A Case of Parathyroid Carcinoma Visualized by $^{67}$Ga Citrate and $^{201}$Tl Chloride Scintigraphy

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Both $^{67}$Ga citrate and $^{201}$Tl chloride accumulated in a parathyroid tumor of a 62 year-old woman with primary hyperparathyroidism. Histological studies disclosed that the tumor was a parathyroid carcinoma. The use of both tumor scanning agents, $^{67}$Ga citrate and $^{201}$Tl chloride to visualize parathyroid carcinoma in a patient with primary hyperparathyroidism has not been reported as far as we could determine.

Key Words: parathyroid carcinoma, primary hyperparathyroidism, gallium-67 citrate, thallium-201 chloride

1. Introduction
Parathyroid carcinoma is responsible for 0.5–5.0% of the cases of primary hyperparathyroidism1). The preoperative differentiation of carcinoma from benign parathyroid neoplasia is extremely difficult2). In this paper we report a case of parathyroid carcinoma which accumulated intensely both $^{67}$Ga-citrate and $^{201}$Tl chloride.

2. Case Report
A 62-yr-old woman was admitted to our hospital with pain in the chest, ribs, pelvis and femur. Physical examination at the time of admission revealed a solid tumor measuring 5.0×5.0 cm in the left anterior cervical region. Laboratory studies disclosed a serum calcium level of 6.4 meq/l (normal: 4.5–5.5), phosphate level of 2.0 mg/dl (normal: 2.5–4.5), and an alkaline phosphatase level of 17.9 K.A.U (normal: 2.7–12.0). A carboxyterminal specific radioimmunoassay of parathyroid hormone showed a level of 3.8 ng/ml (normal: less than 0.5). Renal tubular reabsorption of phosphorus was 79% (normal: 85–98). Therefore this patient was diagnosed to have primary hyperparathyroidism. An ultrasonographic examination of the neck revealed an inhomogeneous hyperechoic oval mass of 4.4×4.0×6.0 cm with a capsule.

A CT examination of the neck showed a low density mass 5.0 cm in diameter located near the lower pole of the left thyroid lobe. In the bone X-ray films subperiosteal resorption in the phalanges was not evident but areas of decreased bone density were shown in the skull lesion. Bone scanning with $^{99}$mTc-MDP showed multiple hot areas in the skeleton. Although a specimen biopsied from iliac bone had the microscopic evidence of metastatic cancer, it was not clear whether the all bone lesions were due to metastasis. An an-
terior thyroidal image was obtained 24 h after oral administration of 7.4 MBq of $^{123}$I, using a gamma camera with a pinhole collimator. This image disclosed a defect or deformity of the lower part of the left thyroid lobe (Fig. 1). Next, anterior 5-min and 1-h pinhole images of the neck were obtained after i.v. injection of 74 MBq of $^{201}$Tl, a tumor imaging agent. Uptake of $^{201}$Tl in the tumor appeared to be higher in the 1-h image than in the 5-min image, suggesting clearance of the radioactivity was slower in the tumor than in the thyroid (Fig. 2 A, B). Five days later, 148 MBq of $^{67}$Ga-citrate, another tumor seeking agent, was injected intravenously. The 48-h overlapping images from the skull to pelvis were obtained using a gamma camera with a medium energy multiparallel hole collimator. The anterior skull-neck image showed an abnormal accumulation of $^{67}$Ga in the left side neck tumor (Fig. 3). No other abnormal findings were observed in the overlapping $^{67}$Ga images. At surgery, a solid firm parathyroid tumor covered by fibrous capsule of 8.5×5.0

Fig. 1 $^{123}$I thyroid scan: A defect or deformity of the lower part of the left thyroid lobe is seen (black arrow).

Fig. 2 $^{201}$Tl thyroid scan: Uptake of $^{201}$Tl in the tumor appeared to be higher in the 1-h image (right: black arrow) than in the 5-min image (left: black arrow), suggesting clearance of the radioactivity was slower in the tumor than in the thyroid.

Fig. 3 $^{67}$Ga citrate scan: The anterior skull-neck image showed an abnormal accumulation of $^{67}$Ga in the left side neck tumor (black arrow).
×4.0 cm was found near the lower part of the left thyroid lobe (Fig. 4). There were adhesions between the tumor and the lower part of the left thyroid lobe. It also adhered to surrounding structures. The tumor was resected enblock with the lower part of the left thyroid lobe. No enlarged regional lymph nodes were found. Microscopically, there was proliferation of atypical cells with solid and trabecular pattern in part separated by thin fibrous bands. The tumor invaded out of the capsule. Vessel invasion and atypical mitotic figures were also observed. The pathological diagnosis was parathyroid carcinoma (Fig. 5).

The serum levels of calcium, phosphate, parathyroid hormone returned to normal within a few days.

3. Discussion

Reliable criteria for preoperative differentiation of a parathyroid carcinoma from a benign parathyroid tumor has not yet been established\(^2\),\(^3\). Scanning with \(^75\)Se selenomethione has been used to localize parathyroid lesions\(^4\),\(^5\). However, it is now seldom used due to its low accuracy of diagnosis\(^6\). Instead \(^201\)Tl chloride–\(^99m\)Tc pertechnetate subtraction imaging is used routinely to localize parathyroid lesions such as adenomas, carcinomas and hyperplasias\(^7\).

\(^67\)Ga citrate scintigraphy has been successfully employed for the detection of malignant tumors and inflammatory lesions\(^8\),\(^9\). Multiple and different mechanisms may explain the concentration of gallium in tumors and inflammatory sites\(^10\). However, the exact mechanism of \(^67\)Ga citrate uptake is still unknown.

Cann and Prussin\(^11\) reported experimentally greater uptake of \(^67\)Ga citrate in the parathyroid gland than in the other tissues examined. However, clinical studies of \(^67\)Ga citrate scanning for diagnosis of parathyroid disorders have rarely been reported. Iwase et al.\(^12\) reported that atypical acidophilic cell carcinoma of the parathyroid was delineated by \(^67\)Ga citrate in one patient but the parathyroid adenoma was not visualized in nine patients. They concluded that scanning with \(^67\)Ga citrate is useful for differentiation of parathyroid carcinoma from adenoma. However, Bekerman et al.\(^13\) reported a case of oxyphilic cell parathyroid adenoma imaged by \(^67\)Ga citrate. In our patient, few oxyphilic cells were present in the carcinoma. The use of \(^201\)Tl and \(^67\)Ga-citrate to visualize parathyroid carcinoma in a patient has not been reported as far as we could determine. Both agents accumulated intensity in the parathyroid carcinoma of our patient. Therefore our experience warrants further studies on the combined use of \(^201\)Tl chloride and \(^67\)Ga-citrate for differentiation of carcinoma from adenoma and hyperplasia of the parathyroids in

Fig. 4 Cross section of the parathyroid carcinoma.

Fig. 5 Microscopicall finding of the parathyroid carcinoma (H.E.: original×100).
a patient with hyperparathyroidism.

References

1) Schantz, A and Castleman, B.: Cancer, 31, 600-605 (1973)