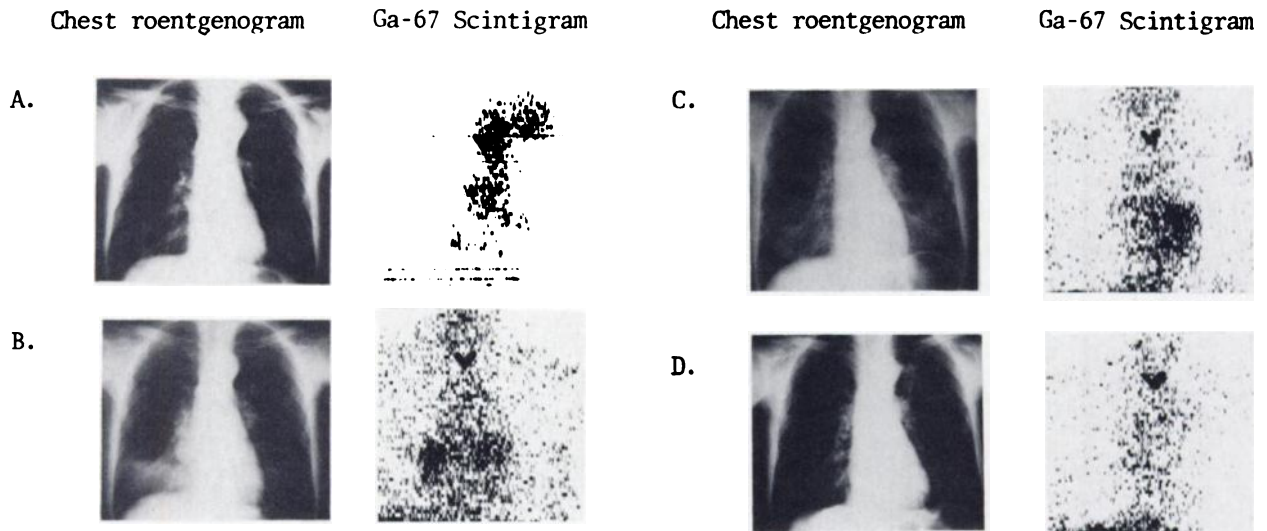


FIG. 7. Sixty-two-year-old female with undifferentiated (small-cell) carcinoma. A: Ga-67 citrate scintigram shows heavy accumulation in thyroid tumor, left supraclavicular region, and mediastinum. Chest radiograph does not show shadow of mediastinal tumor in detail. B: After Co-60 teletherapy (6,000 rad) accumulation of Ga-67 failed in these regions, but occurred around right hilus. Chest radiograph shows swelling of right hilar lymph nodes and atelectasis of right middle lobe. C: After Co-60 irradiation (3,000 rad) of right hilar lymph nodes, uptake of Ga-67 disappeared and chest radiograph shows improvement of right middle lobe. Gallium-67 uptake now appears in left hilar region. D: After 3,000 rad of Co-60 irradiation to left hilar lymph nodes, there is no accumulation of Ga-67.

one positive undifferentiated carcinoma gave a delayed scintigram clearer than the early one.

Gallium-67 citrate was first used by Edwards and Hayes (12) for Hodgkin's disease and thyroid carcinoma. This is one of the most useful tumor-seeking nuclides, and is now found very useful in the diagnosis and follow-up of patients with malignant lymphoma. There are published reports concerning the use of Ga-67 citrate scintigraphy in thyroid tumors (8,13). It showed little affinity for differentiated carcinoma but strong affinity for the undifferentiated types. In the present study of thyroid tumors, we found only 26.7% of the thyroid carcinomas to be gallium positive: only one case with oxyphilic-cell carcinoma and three cases with undifferentiated carcinoma gave positive scans, and papillary carcinoma, medullary carcinoma, and adenoma were all gallium negative. A weak result was therefore obtained when Ga-67 citrate scintigraphy was used to discriminate between carcinoma and adenoma. Furthermore, when only Tl-201 chloride was used, it achieved little or no success in the diagnosis of undifferentiated carcinoma.

We suggest that diagnostic value is enhanced by using Tl-201 and Ga-67 scintigraphy jointly in identifying the histological type of thyroid tumor. All tumors giving a positive scan with Ga-67 were malignant; moreover, they were all highly malignant types. Thyroid tumors that concentrated Tl-201 but not Ga-67 were suspected of being differentiated carcinomas or poorly differentiated adenomas. These two tracers accumulate not only in the primary tumor but also in distant metastases. In our previous study (7)—of differentiated carcinomas with relatively large metastatic lymph nodes in the neck and mediastinum—all showed obvious accumulation of Tl-201. Additionally, our study shows that Ga-67 citrate is also effective in finding distant metastases in undifferentiated carcinoma from the thyroid.

Concerning the treatment of undifferentiated carcinoma of the thyroid, surgical intervention is possible in the early stages. However, many patients cannot withstand surgery, and in these cases irradiation can be uti-

lized. It is very difficult to find distant early metastases around the mediastinum or hilus by chest radiograph, whereas Ga-67 scintigraphy is effective in such cases. Furthermore, it is a useful procedure in determining the irradiation area and in judging the effect of treatment.

REFERENCES

1. THOMAS CG, PEPPER FD, OWEN J: Differentiation of malignant from benign lesions of the thyroid gland using complementary scanning with ⁷⁵Selenomethionine and radioiodide. *Ann Surg* 170:396-408, 1969
2. MORI T, HAMAMOTO K, MORITA R, et al: Clinical evaluation of ^{99m}Tc-bleomycin scintigraphy for diagnosis of thyroid cancer. *J Nucl Med* 15:518-519, 1974
3. MURRAY IPC, STEWART RDH, INDYK JS: Thyroid scanning with ¹³¹Cs. *Br Med J* 4:653-656, 1970
4. MIYAKAWA M, KAWAMURA N, MAKIUCHI M, et al: Diagnostic significance of ¹⁹⁷HgCl₂-scintigraphy in thyroid carcinoma. *Radioisotopes* 26:320-323, 1977
5. TONAMI N, BUNKO H, MICHIGISHI T, et al: Clinical application of ²⁰¹Tl-scintigraphy in patients with cold thyroid nodules. *Clin Nucl Med* 3:217-221, 1978
6. TAKEUCHI A, KOGA S, IWATA S, et al: Thyroid scintigram with ²⁰¹Tl-chloride. *Radioisotopes* 27:150-152, 1978
7. SENGAWA O, MIYAKAWA M, MAKIUCHI M, et al: Diagnostic value of ²⁰¹Tl-chloride scintigraphy for thyroid tumors. *Jpn J Clin Oncol* 9:225-232, 1979
8. TADA A, KUBOTA A, SUGIHARA M, et al: Evaluation of ⁶⁷Ga-citrate scan for nonfunctional thyroid nodule. *Radioisotopes* 26:109-111, 1977
9. LEBOWITZ E, GREENE MW, FAIRCHILD R, et al: Thallium-201 for medical use. 1. *J Nucl Med* 16:151-155, 1975
10. RAYNAUD C, COMAR D, BUISSON M, et al: Radioactive thallium: A new agent for scans of the renal medulla. In *Radionuclides in Nephrology*, Blaufox MD, Funck-Brenano JL, Eds. New York, Grune & Stratton, 1972, pp 289-294
11. SAWA H, FUKUDA T, ITAMI M, et al: Differentiation between malignant and benign thyroid nodules by delayed scintigraphy using ²⁰¹TlCl. *Jpn J Nucl Med* 15:1223-1227, 1978
12. EDWARDS CL, HAYES RL: Tumor scanning with ⁶⁷Ga citrate. *J Nucl Med* 10:103-105, 1969
13. KAPLAN WD, HOLMAN BL, SELENKOW HA, et al: ⁶⁷Ga-citrate and the nonfunctioning thyroid nodule. *J Nucl Med* 15:424-427, 1974

SNM REFERRAL SERVICE

The SNM Referral Service is accepting applications from employers and job applicants. The Service lists positions wanted and positions available in the following nuclear medicine fields: Physician, Technologist, Scientist, Commercial, and Other.

The fee for job applicants is \$5.00 for SNM members and \$50.00 for nonmembers. For employers, the fee is \$50.00 for each position listed.

To obtain more information and an application form, please write to:

Referral Service
Society of Nuclear Medicine
475 Park Avenue South
New York, NY 10016