Schwannoma of the Extremities: Comparison of MRI and Pentavalent Technetium-99m-Dimercaptosuccinic Acid and Gallium-67-Citrate Scintigraphy

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The diagnostic value of MRI and scintigraphy was studied in patients with Schwannomas of the upper or lower extremities. MRI (T1- and T2-weighted imaging), pentavalent ^{99m}Tc-dimercaptosuccinic acid and ^{67}Ga-citrate scintigraphy were performed in 11 patients with 12 histologically proven benign Schwannomas. All six tumors with a maximum diameter ≥ 3 cm showed marked accumulation of pentavalent ^{99m}Tc-dimercaptosuccinic acid, whereas they showed no uptake of ^{67}Ga-citrate. MRI detected all of the tumors, and the lesions had a signal intensity equal to or slightly less than that of skeletal muscle on T1-weighted images and hyperintense to that of subcutaneous fat on T2-weighted images. MRI was superior to detect small Schwannomas of the extremities. A positive ^{99m}Tc-dimercaptosuccinic acid scan and a negative ^{67}Ga-citrate scan however is useful to distinguish sarcoma with myxoid change from Schwannoma.

Key Words: Schwannoma, pentavalent technetium-99m-dimercaptosuccinic acid; gallium-67-citrate, MRI

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Benign Schwannoma (neurilemoma) is the most common tumor of the peripheral nervous system (*1*). Most Schwannomas are solitary except in patients with neurofibromatosis who develop multiple tumors (*1*). Although the radiological findings of Schwannoma in the central nervous system have previously been reported by many, few have reported on the MRI features of this tumor (*2,3*), and no one has reported on scintigraphy of peripheral Schwannomas. We have previously found that scintigraphy with pentavalent ^{99m}Tc-dimercaptosuccinic acid (^{99m}Tc(V)DMSA) and ^{67}Ga-citrate is useful for diagnosing various soft tissue tumors (*4–6*). Accordingly, we investigated the diagnostic value of MRI and scintigraphy in patients with Schwannomas of the upper or lower extremities.

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PATIENTS AND METHODS

Eleven untreated patients (six females and five males, age 18–55 yr), all of whom admitted to the Department of Orthopaedic Surgery, were examined with scintigraphy using both ^{99m}Tc(V)DMSA and ^{67}Ga-citrate at Department of Radiology and Nuclear Medicine, Kyoto University Hospital from 1986 to 1993. Twelve histologically proven Schwannomas of the extremities were retrospectively examined in the present study. The lesions were located in the upper extremity in five patients and in the lower extremity in seven patients. Eight patients had local swelling, six had abnormal sensation in their fingers and three had spontaneous pain. Ten tumors in 10 patients were examined by MRI. In addition, all 12 tumors were examined by ^{99m}Tc(V)DMSA scintigraphy and 11 tumors in 10 patients were examined by ^{67}Ga-citrate scintigraphy.

MRI studies were performed using 0.5T (50A, Toshiba, Tokyo, Japan and Vectra, General Electric, Milwaukee, WI), 1.0 T (Magnetom Impact, Siemens, Illinois), or 1.5 T (Signa, General Electric, Milwaukee) superconducting magnetic systems and the multislice conventional spin-echo technique. T1-weighted images (TR/TE:550–600/25–40) and T2-weighted images (TR/TE:1700–2000/70–80) were always obtained. The signal intensity and extent of the tumor, as well as its relationship to the adjacent structures, were determined.

Technetium-99m(V)DMSA was prepared as previously reported (*5*). Its purity was assessed by thin-layer chromatography and no free pertechnetate or other ^{99m}Tc derivatives were detected. Following the intravenous administration of 370–555 MBq of ^{99m}Tc(V)DMSA or 111 MBq of ^{67}Ga-citrate, whole-body and spot scintigrams were obtained after 2 hr and 72 hr, respectively, using a conventional gamma camera system (Gamma View-F (Hitachi Medical Co. Ltd., Japan) for spot views and Gamma View-E (Hitachi Medical Co. Ltd., Japan) for whole-body scans). For ^{99m}Tc(V)DMSA scintigraphy, ^{99m}Tc photons were collected through a single window (140 keV ± 20%) for 250 sec per image using an intermediate energy (80–180 keV) collimator. For ^{67}Ga-citrate scintigraphy, three windows (93 keV ± 20%, 190 keV ± 20% and 270 keV ± 20%) were utilized to collect ^{67}Ga photons for

TABLE 1
Results of MRI and Scintigraphy in 11 Patients with 12 Schwannomas

Patient no.	Sex	Site	Maximum diameter (cm)	Signal intensity of MRI		Scintigraphy	
				T1	T2	^{99m}Tc(V)DMSA	^{67}Ga-citrate
1	Female	Upper arm	2	=muscle	>fat	+	−
2	Female	Knee	4	=muscle	>fat	+	−
3	Male	Forearm	1	=muscle	>fat	−	ND
4	Female	Lower leg	3	=muscle	>fat	+	−
		Hand	1	ND	ND	−	−
5	Male	Thigh	3	=muscle	=fat	+	−
6	Male	Thigh	1	ND	ND	−	−
7	Male	Elbow	3	<muscle	>fat	+	+
8	Female	Thigh	4	=muscle	>fat	+	−
9	Male	Foot	1	=muscle	>fat	+	−
10	Female	Thigh	2	=muscle	>fat	−	−
11	Female	Forearm	7	<muscle	>fat	+	−

ND = not done, + = positive, − = negative.

250 sec/spot image and for 20 cm/min for whole-body scans with a high-energy collimator (over 180 keV).

RESULTS

The signal intensities of the tumors on T1- and T2-weighted MRI, as well as the tumor uptake of ^{99m}Tc(V)DMSA and ^{67}Ga-citrate, are shown in Table 1. All six Schwannomas that were 3 cm or more in diameter showed marked accumulation of ^{99m}Tc(V)DMSA and were easily detectable in the whole-body views, whereas there was no accumulation of ^{67}Ga-citrate in the tumor (Fig. 1). Sensitivity of ^{99m}Tc(V)DMSA scintigraphy in these patients with Schwannomas of the extremities was 63.6%. MRI detected all 12 tumors and their signal intensity was the same as or slightly less intense than that of skeletal muscle on T1-weighted images and similar or more intense than that of subcutaneous fat on T2-weighted images (Fig. 1 and 2).

DISCUSSION

The benign Schwannoma (also known as neurilemoma, neurinoma and perineural fibroblastoma) is an encapsulated tumor arising from the nerve sheath and consisting of two components, a highly ordered cellular component (Antoni A area) and a looser myxoid component (Antoni B area). The encapsulation and the presence of these two components distinguish Schwannoma from neurofibroma.

Schwannoma occurs at all ages but is most commonly found between 20 and 50 yr (*1*). This tumor has a predilection for the head, neck and flexor surfaces of the upper and lower extremities, with the peroneal and ulnar nerves being most commonly affected in the limbs (*7*). All Schwannomas reported in our series were located on the flexor surfaces of the extremities; thus, posterior whole-body ^{99m}Tc(V)DMSA scintigrams were useful for tumor detection.

No previous report on the scintigraphic features of Schwannoma has been published. In fact, with respect to peripheral nerve sheath tumors, only two papers about the scintigraphic detection of a neurofibroma in the left buttock (*8*) and 28 neurofibromas in patients with neurofibromatosis (*9*) have been published.

The Schwannomas with the longest diameter (≥ 3 cm) were positive for ^{99m}Tc(V)DMSA and negative for ^{67}Ga-citrate. Similar scintigraphic findings have been reported for aggressive fibromatosis (*4*), giant cell tumor of tendon sheath (*6*), deep hemangioma and low-grade sarcoma (*5*). Because of the marked tumor accumulation and low background activity, Schwannomas of the extremities could be easily detected on the whole-body scans.

With MRI, even Schwannomas less than 1 cm in diameter were detectable, and MRI was superior to ^{99m}Tc(V)DMSA for detecting small tumors. Isointensity to muscle on T1-weighted images and hyperintensity to subcutaneous fat on T2-weighted images with conventional spin-echo techniques were characteristic features of Schwannoma, as previously reported (*2*). No specific features of the internal architecture, such as a difference of signal intensity between the two histological compartments, were found on T2-weighted images, except in the case of large Schwannoma (Patient 11). Sarcomas with extensive myxoid change, such as some malignant fibrous histiocytomas and liposarcomas, show signal intensity characteristics similar to Schwannomas on T1- and T2-weighted images. Thus, the differential diagnosis of Schwannomas from these sarcomas would often be difficult using MRI. However, ^{67}Ga-citrate has been reported to accumulate in 60–70% of sarcomas (*5*) and to diagnose the malignant transformation of neurofibroma (*10*). However, ^{67}Ga-citrate did not accumulate in any of the Schwannomas in this series, so uptake of ^{67}Ga-citrate would strongly support the diagnosis of sarcoma.

In conclusion, MRI was superior for detecting small Schwannoma in the extremities. However, scintigraphy

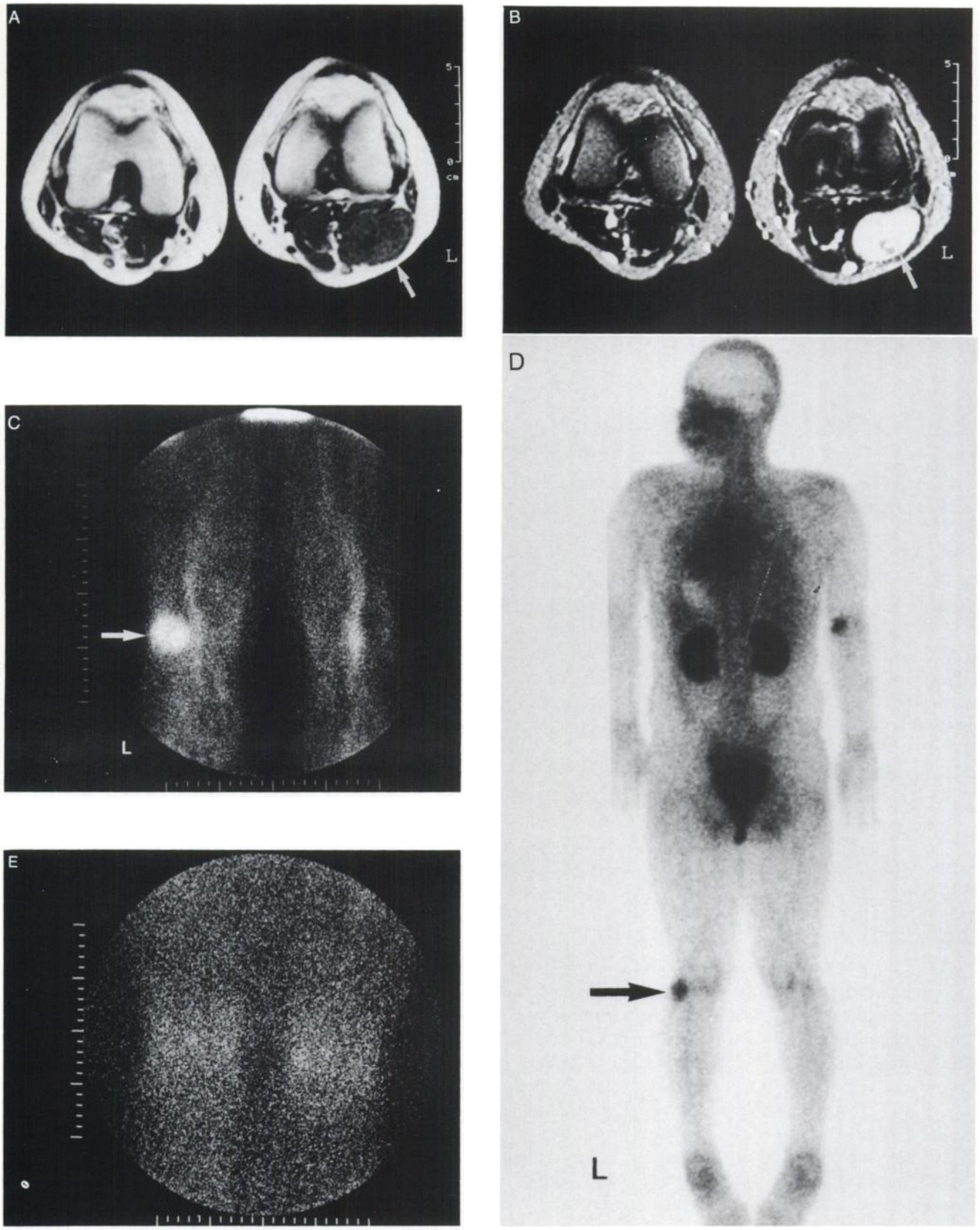

FIGURE 1. (A) T1-weighted MRI in a 45-yr-old woman (Patient 1). A well-defined oval tumor (arrow) that is isointense to the adjacent skeletal muscle is present in the left popliteal fossa. (L = left). (B) T2-weighted MRI reveals that the tumor (arrow) is markedly hyperintense to subcutaneous fat. (C) A posterior spot ^{99m}Tc(V)DMSA scintigram shows marked accumulation in the tumor (arrow). (D) On a posterior whole-body ^{99m}Tc(V)DMSA scintigram, the tumor in the left popliteal fossa (arrow) can easily be detected. The uptake at right elbow was subcutaneous leakage of the tracer. (E) A posterior spot ^{67}Ga-citrate scintigram in the same patient shows no accumulation in the tumor.

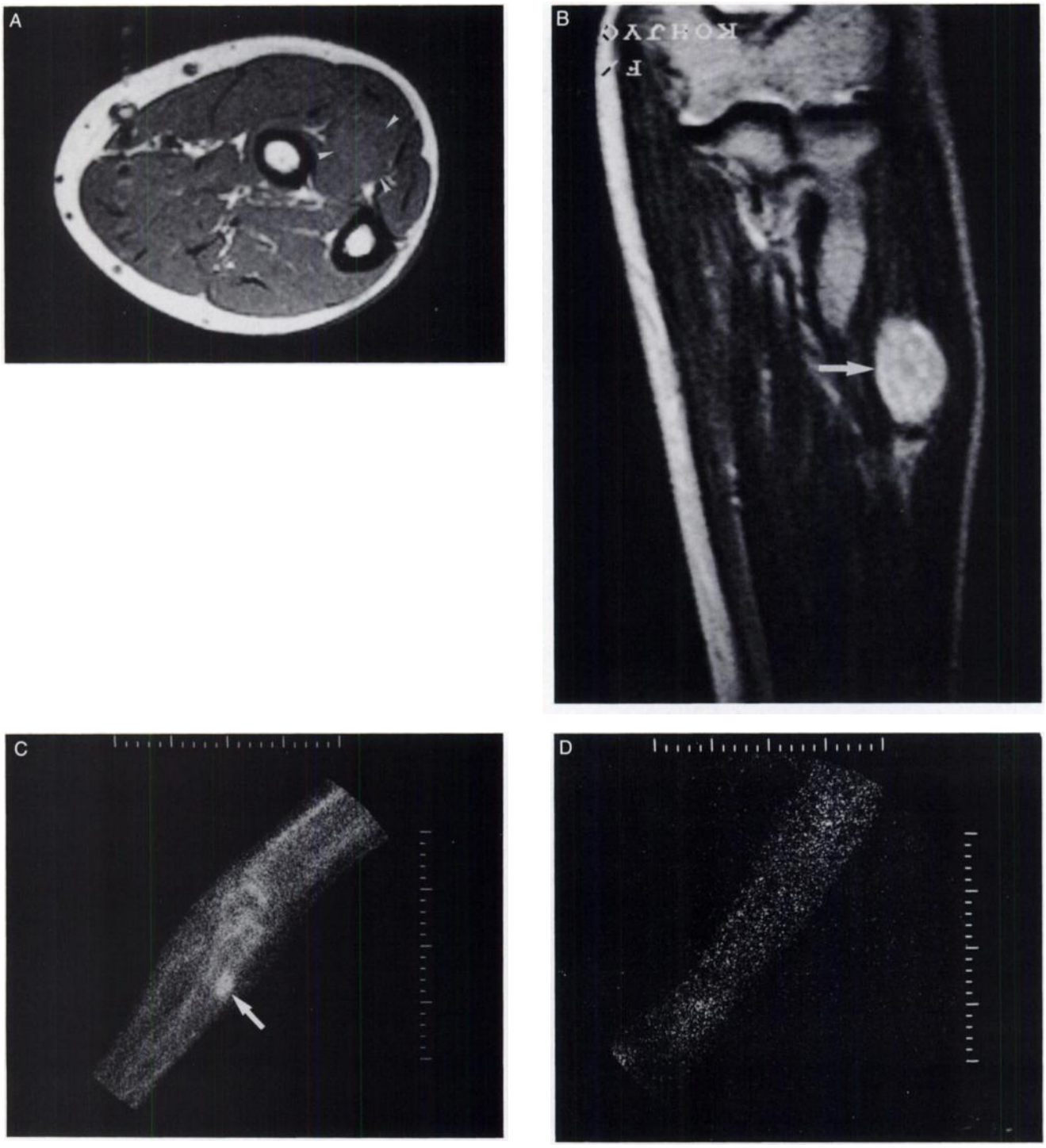

FIGURE 2. (A) (Patient 2). T1-weighted MRI shows a 2-cm round isointense tumor (arrow) in the left forearm. (B) On T2-weighted MRI, the tumor (arrow) is slightly hyperintense to subcutaneous fat. (C) A posterior spot ^{99m}Tc(V)DMSA scintigram shows accumulation in the tumor (arrow). (D) A posterior spot ^{67}Ga-citrate scintigram shows no accumulation in the tumor.

with ^{99m}Tc(V)DMSA and ^{67}Ga-citrate should be able to distinguish Schwannoma from sarcoma with myxoid change, which is sometimes difficult when using MRI. In addition, whole-body scans can easily detect multiple or deep-seated tumors.

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