ORIGINAL

Thallium-201 chloride scintigraphy in soft tissue tumors

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Abstract : *Objective* We report the findings of Thallium-201 chloride (^{201}TlCl) scintigraphy and consider how to use this technique to evaluate the character of soft tissue lesions. *Patients and Methods* We enrolled 91 consecutive patients (45 males and 46 females, age range 8-91-years-old). Nineteen patients were malignant and 72 were benign. Patients were scanned 15 minutes (early phase) and 3 hours (delayed phase) after ^{201}TlCl injection. More intense uptake in the lesion compared to the normal side was considered as 'high', the same degree of uptake was considered 'iso', and decreased uptake was 'low'. The retention index (RI) was calculated in 9 patients in the malignant group and in 16 patients in the benign group. *Results* In malignant tumors, 15 of 19 patients showed high uptake in both the early and delayed phases. One malignant fibrous histiocytoma patient was high only in the delayed phase and 1 liposarcoma patient was high only in the early phase. Two liposarcoma patients showed an iso uptake in both phases. One of these patients was pathologically diagnosed as a myxoid type. In benign lesions, no lipoma showed increased uptake. All neurogenic tumors except for 2 demonstrated high uptake. All 3 ganglions of the lower extremities showed iso uptake. Most inflammatory diseases showed increased uptake. Clinically-considered benign patients consisted of tumorous lesions or inflammatory disease. Only 2 patients were considered 'low', and these were diagnosed as intramuscular hematoma and cyst. RI was variable in both malignant and benign lesions and no statistically significant difference was seen between malignant and benign lesions by t-test (p=0.72). *Conclusions* A high ^{201}TlCl uptake lesion is more frequently seen in malignant tumors, but regardless of whether the tumor is benign or malignant, according to the histopathological variety, the ^{201}TlCl uptake pattern can not be the only indicator to differentiate malignant from benign tumors. We ultimately need to evaluate the nature of tumors by a combination of several imaging techniques. J. Med. Invest. 56 : 136-141, August, 2009

Keywords : *^{201}TlCl scintigraphy, soft tissue tumors, retention index, malignant, benign*

INTRODUCTION

Thallium-201 chloride (^{201}TlCl) scintigraphy is a conventional nuclear medicine technique to evaluate the nature of tumors. Some studies have reported the utility of ^{201}TlCl scintigraphy in the differentiation of malignant from benign lesions in various organs, including soft tissue tumors (1-4). Malignant tumors typically demonstrate intense uptake, whereas benign lesions show less uptake. However, the differentiation between malignant and benign soft tissue tumors by the degree of ^{201}TlCl uptake is sometimes difficult due to the histological variability. ^{201}TlCl uptake reflects not only a malignant character but

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other factors such as vascularity, cell densities or tissue viability regardless of whether the tumor is benign or malignant.

We report here the findings of ^{201}TlCl scintigraphy and consider how to use this technique to evaluate the character of soft tissue lesions.

PATIENTS AND METHODS

We enrolled 91 consecutive patients who were examined for ^{201}TlCl scintigraphy (45 males and 46 females, age range 8-91-years-old) in this study. Nineteen patients were malignant and 72 were benign. All 19 patients with malignant lesions were pathologically proven ; 46 of 72 patients with benign lesions were pathologically proven, and the other 26 patients were clinically diagnosed as benign with at least 6 months of follow up with physical examinations and magnetic resonance imaging. Patients had 111 MBq of ^{201}TlCl, and were scanned 15 minutes (early phase) and 3 hours (delayed phase) after the injection. In the early phase, whole body images and a spot scan of the lesion were obtained and a spot scan was performed in the delayed phase. For visual analysis, more intense uptake compared to the normal side was considered as 'high', the same degree (could not be identified as a tumor) of uptake was considered 'iso', and decreased uptake was 'low'. The retention index (RI) was calculated in 9 patients in the malignant group and in 16 patients in the benign group as follows : RI=(DR-ER)/ER×100 (%). ER (early ratio) is the ratio of lesion count to contralateral soft tissue count in the early phase and DR (delayed ratio) is the ratio of lesion count to contralateral soft tissue count in the delayed phase.

RESULTS

A summary of the patients is shown in Tables 1 and 2. In malignant tumors, 15 of 19 patients showed high uptake in both the early and delayed phases (Figure 1). One malignant fibrous histiocytoma patient was high only in the delayed phase and 1 liposarcoma patient was high only in the early phase. Two liposarcoma patients showed an iso uptake in both phases. One of these patients was pathologically

Table 1 A summary of the patients and the lesions.

91 patients

Age 8–91

Gender male 45 female 46

malignant	
19	all pathologically proven
6	malignant fibrous histiocytoma
3	liposarcoma
2	malignant peripheral nerve sheath tumor
2	metastatic tumor
1	fibrosarcoma
1	extraskeletal myxoid chondrosarcoma
1	synovial sarcoma
1	pigmented villonodular synovitis
1	pleomorphic sarcoma
1	malignant lymphoma

benign		
	72	pathologically proven 46, not proven 26
proven (46)	14	lipoma
	9	schwannoma
	3	hemangioma
	3	ganglion
	2	fibroma
	2	desmoid
	2	granuloma
	2	chronic bursitis
	9	others (e.g. intramuscular myxoma, angiolipoma)
not proven (26)	10	inflammatory disease (bursitis, synovitis, myocytis)
	3	cystic tumor
	2	hemangioma
	2	schwannoma
	2	lipoma
	7	others (e.g.hematoma,lymphangioma)

Table 2 Uptake pattern of ^{201}TlCl scintigraphy. Patients were scanned 15 minutes (early phase) and 3 hours (delayed phase) after ^{201}TlCl injection. More intense uptake in the lesion compared to the normal side was considered as 'high', the same degree of uptake was considered 'iso', and decreased uptake was 'low'.

	Early phase	Delayed phase	patients	detail
malignant	high	high	15	5 MFH, 2 MPNST, 2 SCCmeta, 6 others
19	high	iso	1	liposarcoma
	high	low	0	
	iso	high	1	malignant fibrous histiocytoma
	iso	iso	2	2 liposarcoma
	iso	low	0	
	low	high	0	
	low	iso	0	
	low	low	0	
benign	high	high	21	8 schwannoma, 2 granuloma, 2 chronic bursitis, 9 others
72	high	iso	6	3 inflammatory disease (bursitis, synovitis, myocytis), 3 others
	high	low	0	
	iso	high	0	
	iso	iso	42	13 lipoma, 3 ganglion, 2 hemangioma, 24 others
	iso	low	1	lipoma
	low	high	0	
	low	iso	0	
	low	low	2	hematoma, intramuscular cyst

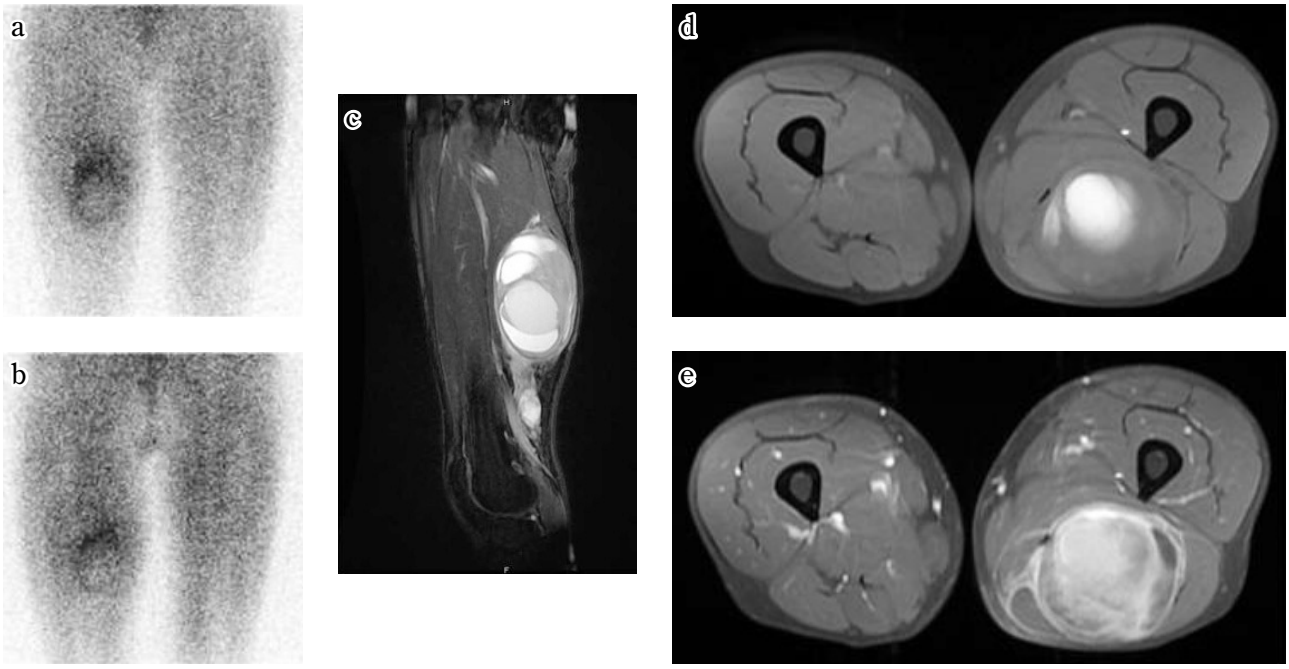

Figure 1 Malignant peripheral nerve sheath tumor (MPNST) in the left femur of patient with neurofiromatosis type I. a : early phase image of ^{201}TlCl scintigraphy, b : delayed phase image of ^{201}TlCl scintigraphy. MPNST showed high uptake in both early and delayed phase. c : FIESTA (fast imaging Employing Steady-state Acquisition) image of MRI of coronal view. This tumor demonstrated the mixed intensity, separated by septum, measured in size of 8×7.5×1.5 cm. Another neurogenic tumor is located in the caudal side, which cannot be detected by ^{201}TlCl scintigraphy. d : Axial T1-weighted SE MR image with fat suppression. Parts of the tumor showed high intensity, while others showed low intensity compared with the muscle. No fat component was evident in the tumor. e : Axial gadolinium-enhanced T1-weighted SE MR image with fat suppression showed strongly enhancement.

diagnosed as a myxoid type (Figure 2) ; while the other had fluoro-deoxy-glucose positron emission computed tomography/computed tomography (FDG-PET/CT) for follow up of uterine cervical cancer and was incidentally noticed to have increased nodular uptake in her leg. The tumor showed iso ^{201}TlCl uptake and was considered benign at the time, but in the follow up period, a malignant component was suspected and it was surgically resected 1.5 years after ^{201}TlCl scintigraphy, and it was confirmed as liposarcoma pathologically. In benign lesions, no lipoma showed high uptake (Figure 3). All neurogenic tumors except for 2 demonstrated high uptake (Figure 4). All 3 ganglions of the

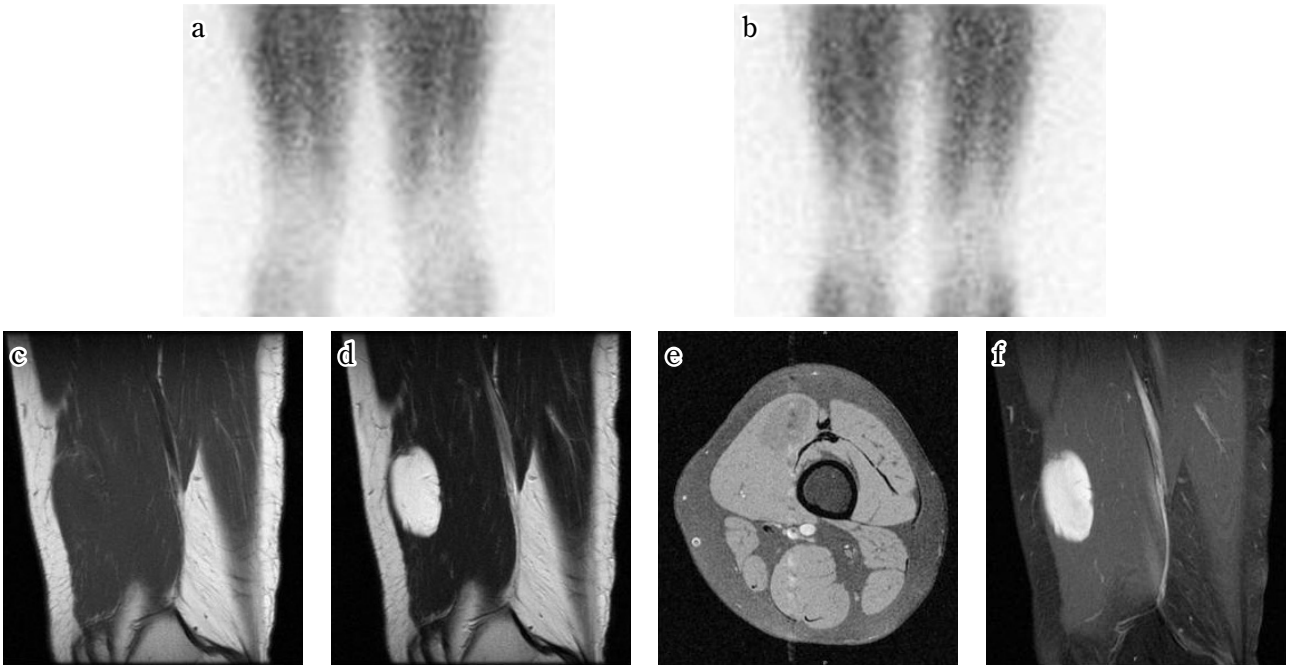

Figure 2 Liposarcoma (myxoid type) in the left femur. Iso uptake pattern in both early and delayed phase in malignant lesion. a : early phase image of ^{201}TlCl scintigraphy. b : delayed phase image. The tumor showed iso uptake in both phases of ^{201}TlCl scintigraphy. c : Sagittal T1-weighted SE MR image. d : Sagittal T2-weighted SE MR image. e : Axial T1 weighted SE MR image with fat suppression. f : Sagittal gadolinium-enhanced T1-weighted SE MR image. The tumor, measuring 30×17×45 mm, showed iso intensity on T1-WI and high intensity on T2-WI compared to the muscle. The tumor intensity was suppressed on fat-suppressed T1-WI and the tumor showed strong enhancement.

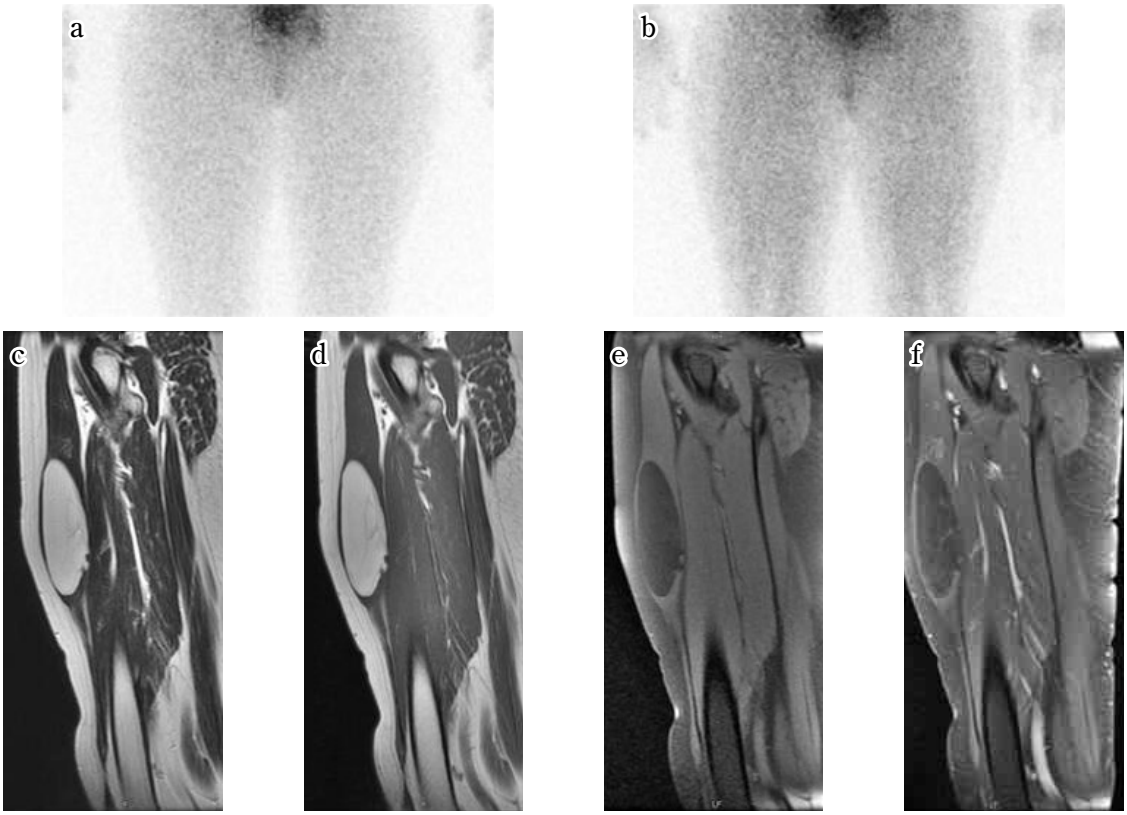

Figure 3 Lipoma in the right femur. a : early phase image of ^{201}TlCl scintigraphy, b : delayed phase image of ^{201}TlCl scintigraphy. The tumor showed iso uptake in both phases of ^{201}TlCl scintigraphy. c : Coronal T2-weighted SE MR image. d : Coronal T1-weighted SE MR image. e : Coronal T1 weighted SE MR image with fat suppression. f : Coronal gadolinium-enhanced T1-weighted SE MR image with fat suppression. The tumor was spindle-shaped and showed uniform high intensity on both T1-WI and T2-WI, measuring 10×3×3 cm, and well suppressed on fat-sat T1-WI. Only septum was enhanced and no other solid component was evident.

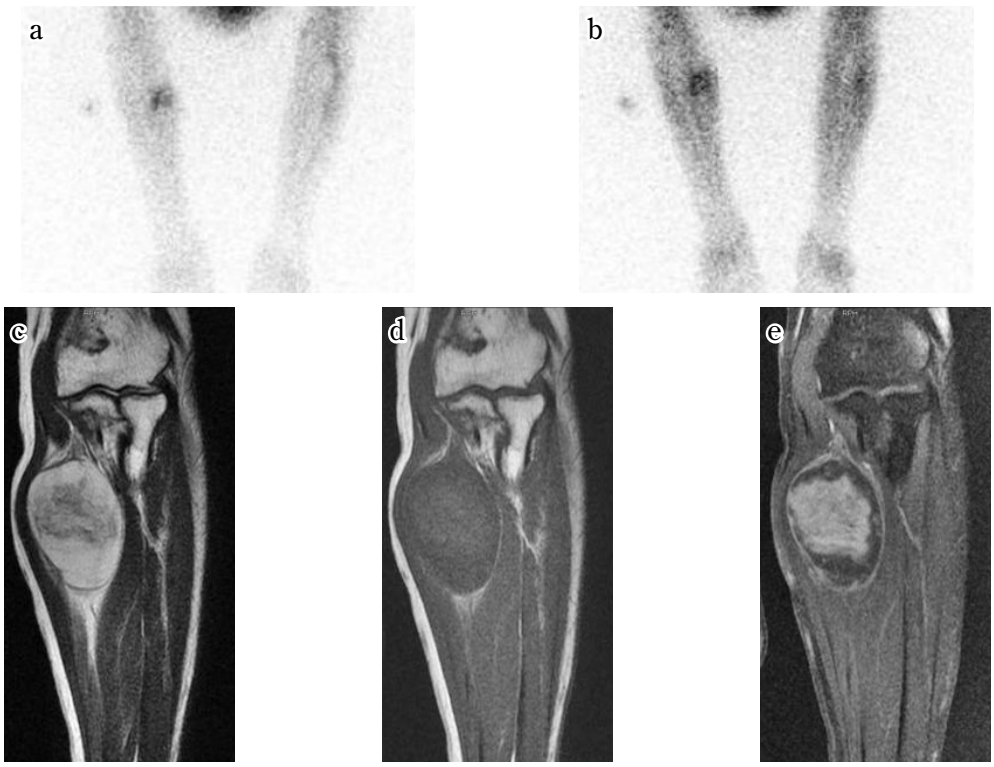

Figure 4 Schwannoma in the left forearm. a : early phase image of ^{201}TlCl scintigraphy, b : delayed phase image of ^{201}TlCl scintigraphy. Tumor showed high uptake in both early and delayed phase of ^{201}TlCl scintigraphy. c : Coronal T2-weighted SE MR image. The tumor was oval-shaped, measuring 38×35×55 mm, and showed peripheral high intensity and central low intensity. d : Coronal T1-weighted SE MR image. The tumor showed peripheral iso-intensity and central slight high intensity compared with the muscle. e : Coronal gadolinium-enhanced T1-weighted SE MR image with fat suppression. The tumor showed central significant enhancement.

lower extremities showed iso uptake. Most inflammatory diseases showed high uptake. Clinically-considered benign patients (no pathology) consisted of tumorous lesions (mainly lipoma and neurogenic tumor) or inflammatory disease. These tumors are stable or remitted clinically. Only 2 patients were considered 'low', and these were diagnosed as intramuscular hematoma and cyst by MRI and CT, respectively. RI was obtained in only high uptake patients. RI was variable in both malignant and benign lesions and no statistically significant difference was seen between malignant and benign lesions by t-test (p=0.72) (Figure 5).

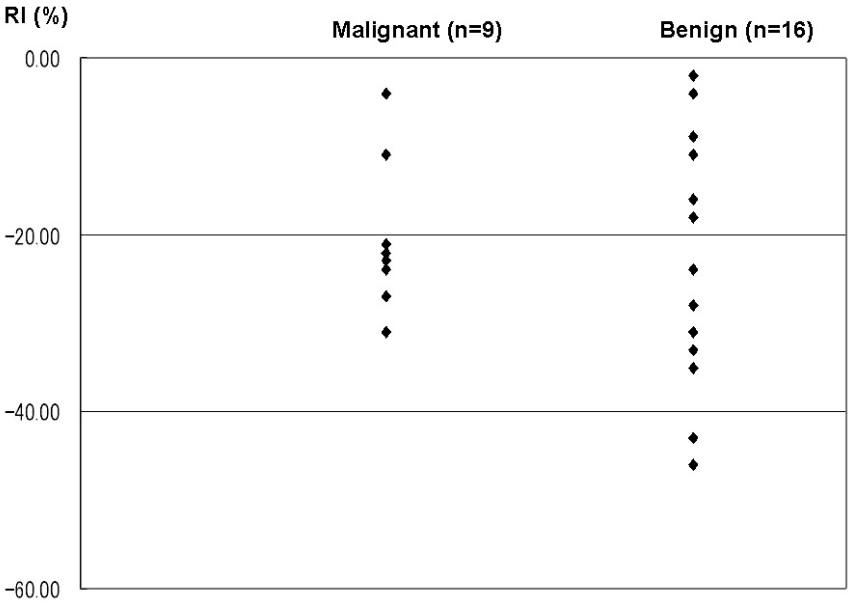

Figure 5 Retention Index (RI) was calculated in 25 patients (9 malignant and 16 benign lesions). there were significant overlap between malignant and benign lesion, and no statistical difference was observed (p=0.72).

DISCUSSION

It is important to evaluate the nature of a lesion and differentiate malignant from benign in the management of patients with soft tissue tumors. Imaging techniques are essential and ^{201}TlCl scintigraphy has played an important role. FDG-PET is newly developed in tumor imaging but the clinical indication for soft tissue tumor is limited and not so widely used compared with ^{201}TlCl scintigraphy (5). Thallium is a potassium analogue and accumulates in tumors reflecting many factors. There are some reports that have described the utility of ^{201}TlCl scintigraphy in the differentiation of malignant from benign lesions based on the degree of ^{201}TlCl uptake. In dual time scanning (early and delayed phase), the early phase uptake mainly reflects tumor vascularity and the delayed phase uptake substantially reflects tumor viability. In our study, most of the malignant lesions demonstrated high uptake in both the early and delayed phases. Two of the malignant tumors that showed iso uptake were liposarcoma. In these cases, Gadolinium-enhanced MRI was useful to detect ill-defined malignant soft tissue components. It is reported that a low ^{201}TlCl uptake is shown in well-differentiated or myxoid liposarcoma (6). One of our patients was incidentally detected by FDG-PET/CT for follow up of uterine cervical cancer, and the lesion showed high FDG uptake. The tumor was resected 1.5 years after ^{201}TlCl scintigraphy and was proven as liposarcoma. We were unable to determine the existence of a malignant component at the time of ^{201}TlCl scintigraphy. The RI is reportedly useful for differentiating benign from malignant tumors. In our study, we calculated RI in high uptake patients. The RI was variable in both malignant and benign lesions, and no statistically significant difference was observed. We believe that this is due to histological variability, variable lesion size and normal physiological muscle uptake. We evaluated RI using planar images that demonstrated an overlapped uptake in the lesion and normal muscle. A small lesion is sometimes masked by surrounding tissue and may not show high uptake.

A high ^{201}TlCl uptake is more frequently seen in malignant tumors, but regardless of whether the tumor is benign or malignant, according to the histopathological variety, the ^{201}TlCl uptake pattern can not be the only indicator to differentiate malignant from benign tumors. We ultimately need to evaluate the nature of tumors by a combination of several imaging techniques.

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