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Soft tissue hemangiomas: MR manifestations in 23 patients

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Abstract. In order to assess magnetic resonance (MR) findings, MR images of 23 patients with soft tissue hemangiomas were reviewed retrospectively. All but five hemangiomas were proven histologically. All hemangiomas showed high signal intensity on T2-weighted images; common MR findings were high signal intensity in some areas on T1-weighted images (70%), the configuration of multiple small lobules or tubules (57%), and signal voids (70%). We observed all three of these findings in 6 cases (26%), two of three in 11 cases (48%), only one in 5 cases (22%), and none in 1 recurrent case. Five of 11 intramuscular hemangiomas (45%) showed atrophic change of muscles. Parts of the tubular pattern enhanced in 15 out of 17 patients with a T1-weighted sequence after injection of gadopentetate dimeglumine. Dilated vessels were seen in 2 of 4 with MR angiography. No single feature is specific for hemangioma, but a combination of several MR findings may allow a correct diagnosis.

Key words: Angioma, 40.362 – Angioma, muscular – Magnetic resonance (MR), tissue characterization – Magnetic resonance (MR), vascular studies

Hemangioma is a common tumor occurring in the soft tissue [1]. We have here preferred to use the generic term "hemangioma" on the basis of size of vessels [2], rather than the "vascular malformation" of the biological classification [3–6], because we were not always successful in distinguishing hemangiomas from vascular malformations clinically or histologically. Because patients with deep-seated hemangiomas often present with a mass rather than vascular lesions, it is difficult to make a diagnosis based on physical examination. Therefore MR studies are performed to assess the nature and extent of deep-seated masses. In contrast cutaneous hemangiomas, which occur more commonly, are easily diagnosed clinically because masses are accompanied by color changes of the skin.

MR imaging provides detail of the anatomic localization as well as the tissue characteristics of soft tissue masses, because it has a multiplanar capability and gives better tissue contrast than other imaging methods. Several investigators have reported on MR findings of hemangiomas that were of high signal intensity on both T1- and T2-weighted images (T1WI, T2WI) or showed a serpentine pattern or focal muscle atrophy and/or a striated-septated configuration [7–12]. The frequency of each MR finding has not been discussed previously in respect of a large series of patients. We present MR findings which allow a presumptive diagnosis of hemangioma to be made.

Material and methods

MR studies of 23 patients with proven hemangiomas performed between 1990 and 1992 were reviewed. A hemangioma was not clinically suspected in 11 (48%) of 23 patients prior to imaging studies. There were 11 male and 12 female patients with ages ranging from 5 months to 63 years (mean 21 years). Seven patients had suffered pain while 16 had noticed painless masses or swelling. All patients were diagnosed as having hemangiomas: 18 were treated by surgical resection and had histological confirmation, and 5 were confirmed by the combination of angiography and physical examination. There were 13 cavernous, two venous, and two capillary hemangiomas as well as one arteriovenous malformation. Ten occurred in the legs, seven in the thigh, two in the knee joint, and one each in the hand, forearm, buttock, and back.

Eight MR examinations were performed on a 1.5-T imager (Signa, General Electric, Milwaukee, Wis.) and 15 were performed on a 0.5-T imager (either Shimadzu, Japan, or Max, General Electric). For all patients T1WI/T2WI of conventional spin-echo (SE) pulse sequences were obtained. For T1WI the repetition time (TR) was 400–600 ms and the echo time (TE) 11–20 ms (400–600/11–20). For T2WI, 2000–3000/20, 70–130 were the settings used. Immediately after administration of 0.2 ml gadopentetate dimeglumine per kilogram of body weight, T1WI with and without chemical shift fat suppression were obtained for 6 and 11

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Table 1. A summary of magnetic resonance manifestations in 23 hemangiomas

	n	(%)
a High signal on T2WI	23	100
b High signal on T1WI	16	70
c Tubular appearance	13	57
d Signal void	16	70
b+c+d	6	26
b+c	1	4
b+d	6	26
c+d	4	17

T2WI, T1WI: T2-, T1-weighted images

patients respectively. In addition, T2WI with fat suppression were obtained in two patients and multiplanar gradient-recalled acquisition in a steady state (MPGR, 600/15; flip angle = 25°) images in three patients. MR angiography was performed with the Multisequence Vascular Package: 2D time-of-flight (TOF) technique in two cases, and 2D TOF and either 2D or 3D phase contrast techniques in two cases. For imaging we selected an extremity, body, or spine coil, and various fields of view depending on the location of the lesions.

We assessed the images for the following characteristics: the signal characteristics on both T1WI and T2WI, the configuration of the lesions, the distinctiveness of the margins, the presence of signal void on T2WI, the presence of enhancement, and the anatomic location of the hemangiomas (intramuscular, intermuscular, subcutaneous, and synovial). Conventional radiographs of all patients were reviewed for the detection of phleboliths.

Results

Eleven intramuscular, five intermuscular, five subcutaneous, and two synovial-type hemangiomas were shown. The results of MR findings are summarized in Table 1. All lesions revealed high signal intensity on T2WI. The borders were indistinct in 16 lesions (70%). Multiple, small areas of high signal intensity were present within the lesion on T1WI in 16 cases (70%; Fig. 1A). The shape of hemangiomas seen in 13 cases (57%) was either multilobulated or tubular on T2WI (Fig. 1B). We observed signal voids on T2WI in 16 cases (70%; Fig. 2B). We relied on the MR findings of high signal intensity on the T1WI, signal void, and multilobulated or tu-

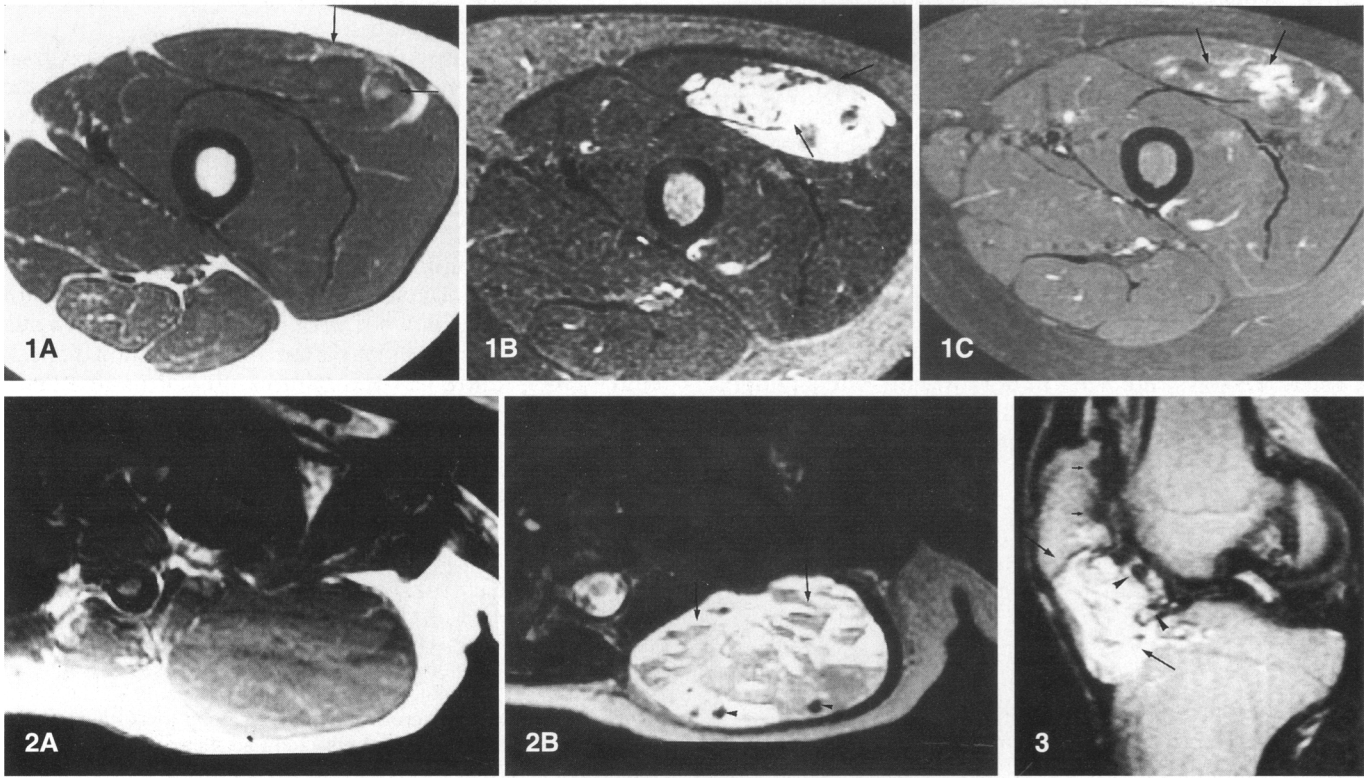

Fig. 1 A–C. A 9-year-old girl with a cavernous hemangioma in the thigh. **A** Axial T1-weighted (600/13) image shows linear and nodular high signal intensity (*arrows*) within a lesion of the rectus femoris muscle. **B** Axial fat-suppression T2-weighted (2000/60) image demonstrates high signal intensity with nodular low signal areas (*arrows*) in the mass. **C** Axial fat-suppression and gadopentetate dimeglumine enhanced T1-weighted image shows enhancement of tubular and nodular pattern (*arrows*) to some extent. Plain radiograph (not shown here) demonstrated calcified phleboliths

Fig. 2 A, B. A 5-month-old boy with a cavernous hemangioma in the back. **A** Axial T1-weighted (600/16) image shows a well-delineated and slightly hyperintense mass compared with adjacent muscles. **B** Axial heavily T2-weighted (3000/80) image demonstrates signal voids (*arrowheads*) and numerous fluid-fluid levels (*arrows*) in the well-defined mass: the *upper* portions are bright, representing abundant free proton components of serum or methemoglobin; the *lower* portions are of relatively low or intermediate signal intensity, corresponding to the debris of hemorrhage such as hemosiderin or clot

Fig. 3. A 24-year-old man with a synovial hemangioma in the right knee joint. Sagittal T2-weighted (2000/70) image shows a high-signal-intensity lesion (*arrows*) and signal voids (*arrowheads*) within the mass. Erosions of subchondral bones (*small arrows*) are seen

bular shape instead of common, nonspecific findings of high signal intensity on T2WI and border definition of the soft tissue tumors. All three findings were visualized in only six cases (26%; Fig. 1), high signal intensity on T1WI and signal void on T2WI in six cases (26%; Fig. 2), signal void and tubular appearance in four cases (17%), only high signal intensity on T1WI in three cases (13%), and high signal intensityon T1WI and tubular appearance in one case (4%). Two hemangiomas showed only tubular appearance of high signal intensity on T2WI, similar to vessels. They did not have either high signal intensity on T1WI or signal void.

In the 17 histologically proved cases, we did not find an area of signal void in either of the two capillary hemangiomas or in the one venous hemangioma. A sharp border to the mass was shown in 3 of 11 of the intramuscular type, two of five of the intermuscular type, two of five of the subcutaneous type, and neither of the two of the synovial types. Five of the 11 intramuscular hemangiomas did not cause a bulging-out appearance of the fascial boundary of the involved muscles (Fig. 1) and there was some muscle atrophy in three cases. Two synovial hemangiomas showed MR findings that were no different to those seen in hemangiomas in an extrasynovial location (Fig. 3). A recurrent small hemangioma did not show any of these common MR findings.

In 17 patients following administration of gadopentetate dimeglumine, all but two lesions showed areas of enhancement. As the images were obtained in 3–5 min after injection of MR contrast, the enhancement did not occur in most areas but in small and multiple areas in hemangiomas of bright signal intensity seen on T2WI (Fig. 1C). Two of the four patients with MR angiography showed dilated vessels in or near their lesions. One lesion was an arteriovenous malformation that showed numerous vessels with both techniques. The other was a cavernous hemangioma that revealed subtle high signal intensity on 3D phase contrast images but not on 2D TOF images (velocity encoding adjusted to 5 cm/s). However, we could not tell whether the vessels were arteries or veins.

MR images of three hemangiomas were misinterpreted preoperatively. One was initially thought to show intramuscular hemorrhage following trauma but it was noted retrospectively to have tubular signal voids as well as areas of high signal intensity on T1WI. Another was thought to show an infective lesion, but the lesion proved to be a hemangioma associated with superimposed infection of the adjacent soft tissue. This lesion showed areas of high signal intensity only on T1WI, which were considered to be fatty tissue lying between infected lesions. The third lesion was a small recurrent mass without consistent MR findings.

Plain radiographs revealed phleboliths in ten cases, all of which showed as signal voids on T2WI. In MPGR sequences in three cases, several signal void regions in one patient were disclosed to be either phleboliths or vessels but there were no areas of signal void in the other two patients.

Discussion

MR imaging enabled us easily to identify soft tissue hemangiomas as well as to discriminate lesions from the surrounding normal muscles, owing to its superior tissue contrast and multiplanar capability compared with other imaging methods [9, 10, 13].

The classification of vascular lesions is not universally accepted. In this paper, we use the term "soft tissue hemangioma", which is generically subclassified as capillary, cavernous, mixed and venous in type, based on the size of the vascular lumen and endothelial walls [2]. We often experienced difficulty in distinguishing a hemangioma from a vascular malformation both clinically and radiologically. Recently, a biological classification of soft tissue vascular lesions has been proposed [4] and has been adopted for interventional radiology [6].

Hemangioma is a common soft tissue tumor, making up 7% of all benign tumors [1]. Cutaneous hemangiomas are common and regress spontaneously in childhood. The majority are the capillary type histologically and are easy to diagnose clinically. Deep soft tissue hemangiomas are relatively uncommon [1, 14] and may be intramuscular, intermuscular, synovial, or a mixed form, depending on the location of the lesion. Most patients with deep-seated hemangiomas present with either pain or swelling intermittently. Sometimes they complain of poorly delineated masses that become larger or smaller from time to time. However, deep seated hemangiomas cannot be distinguished from malignant soft tissue tumors without imaging studies.

With MR imaging a presumptive diagnosis can be made in cases of hemangioma as well as other soft tissue masses such as lipoma, hematoma, fibromatosis, and neurogenic tumor [15, 16]. Hemangiomas often appear as areas of high signal intensity on bothT1WI and T2WI, in contrast to most soft tissue tumors, which show tissue characteristics of intermediate signal intensity on T1WI and high signal intensity on T2WI [7, 8, 10, 12, 17]. Therefore, T1WI is important in evaluating hemangiomas. Hemangiomas have vascular tissue as well as variable amounts of nonvascular components consisting of adipose, fibrous, and muscle tissues as well as thrombi in the vessels [2]. The proportion of high signal intensity observed on T1WI depends upon the abundance of fatty components within hemangiomas [7, 12, 17, 18]. Lipomas have high signal intensity within most areas of the masses on T1WI. However, cavernous hemangiomas are easily distinguished from fatty tumors because the former are composed of abundant nonvascular tissues. In cases of capillary hemangiomas or small hemangiomas, T1WI may not reveal areas of high signal intensity [7, 17]. T1WI may not be useful, particularly in cases of subcutaneous hemangiomas, in determining whether high signal intensity corresponds to fatty tissue of the tumor or subcutaneous fat tissue. Hemangiomas may be misdiagnosed on MR images as other fat-containing tumors such as benign or malignant lipomatous tumors, elastofibromas, muscular atrophy, fatty invasion of malignant tumors, and neural tumors [18]. We have observed two hemangiomas, one of which was

thought to be an intramuscular hemorrhage owing to high signal intensities on T1WI, while the other was considered to be an infection in the intermuscular space of the popliteal region in which there was abundant fat tissue.

Within the tumors are areas of mostly low signal intensity (signal voids) on both T1WI and T2WI. These could be considered vessels with either high-flow blood or thrombi, phleboliths, and dense fibrous tissues seen in cross section [3, 8, 12, 19]. Plain radiographs and computed tomographs (CT) are superior to MR imaging in identifying calcified thrombi (phleboliths) [7]. In our experience, however, signal voids, which are frequently observed on both T1WI and T2WI, can be uncalcified thrombi. According to our own data, signal voids are seen more commonly on MR imaging than phleboliths are observed on plain radiographs. A gradient-recalled echo sequence with gradient-moment nulling may demonstrate bright signal of high-flow vessels, which differs from signal voids of thrombi or fibrous tissue [3, 7].

On T2WI, all hemangiomas showed the high signal intensity lesions with multiple small lobular configurations like a bunch of grapes, which has been thought to be due to vascular spaces containing stagnant blood [3, 4, 6, 7, 9, 11]. Linear and lace-like areas of low or intermediate signal are seen between numerous lobules and correspond histologically to fibrofatty tissues [8]. The extent or boundary definition of hemangiomas is shown better on T2WI than T1WI. A heavily T2WI improves the demarcation and defines the extent of hemangiomas [11]. Some intramuscular hemangiomas did not produce a mass effect in the muscle involved, even though they were well demarcated. We observed multiple fluid-fluid levels within three cavernous hemangiomas, probably caused by cystic hemorrhagic components. In the biological classification, this was thought to be a lymphaticovenous malformation with hemorrhage [3]. This observation could become more common if resolution improves for the detection of small blood pool spaces and appropriate imaging planes are chosen.

There have been no reports about the benefit of gadopentetate dimeglumine in the evaluation of vascular tumors, although there have been a few reports on enhancement of the vascular elements of hemangiomas [3, 9]. In our experience, small areas of hemangiomas often enhanced and showed tubular structures, even though most areas of the tumors showed bright signal in vascular structures on T2WI. It may be speculated that enhancement varies depending on the rate of inflow of MR contrast agent into the stagnant blood-pooled vascular space. Therefore the pattern and extent of enhancement may vary with imaging time following MR contrast injection as well as with flow velocities of the blood in the vessels of the hemangioma. Until now the benefit of using MR contrast agents for diagnostic accuracy or the evaluation of the extent of hemangiomas has been uncertain. We have employed MR imaging with contrast in patients with hemangiomas as we have for the evaluation of other soft tissue tumors. Fat-suppression and contrast-enhancement T1WI could be helpful when there is difficulty in distinguishing enhancing vascular spaces from fatty tissue.

In two cases of synovial hemangioma of the knee, the configuration and signal intensities on MR images were similar to extra-articular soft tissue hemangiomas, except for pressure erosions of adjacent subcortical bone and low signal along the synovial lining surfaces of the joint. Pigmented villonodular synovitis, synovial chondromatosis, hemophilic arthropathy, and hypertrophic synovitis should be considered when low signal lesions are seen.

In summary, the characteristic patterns of signal intensities and morphology of hemangiomas on MR images may allow one to make a presumptive diagnosis of hemangioma even in patients who are not suspected of having vascular lesions on the basis of the clinical examination. MR imaging might be helpful in the evaluation of deep-seated hemangiomas.

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