patient. Further studies are needed to optimize ^{131}I therapy in hyperthyroid patients with rapid thyroidal ^{131}I turnover.

REFERENCES

1. Solomon B, Glinoer D, LaGasse R, Wartofsky L. Current trends in the management of Graves' disease. *J Clin Endocrinol Metab* 1990;70:1518–1524.
2. Becker DV, Hurley JR. Current status of radioiodine (^{131}I) treatment of hyperthyroidism. In: Freeman LM, Weissmann HS, eds. *Nuclear medicine annual*. New York: Raven Press; 1982;265–290.
3. Graham GD, Burman KD. Radioiodine treatment of Graves' disease: an assessment of its potential risks. *Ann Intern Med* 1986;105:900–905.
4. Shapiro B. Optimization of radioiodine therapy of thyrotoxicosis: what have we learned after 50 yr? *J Nucl Med* 1993;34:1638–1641.
5. Rapoport B, Caplan R, DeGroot LJ. Low-dose sodium iodide-131 therapy in Graves' disease. *JAMA* 1973;224:1610–1613.
6. Roudebush CP, Hoye KE, DeGroot LJ Compensated low-dose ^{131}I therapy of Graves' disease. Ann Intern Med 1977;87:441–443.
7. Goolden AWG, Stewart JSW. Long-term results from graded low dose radioactive iodine therapy for thyrotoxicosis. *Clin Endocrinol* 1986;24:217–222.
8. Nordyke RA, Gilbert FI Jr. Optimal iodine-131 dose for eliminating hyperthyroidism in Graves' disease. *J Nucl Med* 1991;32:411–416.
9. Harbert JC. Radioiodine therapy of hyperthyroidism. In: Harbert JC, Eckelman WC, Neumann RD, eds. *Nuclear medicine diagnosis and therapy*. New York: Thieme Medical Publishing Inc.; 19;951–973.
10. Berg GEB, Michanek AMK, Holmberg ECV, Fink M. Iodine-131 treatment of hyperthyroidisim: significance of effective half-life measuremments. *J Nucl Med* 1996;37:228–232.
11. Clerc J, Izembart M, Dagousset F, et al. Influence of dose selection on absorbed dose profiles in radioiodine treatment of diffuse toxic goiters in patients receiving or not receiving carbimazole. *J Nucl Med* 1993;34:387–393.
12. Malamos BK, Daikos GK, Samara V, Koutras DA. The use of radioiodine for the diagnosis and treatment of thyroid diseases. *Acta Endocrinol (Copenh)* 1959;32:311–329.
13. Jackson GL. Calculated low dose radio-iodine therapy of thyrotoxicosis. *Int J Nucl Med Biol* 1975;2:80–81.
14. Green M, Fisher M, Miller H, Wilson GM. Blood radiation dose after ^{131}I therapy of thyrotoxicosis. Calculations with reference to leukemia. *Br Med J* 1961;2:210–215.
15. McConahey WM, Keating FR Jr, Power MH. The behavior of radioiodine in the blood. *Clin Invest* 1949;28:191–198.
16. Rall JE, Sonenberg MS, Robbins J, Lazerson R, Rawson RW. The blood level as guide to therapy with radioiodine. *J Clin Endocrinol Metab* 1953;13:1369–1377.
17. Koutras DA, Alexander WD, Buchanan WW, Crooks J, Wayne EJ. Studies of stable iodine metabolism as a guide to the interpretation of radioiodine tests. *Acta Endocrinol (Copenh)* 1961;37:597–606.
18. Alevizaki CC, Alevizaki-Harhalaki MC, Ikkos DG. Radioiodine-131 treatment of thyrotoxicosis: dose required for and some factors affecting the early induction of hypothyroidism. *Eur J Nucl Med* 1985;10:450–454.
19. Cunnien AJ, Hay ID, Gorman CA, Offord KP, Scanlon PW. Radioiodine-induced hypothyroidism in Graves' disease: factors associated with the increasing incidence. *J Nucl Med* 1982;23:978–983.
20. Hoffman DA. Late effects of iodine-131 therapy in the United States. In: Boice JD Jr, Fraument JF Jr, eds. *Radiation carcinogenesis*. New York: Raven Press 1984;273–280.
21. Schimmel M, Utiger RD. Acute effect of inorganic iodide after ^{131}I therapy for hyperthyroidism. *Clin Endocrinol* 1977;6:329–332.
22. Bliddal H, Hansen JM, Rogowski P, Johansen K, Friis T, Siersbaek-Nielsen K. Iodine-131 treatment of diffuse and nodular toxic goitre with or without antithyroid agents. *Acta Endocrinol (Copenh)* 1982;99:517–521.
23. Sridama V, McCormick M, Kaplan EL, Fauchet R, DeGroot LJ. Long-term follow-up study of compensated low-dose iodine-131 therapy for Graves' disease. *N Engl J Med* 1984;311:426–432.
24. Wu P, McIver B, Thomson K, Toft A. Predictive factors of recurrent hyperthyroidism following radioactive iodine treatment for Graves' disease [Abstract]. *The Endocrine Society, Program and Abstracts* 1994;41:264.
25. Steinbach JJ, Donoghue GD, Goldman JK. Simultaneous treatment of toxic diffuse goiter with iodine-131 and antithyroid drugs: a prospective study. *J Nucl Med* 1979;20:1263–1267.
26. Einhorn J, Saterborg NE. Antithyroid drugs in iodine-131 therapy of hyperthyroidism. *Acta Radiology* 1962;58:161–167.
27. Limperos G, Mosher WA. Protection of mice against x-radiation by thiourea. *Science* 1950;112:86–87.
28. Goolden AWG, Fraser TR. Effect of pretreatment with carbimazole in patients with thyrotoxicosis subsequently treated with radioactive iodine. *Br Med J* 1969;3:443–444.
29. Gimlette TMD, Kocak R, Herbert RG, Squire CR. The effect of carbimazole following radioiodine therapy on radiation dose to the thyroid. *Nuklearmedizin* 1981;20:72–75.
30. Heath RC, Gossain VV, Rovner DR. Alteration of radioactive iodine uptake after treatment of hyperthyroidism with iodine-131. *South Med J* 1988;81:601–605.
31. Goldsmith R. Experience with the radioiodine tracer test in radioiodine-treated thyrotoxic patients. *Am J Med Sci* 1954;227:403–407.
32. Eckert H, Green M, Kilpatrick R, Wilson GM. Thyroid function after the treatment of thyrotoxicosis by partial thyroidectomy or ^{131}I. *Clin Sci* 1960;20:87–97.
33. DeGroot LJ, Mangklabruks A, McCormick M. Comparison of RA1 iodine-131 treatment protocols for Graves' disease. *J Endocrinol Invest* 1990;13:111–118.
34. Becker DV, Hurley JR, Zanzonico PB, Kusic Z. Antithyroid drugs given during iodine-131 treatment maintain clinical control of hyperthyroidism and reduce whole body radiation [Abstract]. *Endocrinology Suppl* 1988;121:23.
35. Burrow GN, Burke WR, Himmelhoch JM, Spencer RP, Hershman JM. Effect of lithium on thyroid function. *J Clin Endocrinol* 1971;32:647–652.
36. Brunn J, Block U, Ruf G, Bos I, Kunze WP, Scriba PC. Volumetrie der Schilddrusenlappen mittels real-time-sonographie. *Dtsch Med Wochenschr* 1981;106:1338–1340.

Will Thallium-201 Replace Gallium-67 in Salivary Gland Scintigraphy?

Ali Syed Arbab, Kiyoshi Koizumi, Sachiko Hiraike, Keiji Toyama, Takao Arai and Tsutomu Araki

Department of Radiology, Yamanashi Medical University, Tamaho-cho, Nakakoma-gun, Yamanashi-ken, Japan

We investigated and compared findings on combined ^{99m}Tc pertechnetate-^{201}Tl with those of [^{99m}Tc]pertechnetate-^{67}Ga scintiscans to elucidate the advantages of ^{201}Tl in detecting various salivary glands disorders. **Methods:** We studied 23 patients: 6 had sialadenitis, 12 had benign tumors and 5 had malignant tumors. All but four patients had undergone [^{99m}Tc]pertechnetate (before and after lemon stimulation), ^{201}Tl (early and delayed) and ^{67}Ga imaging. **Results:** Five of six sialadenitis patients showed various degrees of diffuse uptake of ^{99m}Tc. All six except one showed early uptake without retention of ^{201}Tl on delayed imaging. The ^{67}Ga scan showed uptake in all patients except one. Nine of 12 benign tumors showed a cold defect on ^{99m}Tc scans. Patients with Warthin's tumors and plasmacytoma showed increased ^{99m}Tc uptake at the tumor with retention. The ^{201}Tl scan showed early uptake without retention in benign tumors except in three patients, two of whom had Warthin's tumor. Five of the benign tumors, however, were positive on ^{67}Ga scan. None of the malignant tumors showed any uptake of ^{99m}Tc. The ^{201}Tl scan showed uptake with tumor retention on delayed images in three patients; three other patients also had positive ^{67}Ga scans. Overall, sensitivity and specificity of ^{201}Tl in detecting malignant tumors were 60% and 73%, respectively, with a negative predictive value of 85%. Sensitivity and specificity for ^{67}Ga were 60% and 47%, respectively, with a negative predictive value of 80%. **Conclusion:** In view of sensitivity, specificity and convenience of ^{201}Tl as well as future prospects for dual-isotope acquisition, ^{67}Ga may be replaced by ^{201}Tl in detecting salivary gland disorder.

Key Words: salivary glands; technetium-99m; thallium-201; gallium-67

J Nucl Med 1996; 37:1819–1823

The usefulness of [^{99m}Tc]pertechnetate to image the major salivary glands is well-established and the introduction of ^{67}Ga-citrate imaging has opened a new way of differentiating various pathological entities involving the salivary glands (*1–6*). Gallium-67, however, has shown some limitations in differentiating malignant from benign tumors (*4,7*). Thallium-201-chloride has already shown its potential for detecting

Received Oct. 13, 1995; revision accepted Feb. 28, 1996.

For correspondence or reprints contact: Ali Syed Arbab, Department of Radiology Yamanashi Medical University, Tamaho-cho, Nakakoma-gun, Yamanashi-ken, 409-38, Japan.

malignant tumors in various organs, and retention of ^{201}Tl in the delayed phase indicates possibile malignancy (*8–10*), although ^{201}Tl has not previously been applied in detecting the salivary gland disorders.

In this study, we compared ^{201}Tl and ^{67}Ga scan results to elucidate the advantage of ^{201}Tl in detecting various salivary gland disorders and determine the possibility of replacing ^{67}Ga with ^{201}Tl.

MATERIALS AND METHODS

Patient Population

Twenty-three patients (13 men, 10 women; age 20–84 yr) with major salivary gland swelling, were studied. All but four patients underwent ^{99m}Tc, ^{201}Tl and ^{67}Ga scintigraphy. Three of these four only had ^{99m}Tc and ^{67}Ga scans and the remaining patient only had ^{99m}Tc and ^{201}Tl scans. Six patients had sialadenitis, 12 had benign tumors (8 adenoma, 2 Warthin's tumor, 1 lipoma and 1 extramedullary plasmacytoma) and 5 had malignant tumors of various types. All tumors were diagnosed histopathologically after surgery, and sialadenitis are diagnosed either histologically after surgery or by clinical response to antibiotics indicated by decreased swelling and/or pain.

Technetium-99m Scans

Five to 10 min after intravenous injection of 185–370 MBq ^{99m}Tc, static spot images in the anterior and both anterior lateral oblique positions were taken by a gamma camera mounted with a LEAP collimator. Usually 500K counts/frame were acquired for the first frame and then settings were switched to the time required to obtain the first frame. After static images were acquired, the salivary glands were stimulated by 100% lemon juice (5–10 ml) and images after stimulation were obtained in the same three positions. Interpretations of scintigraphic findings have been described in details elsewhere (*7*). Briefly, nodular lesions were interpreted as cold, warm or hot; those with diffuse lesions were interpreted as decreased, increased or equal. The images after stimulation were interpreted as retention positive (+) or negative (-).

Thallium-201 Scans

For early images, 5–10 min after intravenous injection of 111 MBq ^{201}Tl, anterior and both lateral oblique views were obtained using the same gamma camera, collimator and acquisition methods as in the ^{99m}Tc study. For delayed images, the same views were obtained 3–4 hr after injection. The early images were interpreted as warm (activity in the tumor or involved gland was equal to the normal gland), hot (activity in the tumor or gland was more than the normal gland) and cold (activity in the tumor was less than the normal gland or surrounding normal glandular tissue). Delayed images were interpreted as retention-positive (+), when activity in the tumor or gland was more than the normal gland or surrounding glandular tissue, and retention-negative (-), when activity in the tumor or gland was equal to the normal gland or tissue.

Gallium-67 Scans

Seventy-two hours after intravenous injection of 111 MBq ^{67}Ga, static images in three positions (anterior and lateral) were taken by a gamma camera mounted with a medium-energy collimator. Scan findings were interpreted as negative (-) when activity in the tumor or gland was equal or less than the normal contralateral gland, positive (+) when activity was higher than that in the contralateral gland, but equal to or less than the normal nasal activity, and strongly positive (++) when activity was higher than the normal nasal activity.

RESULTS

Table 1 shows a summary of the patients and their scan findings. All patients with sialadenitis showed various degrees of diffuse ^{99m}Tc uptake except for one, who did not have any uptake in the glands due to Sjogren syndrome with multiple cystic changes. Only one patient demonstrated retained ^{99m}Tc activity after lemon stimulation. The early ^{201}Tl scan showed various degrees of diffuse activity in all patients except the patient with Sjogren syndrome who had multiple photopenic areas in both parotid glands. Tumoral retention of ^{201}Tl occurred in only in one patient who had sialadenitis with intraparotid lymphadenitis. Gallium-67 scans showed accumulation in all involved glands except for the patient of lymphadenitis.

The ^{99m}Tc scans for 9 of 12 patients with benign tumors demonstrated a cold area at the tumor site without tumor tracer retention after lemon stimulation. Two patients with Warthin's tumor had hot areas with retention on their ^{99m}Tc scan. Thallium-201 scans depicted various degrees of early accumulation without retention on the delayed scan except in three patients. Two of the patients had Warthin's tumor; tracer retention was depicted on their delayed ^{201}Tl images. Thallium scans also depicted central photopenia in two patients with cystic change. In contrast, 5 of 11 patients had positive ^{67}Ga scan results. Figure 1 depicts a patient with typical pleomorphic adenoma. Figure 2 shows a patient with Warthin's tumor. The ^{201}Tl, ^{67}Ga and ^{99m}Tc scans of the patient with lipoma depicted cold spots at the tumor site. The ^{99m}Tc scan results for the patient with plasmacytoma mimicked Warthin's tumor whereas the early ^{201}Tl scan depicted activity without tumor retention.

All patients with malignant tumors had cold areas without tumor retention on the ^{99m}Tc scans. The ^{201}Tl scans in three of five patients showed increased tracer accumulation with retention in all tumors and lymph nodes. One patient had a cystic cavity inside the tumor, which appeared as a photopenic area on the early ^{201}Tl images. There were also three positive ^{67}Ga scan results, including lymph nodes. Figure 3 shows a case of lymphoma within the right submandibular gland with lymph node metastasis.

DISCUSSION

We previously reported the results of combined ^{99m}Tc and ^{67}Ga scintiscans in various disorders of the major salivary glands, which showed its advantage in diagnosing sialadenitis and its high negative predictive value (NPV) for malignancy (*7*). The ^{67}Ga scans were nonspecific in differentiating benign from malignant lesions due to high uptake by inflammatory lesions; an observation also reported by others (*4*). Moreover, ^{67}Ga scanning is usually performed 72 hr after injection, which is inconvenient for both patients and technologists with regard to time and schedule. Thallium-201 has already shown its potential to differentiate benign from malignant tumors in various organs, and retention of ^{201}Tl in the tumor 2–4 hr after injection increases the probability of malignancy (*8–10*). Moreover, both ^{201}Tl and ^{99m}Tc scintigraphy can be performed within a single day, eliminating the need to return for a second examination.

To date, various radiopharmaceuticals, including positron emitters, have been used to differentiate benign from malignant salivary gland disorders (*11,12*). In this study, ^{99m}Tc, ^{201}Tl and ^{67}Ga scans were obtained to compare the scan results of combined $^{99m}Tc/^{201}Tl$ with that of $^{99m}Tc/^{67}Ga$ to determine the advantage of ^{201}Tl and the possibility of replacement of ^{67}Ga for the investigation of salivary gland disorders.

All scan interpretations were determined by visual analysis. In our previous study (*7*), the criterion for diagnosis of sialadenitis was various degrees of diffuse ^{99m}Tc uptake with positive ^{67}Ga accumulation in the involved gland. All but one

TABLE 1
Scintigraphic Findings

Patient no.	Age (yr)	Sex	Dx	^{99m}Tc-scan	Lemon stimulation	^{201}Tl Early	^{201}Tl Delayed	^{67}Ga
1†	54	M	LA	I	R (−)	W	+	−
2†	58	F	SA	I	R (−)	W	−	+
3†	68	F	SA	I	(R (−)	H	−	++
4†	44	M	SA	D	R (−)	H	−	++
5†	40	F	SA	ns	R (−)	W*	−	+
6†	48	M	SA	D	R (+)	W	−	+
7‡	22	M	PA	C	R (−)	W	−	++
8‡	62	M	PA	C	R (−)	H	−	−
9‡	47	M	PA	C	R (−)	nd	nd	+
10‡	60	F	PA	C	R (−)	W	−	+
11‡	20	F	PA	C	(R (−)	nd	nd	
12‡	84	F	PA	C	R (−)	H	+	++
13‡	67	F	PA	C	R (−)	nd	nd	+
14‡	74	M	MA*	C	R (−)	C	−	−
15‡	63	M	L	C	R (−)	C	−	C
16‡	71	F	WT	H	R (+)	H	+	−
17‡	71	F	WT*	H	R (+)	W*	+	−
18‡	64	F	PC	H	R (+)	W	−	nd
19§	76	M	MM	C	R (+)*	W*	−	−
20§	69	M	AC	C	R (−)	W	−	+
21§	65	M	AS	C	R (−)	H**	+	++**
22§	61	M	ML	C	R (−)	H**	+	++**
23§	59	M	SCC	C	R (−)	H**	+	−

* Tumor with cystic change.
† Patients with sialadentis.
‡ Patients with benign tumors.
§ Patients with malignant tumors.
** Uptake to both primary tumors and lymphnodes.
LA = intraparotid lymphadenitis; SA = sialadenitis; PA = pleomorphic adenoma; MA = monomorphic adenoma; L = lipoma; WT = Warthin's tumor; PC = extramedullary plasmacytoma; MM = malignant myoepithelioma; AC = adenocarcinoma; AS = anaplastic small cell carcinoma; I = diffuse increased uptake; D = diffuse decreased uptake; ns = not seen due to Sjogren syndrome; C = cold; H = hot (activity more than normal gland); R = retention; R* = retention to peripheral normal tissue; W = warm (activity equal to normal gland); W* = warm with a cold area/areas; and nd = not done.

patient with sialadenitis in this study also fulfilled this criterion. The exception was a case of suspected intraparotid lymphadenitis that did not show any avidity for ^{67}Ga; the disease subsided after one course of antibiotics. If we consider various degrees of diffuse ^{99m}Tc uptake and early diffuse uptake without retention of ^{201}Tl as criteria for sialadenitis, five of six patients with sialadenitis fulfilled the criteria. In each study, the patient who did not fulfill the criteria had lymphadenitis, there was also retention of ^{201}Tl at the site of intraparotid lymph node swelling. The reason for the absence of ^{67}Ga uptake was not clear but might have been due to smaller (<1.5 cm) lymph node size, while ^{201}Tl retention might be due to an inflammatory process causing extracellular edema and delayed clearance. A comparison of the ^{67}Ga ^{201}Tl scan resutls show that both agents have similar sensitivity in detecting sialadenitis, but ^{201}Tl has the advantages of convenience and time-efficiency.

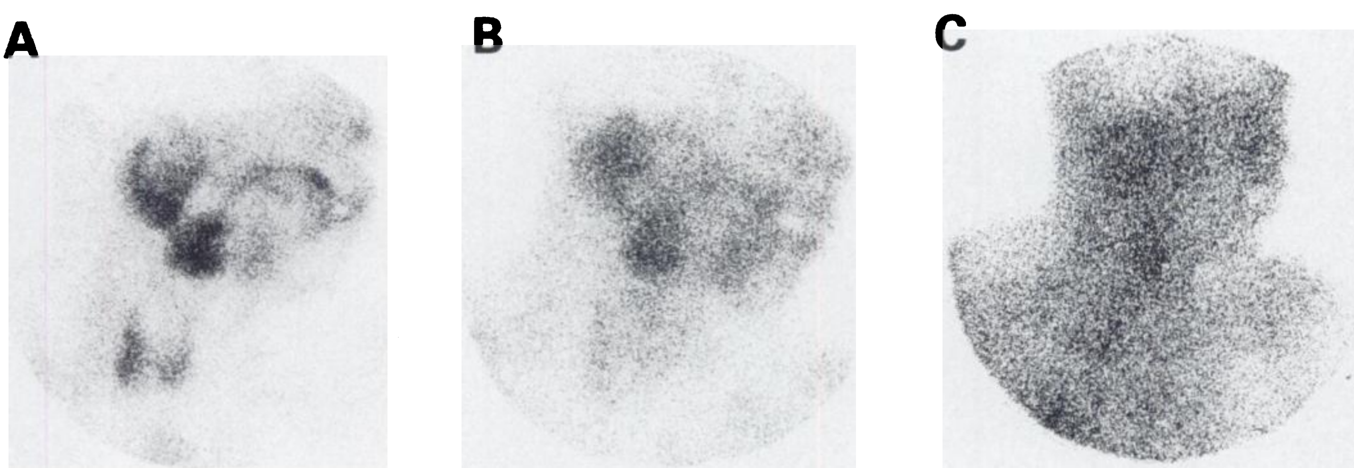

FIGURE 1. Typical pleomorphic adenoma (mixed tumor) in a 62 yr-old man. (A) Technetium-99m scan shows a cold defect at the mass in right parotid gland. (B) Delayed ^{201}Tl scan shows no retention at the mass. (C) Gallium-67 scan shows negative (−) uptake by the tumor.

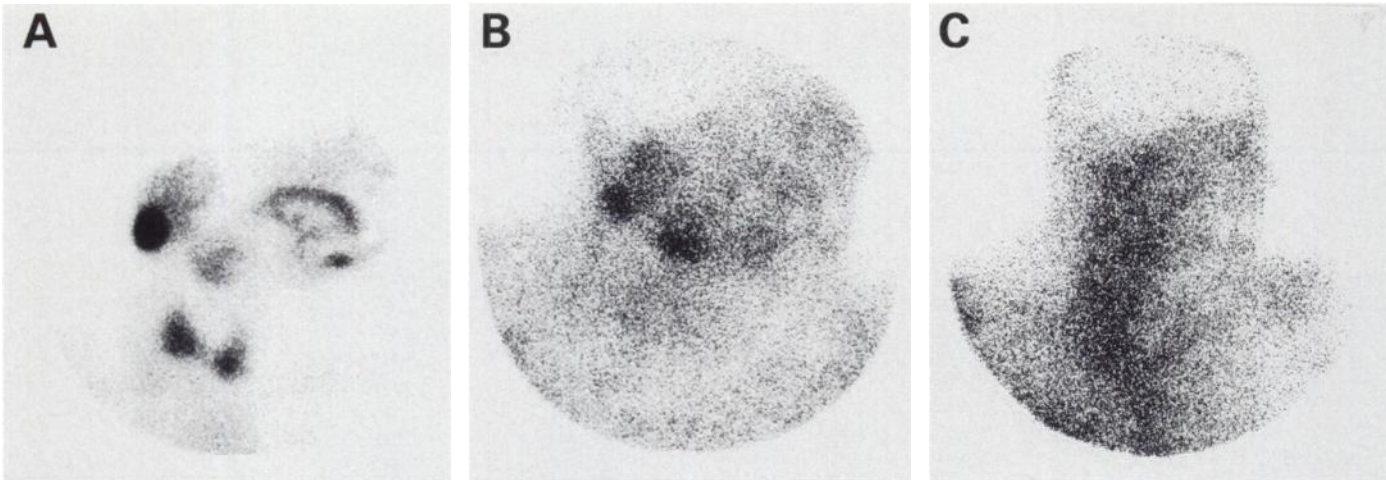

FIGURE 2. A 71-yr-old woman with Warthin's tumor. (A) Technetium-99m scan after lemon stimulation shows intense retention at the mass in the right parotid gland. (B) Delayed ^{201}Tl scan also showed retention at the mass. (C) Gallium-67 scan showed no uptake in the mass.

We (*7*) and others (*4*) previously showed false-positive uptake of ^{67}Ga in pleomorphic adenoma due to the presence of ^{67}Ga-avid protein and other factors (*13–15*). Except for Warthin's and oncocytoma (*16,17*), most tumors appear as cold defects on ^{99m}Tc scans. In the current study, the patient with benign extramedullary plasmacytoma also had increased tumoral ^{99m}Tc uptake. If we exclude these exceptional cases with hot ^{99m}Tc scan results, then it would be important to differentiate benign from malignant tumors from the cold lesions on the ^{99m}Tc scans. Of the nine benign cold lesions on the ^{99m}Tc scan, ^{67}Ga depicted five false-positive scans, whereas ^{201}Tl demonstrated various degrees of uptake without retention on delayed images for all patients except one. Moreover, ^{201}Tl detected cystic change as a photopenic area inside the tumor. The two patients with Warthin's tumors showed typical ^{99m}Tc scan patterns as well as retention of ^{201}Tl on delayed scans. The exact mechanism of ^{201}Tl retention could not be explained but may be due to the active metabolism in Warthin's tumor resulting in an increased Na^+, K^+ ATPase system because Warthin's tumor has marked mitochondrial density (*18*). Diagnosis of Warthin's tumor or oncocytoma, however, could be confirmed by ^{99m}Tc imaging alone (*16,17*). The ^{99m}Tc scan results of plasmacytoma were similar to that of Warthin's tumor but the uptake mechanism was not known and further clarification is needed. A comparison of ^{67}Ga and ^{201}Tl scan results in cold lesions with ^{99m}Tc shows that ^{201}Tl is more advantageous than ^{67}Ga with regard to specificity. Also, ^{201}Tl detected more tumors with cystic changes.

Of the five malignant cold lesions on ^{99m}Tc scans, both ^{67}Ga and delayed ^{201}Tl imaging had two false-negative results. Thallium-201 detected lymph node metastasis in all patients but ^{67}Ga failed to detect the tumor as well as lymph node metastasis in one patient. One negative ^{201}Tl scan depicted a malignant myoepithelioma with cystic change inside the tumor, which appeared as a photopenic area on the early images. Therefore, ^{201}Tl retention might not be prominent due to a lack of solid tissue, but the ^{67}Ga scan also showed absence of uptake. At surgery, the origin of the tumor on the other false-negative ^{201}Tl scan was unclear. The tumor (<1.5 cm) was believed to have originated from the skin. Nonretention of ^{201}Tl might be due to smaller tumor size, but the ^{67}Ga showed positive uptake. In detecting malignant tumors, both ^{201}Tl and ^{67}Ga had similar results, but ^{201}Tl detected cystic change in one patient .

If the results of delayed ^{201}Tl scans and ^{67}Ga scans are compared for all patients, the sensitivity and specificity for ^{201}Tl scans in detecting malignancy were 60% (3/5) and 73% (11/15), with positive (PPV) and negative predictive values (NPV) of 43% (3/7) and 85% (11/13), respectively. Sensitivity and specificity of the ^{67}Ga scans were 60% (3/5) and 47% (8/17), with PPV and NPV of 25% (3/12) and 80% (8/10),

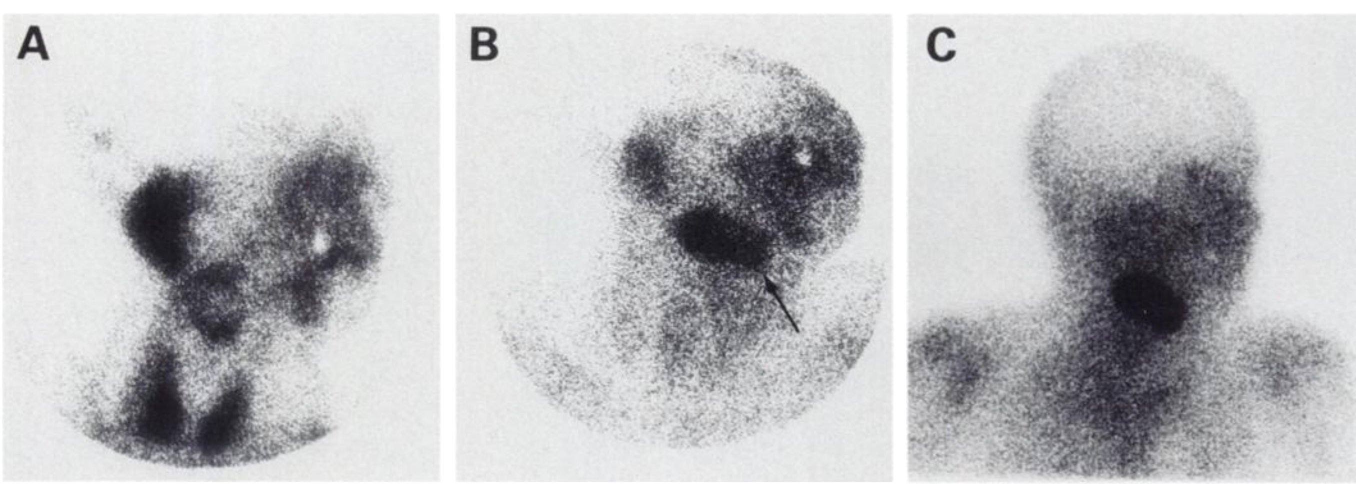

FIGURE 3. Malignant lymphoma with lymph node metastasis in a 61-yr-old man. (A) Technetium-99m scan showed cold defect at the mass in the right submandibular gland. (B) Thallium-201 scan showed retention of activity by both the tumor and lymphnode (arrow) on delayed image. (C) Gallium-67 image showed strong uptake (++) in the tumor and lymph node.

respectively. Since sialadenitis could be differentiated by the diffuse nature of ^{99m}Tc uptake and Warthin's tumor could be diagnosed by the ^{99m}Tc scan alone due to their hot uptake (except for a few rare tumors), only cold lesions on ^{99m}Tc scans would be potentially malignant tumors. A comparison of ^{201}Tl and ^{67}Ga scans of lesions that were cold on ^{99m}Tc scans reveals that ^{201}Tl had a sensitivity of 60% (3/5) sensitivity, specificity of 83% (5/6), PPV pf 75% (3/4) and NPV of 71% (5/7), while the sensitivity and specificity of ^{67}Ga scans were 60% (3/5) and 55% (5/9), with a PPV and NPV of 43% (3/7) and 71% (5/7), respectively. Moreover, ^{201}Tl detected all cases of cystic changes and could be used for SPECT imaging with semiquantitative analysis to increase the detectability of the smaller mass. Dual-isotope acquisition (^{99m}Tc and ^{201}Tl) with application of the triple-energy window (TEW) method will further decrease the total examination time.

CONCLUSION

Our preliminary experience indicates that $^{99m}Tc/^{201}Tl$ imaging of salivary gland disorders may be superior to $^{99m}Tc/^{67}Ga$ imaging due to their sensitivity and specificity in detecting malignant lesions, convenience for both patients and technologists and future prospects for dual-isotope acquisition with TEW.

ACKNOWLEDGMENT

This study was presented in part at the 42nd annual meeting of the Society of Nuclear Medicine, Minneapolis, MN, June 1995.

REFERENCES

1. Chaudhuri TK, Stadalnik RC. Salivary gland imaging. *Semin Nucl Med* 1980;10:400–401.
2. Ohrt HJ, Shafer RB. An atlas of salivary gland disorders. *Clin Nucl Med* 1982;7:370–376.
3. Liu RS, Yeh SH, Yen TC, Hsu DF. Salivary gland scintigraphy with vitamin C stimulation: an aid in differentiating unilateral parotitis from Warthin's tumor. *Eur J Nucl Med* 1990;16:689–691.
4. Higashi T, Shindo J, Everhart R, Mori Y, Kasai H, Kogure S, Wakao H. Technetium-99m-pertechnetate and gallium-67 imaging in salivary gland disease. *Clin Nucl Med* 1989;14:504–514.
5. Hardoff R, Gips S, de Myttenaere SB. Surgical parotitis' demonstrated by gallium-67 scintigraphy in critically ill patients. *Clin Nucl Med* 1991;16:187–188.
6. Oates E, Touliopoulos P, Wazer DE. Demonstration of unilateral sialadenitis on post radiotherapy gallium-67-citrate imaging. *J Nucl Med* 1993;34:953–954.
7. Arbab AS, Koizumi K, Uchiyama G, Arai T. The usefulness and limitations of combined technetium-99m-pertechnetate and gallium-67-citrate imaging of salivary gland disorders. *Clin Nucl Med* 1995;20:5–12.
8. Elgazzar AH, Fernandez-Ulloa M, Silberstein EB. Thallium-201 as a tumor-localizing agent: current status and future considerations. *Nucl Med Commun* 1993;14:96–103.
9. Caluser C, Macapinlac H, Healey J, et al. The relationship between thallium uptake, blood flow and blood pool activity in bone and soft tissue tumors. *Clin Nucl Med* 1992;17:565–572.
10. Tonami N, Yokoyama K, MIchigishi T, Aburano T, Hisada K, Watanabe Y. Thallium-201 single-photon emission computed tomography of double cancers: lung and breast. *Clin Nucl Med* 1989;14:594–596.
11. Kairemo KJA, Hopsu EVM. Diagnosis of tumors of the parotid gland with anti-CEA immunoscintigraphy. *Am J Roentgenol* 1990;154:1259–1262.
12. Keyes JW, Harkness BA, Greven KM, Williams DW, Watson NE, McGuirt WF. Salivary gland tumors: pretherapy evaluation with PET. *Radiology* 1994;192:99–102.
13. Min-Fu T, Scheffel U . Mechanism of gallium-67 accumulation in tumors. *J Nucl Med* 1986;27:1215–1219.
14. Weiner R . Letters to the editor. *Clin Nucl Med* 1982; 7:242–243.
15. Alpert L, Friedman R. Gallium scintigraphy demonstration of an appendiceal mucocele: a proposed mechanism of uptake. *Clin Nucl Med* 1981;6:378–379.
16. Sostre S, Medina L, de Arellano GR . The various scintigraphic patterns of Warthin's tumor. *Clin Nucl Med* 1987;12:620–626.
17. Kosuda S, Gokan T, Tamura K, Kubo A. Radionuclide imaging for parotid oncocytoma. *Clin Nucl Med* 1987;12:150–151.
18. The neoplastic cell II: cytoplasmic ultrastructure. In: Henderson DW, Papadimitriou JM, eds. *Ultrastructural appearances of tumors-a diagnostic atlas.* Edinburgh: Churchill Livingstone; 1982:117–175.

FIRST IMPRESSIONS

What is the finding at the right 10-11 costal area?
For acquisition information, see page 1920.