MRI manifestations of soft-tissue haemangiomas and accompanying reactive bone changes

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Objectives: Soft tissue haemangiomas are common benign vascular lesions that can be accompanied by reactive changes in the adjacent bone structure. This study aimed to discuss the MRI features of soft-tissue haemangiomas with an emphasis on changes in bone.

Methods: The radiographic and MRI findings of 23 patients (9 males, 14 females; mean age 25 years; age range 2–46 years) with soft-tissue haemangiomas were analysed retrospectively. MR images were evaluated for location of the lesion, size, configuration, signal features, contrast patterns, proximity to adjacent bone and changes in the accompanying bone. Excisional biopsy was performed in 15 patients.

Results: Radiographs demonstrated phleboliths in 8 patients (34%) and reactive bone changes in 4 (19%). On MRI, T_1 weighted images showed that most of the lesions were isointense or isohyperintense, as compared with muscle tissue; however, on T_2 weighted images all lesions appeared as hyperintense. Following intravenous gadolinium-diethylene triamine pentaacetic acid (DTPA) administration, homogeneous enhancement was observed in 3 lesions and heterogeneous enhancement was seen in 19. No enhancement was observed in one patient. Bone atrophy adjacent to the lesion was observed in four patients.

Conclusion: MRI is the most valuable means of diagnosing deep soft-tissue haemangiomas. Bone changes can accompany deeply situated haemangiomas; in four of our patients, we found atrophy of the bone adjacent to the lesion. To our knowledge, this is the first report in the literature regarding atrophy of the bone adjacent to a lesion.

Soft-tissue haemangioma, a frequently encountered benign vascular lesion, accounts for 7% of all benign soft-tissue tumours [1–5]. Such lesions can be cutaneous, subcutaneous, intramuscular or synovial [1]. Intramuscular haemangioma is rare and responsible for 0.8–1.8% of all haemangiomas [3, 5, 6]. Superficial haemangiomas are diagnosed easily because they cause discolorations of the skin; imaging techniques are rarely needed [1]. However, deep lesions are difficult to diagnose clinically, because they do not cause discolorations and grow slowly; imaging techniques are required to discriminate these deep haemangiomas from malignant lesions [1, 2, 7]. Bone changes accompanying haemangiomas have been reported previously in the literature and include cortical thickening, erosion, medullary sclerosis, trabecular coarsening and hypertrophy [1, 8]. Here, we present the MRI manifestations of soft-tissue haemangiomas and reactive changes to the neighbouring bones. To the best of our knowledge, this is the first report of its kind in the English literature.

Methods and materials

This was a retrospective study of 23 patients (9 males, 14 females; mean age 25 years; age range 2–46 years) who presented at our hospital between May 2001 and April 2006 with pain and/or swelling at the site of lesions; on the basis of MRI and plain radiographs, these patients were thought to have soft-tissue haemangiomas. Two radiologists (AP, MAP) retrospectively reviewed both the radiographs and the MR images and arrived at a consensus regarding the interpretation of the imaging features. Although all patients had plain radiograph and MRI results, only four had angiography. Table 1 shows the distribution of patients by age, complaint, duration of complaint, type and size of lesion and the lesion's location based on the compartment anatomy and presence of phleboliths.

MRI was performed using an MR unit with a 1.5 T superconductive magnet and a body phased-array coil (Magnetom Vision, Siemens, Erlangen, Germany). Routine MRI involved T_1 weighted spin echo (SE) (repetition time (TR) 550–750 ms; echo time (TE) 12–20 ms; number of excitations (NEX) 1–2; section thickness 3–4 mm; gap 1 mm), T_2 weighted SE (TR 3500–4000 ms; TE 80–99 ms; NEX 1–2; section thickness 3–4 mm; gap 1 mm) and fat-suppressed T_2 weighted turbo spin echo (TSE) (TR 4000–4500 ms; TE 90–99 ms; section thickness 3–4 mm; gap 1 mm) images in at least one plane. Following

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Table 1. Distribution of patient age, complaint, duration of complaint, type and size of lesion and lesion location based on the compartment anatomy and presence of phleboliths

Patient no.	Complaint	Age (years)	Gender (M/F)	Duration of complaint	Compartment	Location	Anatomical compartment	Size of lesion (cm)	Phlebolith
1	Mass, pain	33	M	6 years	Im	Forearm	Volar	1.5 × 4 × 9	Present
2	Mass	38	M	6 years	Im	Chest wall	–	6 × 11 × 14	Absent
3	Mass	40		3 years	Im	Knee	Anterior	1 × 1 × 2	Absent
4	Mass	3	M	Congenital	Sc+Im	Knee	Posterior	Diffuse	Absent
5	Mass	17	M	Congenital	Im	Cheek	–	3 × 4.5 × 5	Absent
6	Pain	42	F	1 years	Synovial	Knee	Ip bursa	3.5 × 3.5 × 4	Absent
7	Mass	28	F	5 years	Im	Forearm	Volar + dorsal	3 × 5 × 13	Present
8	Mass, pain	46	F	2 years	Im	Lower leg	Posterior	3 × 5 × 7	Present
9	Pain	29	M	1 years	Im	Lower leg	Deep posterior	1.5 × 3	Absent
10	Mass	6	M	3 years	Im	Knee	Anterior	1.5 × 2.5 × 2.5	Absent
11	Mass, pain	22		9 years	Inm	Forearm	Volar	1 × 2 × 6	Absent
12	Mass, pain	20	M	6 months	Im	Forearm	Volar	2 × 3.5 × 5.5	Present
13	Mass	33	F	2 years	Sc+Im+C	Lower extremity	Ap	Diffuse	Present
14	Mass	2	F	Congenital	Sc+Im	Thigh	Apm	Diffuse	Absent
15	Mass	27	F	Congenital	Im	Lower leg	Posterior	3 × 4 × 8	Present
16	Mass, pain	16	F	1.5 years	Im	Neck	Posterior	1.5 × 2 × 3.5	Absent
17	Mass, pain	27	F	1 years	Im	Knee	Anterior	1 × 1.5 × 1.5	Absent
18	Pain	29	F	2 years	Im	Shoulder	Periscapular	2 × 2 × 3	Present
19	Mass	46	F	Congenital	Im	Shoulder	Periscapular	1.5 × 2 × 3	Absent
20	Mass	23	F	Congenital	Sc+Im+C	Lower extremity	Ap	Diffuse	Absent
21	Mass	8	F	3 months	Sc+Im	Lower leg	Posterior	1 × 2 × 10	Absent
22	Mass	10	M	2 years	Synovial	Knee	Bursa	Diffuse	Absent
23	Mass	31	M	3 years	Im	Arm	Anterior	1.5 × 6.5 × 10	Present

Ap, anteroposterior; Apm, anteroposteromedial; C, cutaneous; Im, intramuscular; Inm, intermuscular; Ip, Infrapatellar; Sc, subcutaneous.

Table 2. MRI signal properties, contrast patterns and bone changes of the lesions and their distance to the neighbouring bones

Patient no.	T ₁ weighted images	T ₂ weighted images	Contrast patterns	Distance to neighbouring bone (mm)	Bone change
1	Isointense	Hyperintense	Heterogeneous	4	Absent
2	Isohyperintense	Hyperintense	Heterogeneous	0	Absent
3	Hypointense	Hyperintense	Absent	8	Absent
4	Isointense	Hyperintense	Homogeneous	2	Absent
5	Slightly hyperintense	Hyperintense	Heterogeneous	0	Absent
6	Isointense	Hyperintense	Homogeneous	0	Absent
7	Isohyperintense	Hyperintense	Heterogeneous	0	Atrophy, CT, TC
8	Isohyperintense	Hyperintense	Heterogeneous	0	Absent
9	Isointense	Hyperintense	Heterogeneous	0	Absent
10	Isointense	Hyperintense	Heterogeneous	0	Absent
11	Isointense	Hyperintense	Heterogeneous	4	Absent
12	Slightly hyperintense	Hyperintense	Heterogeneous	0	Absent
13	Isointense	Hyperintense	Homogeneous	0	Atrophy
14	Isohyperintense	Hyperintense	Heterogeneous	0	Atrophy
15	Isohyperintense	Hyperintense	Heterogeneous	12	Absent
16	Isohyperintense	Hyperintense	Heterogeneous	12	Absent
17	Isohyperintense	Hyperintense	Heterogeneous	2	Absent
18	Isohyperintense	Hyperintense	Heterogeneous	4	Absent
19	Isohyperintense	Hyperintense	Heterogeneous	0	Absent
20	Isohyperintense	Hyperintense	Heterogeneous	0	Atrophy, ME, CT, PR
21	Isohyperintense	Hyperintense	Heterogeneous	3	Absent
22	Isohyperintense	Hyperintense	Heterogeneous	0	Absent
23	Isohyperintense	Hyperintense	Heterogeneous	0	Absent

CT, cortical thickening; ME, medullary expansion; PR, periosteal reaction; TC, trabecular coarsening.

Figure 1. A 33-year-old man with history of swelling of his forearm for 6 years. Anteroposterior radiograph of the radius and ulna demonstrates multiple phleboliths in soft tissue, suggesting intramuscular haemangioma.

intravenous injection of 0.1 mmol kg^{-1} paramagnetic contrast medium, T₁ weighted SE or fat-suppressed T₁ weighted SE (TR 800–980 ms; TE 15–25 ms; NEX 1–2; section thickness 3–4 mm; gap 1 mm) images in at least two planes were obtained from all patients. The field of view (FOV) was adjusted for the location of the lesions. All MRI sequences had an image matrix of 192×256 . Pathological biopsy results were available for 15 patients.

Figure 2. A 33-year-old woman with a history of swelling of her right lower extremity. Coronal T₂ weighted MR image (TR/TE 3500/80) of the right lower extremity shows a soft tissue mass, which is homogeneous and very bright in appearance with slightly lobulated margins.

Results

Table 2 shows the MRI signal properties, contrast patterns and bone changes of the lesions together with their distance to the neighbouring bones.

Plain radiographs showed phleboliths in 8 patients (34%; Figure 1). All lesions with phleboliths were located intramuscularly. On MRI, phleboliths were visualised in the form of nodular hypointense spots. The size of the focal lesions ranged from $1 \times 1 \times 2$ cm to $6 \times 11 \times 14$ cm. The lesions diffusely involved the extremities in four patients (Figure 2). Five patients (three of whom were children) had a lesion with a subcutaneous component; two of the children had both haemangioma and lymphangioma.

On T_1 weighted MR images, the lesions and neighbouring muscle tissue were isohyperintense in 13 patients, isointense in 7 patients, slightly hyperintense in 2 patients and hypointense in 1 patient (Figure 3). A hyperintense rim in the margin of the lesion was observed in three patients (Figure 3d).

On T_2 weighted MR images, all lesions had hyperintense signals. On T_2 weighted MR images, there were nodular hypointense areas in the lesions in 13 patients (Figure 4). There was lobulation and septation in 19 patients and septation alone in one patient. Two patients had a fluid–fluid level in the haemangioma (Figure 5). There was a neighbouring lesion with a haemosiderin ring in its membrane in one patient, suggestive of a haematoma in its chronic stage. The vessel supplying the lesion could be viewed in one patient.

Following injection of the contrast medium, 19 patients had heterogeneous enhancement patterns, while 3 patients had homogeneous enhancement patterns (Figure 6). One patient did not show contrast enhancement.

The lesion was in contact with the neighbouring bone cortex in 14 patients, 4 of whom had atrophy of the bone adjacent to the lesion. Of these four patients, one had a lesion extending from the elbow to the middle segment of the forearm involving both volar and dorsal compartments. Plain radiographs showed diffuse atrophy in one-third of the proximal radius, cortical thickening and

Figure 3. (a) A 2-year-old girl with a history of swelling and changing of skin colour of her left thigh. Coronal T_1 weighted MR image (repetition time (TR)/echo time (TE) 700/20) of the thigh shows a poorly defined, infiltrative mass within the left vastus lateralis muscle that is iso- to hyperintense in signal intensity (arrows) compared with the surrounding muscle. (b) A 29-year-old man with a history of pain of his lower leg. Axial T_1 weighted MR image (TR/TE 700/20) of the left lower leg shows an isointense soft tissue mass (arrows) within the flexor digitorum longus muscle. (c) An 8-year-old girl with a history of swelling of her right lower leg. Axial T_1 weighted MR image (TR/TE 700/20) of the right lower leg shows a marked hyperintense soft tissue mass within the gastrocnemius muscle. (d) A 40-year-old woman with a history of pain of her thigh. Axial T_1 weighted MR image (TR/TE 700/20) of the thigh shows low signal intensity and a soft tissue mass that is intramuscular and delineated by a hyperintense margin (arrow).

Figure 4. A 27-year-old woman with a history of knee pain. Axial T_2 weighted MR image (repetition time/echo time 3500/80) of the knee shows a high signal intensity mass with low signal intensity foci (arrow).

trabecular coarsening in the ulna and soft tissue phleboliths. Another patient had an intramuscular lesion in the thigh with a subcutaneous component. The lesion was located in the anterior, medial and posterior compartments and the femur adjacent to the lesion had atrophy (Figure 7). Another patient had diffuse intramuscular lesions located in both the thigh and the lower leg. The lesions involved the anterior and posterior compartments. Both MRI and plain radiographs showed diffuse atrophy in the femur (Figure 8). The final patient had lesions unilaterally involving the entire lower extremity. The cutaneous, subcutaneous and intramuscular lesions

Figure 5. A 28-year-old woman with a history of swelling of her forearm. Axial T_2 weighted MR image (repetition time/echo time 3500/80) of the forearm shows a high signal intensity mass with a fluid-fluid level (arrow).

involved all anatomical compartments of both the thigh and the lower leg. There was atrophy in the femur, expansion and sclerosis of the medullary bone distal to the fibula, a periosteal reaction of the lateral cortex of the tibia, thickening of the medial cortex of the tibia and sclerosis of the medullary bone (Figure 9). On MRI, none of the four patients had signal changes from the medullary bone. In the remaining 10 patients with lesions that were in contact with the bone, there were no reactive bone changes.

The diagnosis of soft-tissue haemangioma was based on excisional biopsy in 15 patients (65%) and on clinical signs and MRI findings in 8. Histological examination in 15 patients revealed that the tumour was cavernous

(a)

(b)

Figure 6. (a) A 23-year-old woman with a history of diffuse swelling of her right lower extremity. Axial postgadolinium, fat-suppressed, T_1 weighted MR image (repetition time (TR)/echo time (TE) 598/18) shows heterogeneous enhancement of the muscles and subcutaneous fat tissue of the right thigh. Note the diffuse atrophy of the right femur. (b) A 33-year-old woman with a history of swelling of her right lower extremity. Axial postgadolinium, fat-suppressed, T_1 weighted MR image (TR/TE 600/20) shows homogeneous enhancement of the muscles and subcutaneous fat tissue of the right thigh.

Figure 7. A 2-year-old girl with a history of swelling and changing of skin colour of her left thigh. Axial T_2 weighted MR image (repetition time/echo time 3500/80) of the left thigh shows a high signal intensity lobulated and septated mass within the muscle. Note atrophy of the left femur.

haemangioma in 13 cases and arteriovenous haemangioma in 2. Of the four patients who underwent angiography, one had pre-operative embolisation and three had sclerotherapy. On pathological examination, two patients received a diagnosis of synovial haemangioma (Figure 10). Two children had haemangioma accompanied by lymphangioma. One child had had abdominal lymphangioma 1 year earlier. One patient with a lesion in the knee had a recurrence 3 years after surgery.

Discussion

There is no general agreement regarding the aetiology of soft-tissue haemangioma. Although symptoms frequently appear after a trauma, most of these tumours are thought to be congenital [1, 5, 9]. Patients with haemangioma deeply located in tissue present with pain, swelling or both. Sometimes, patients note that the lesions grow and then get smaller [2].

The lesions are located in the lower extremities in 45% of patients [9]. Patients with phleboliths (20–67%)

have typical soft-tissue haemangioma [1, 4]. Malignant transformation is rare [1, 10]. Metastases of the lesions have not been reported [1]. No sex preponderance was stated in the study by Wild et al [9], although the lesions appeared more frequently in women [4] as reported in the present study. In 90% of patients, lesions are diagnosed in the first three decades of life [9]. In line with this observation, in 65% of our patients the lesions occurred in the first three decades of life.

Histologically, soft-tissue haemangioma can be classified into five types: capillary, cavernous, arteriovenous, venous and mixed haemangioma [1, 3, 4]. Capillary haemangioma is the most frequent haemangioma. This type of lesion is located in the cutaneous or subcutaneous tissues and is diagnosed in the first decade of life. Most instances of capillary haemangioma undergo involution spontaneously. Cavernous haemangiomas are large, deeply located and are diagnosed later in life; these lesions are frequently intramuscular, do not have spontaneous involution and require surgical treatment [4]. Arteriovenous haemangioma is composed of shunts and prevalence rates vary [4]; these lesions can be

(a)

(b)

Figure 8. A 33-year-old woman with history of swelling of her right thigh. (a) Anteroposterior radiograph of both femurs demonstrates diffuse atrophy of the right femur and phleboliths within the soft tissue. (b) Axial T_1 weighted MR image (TR/TE 700/20) of the thigh shows atrophy of the right femur and an iso- to hyperintense soft-tissue mass in the vastus lateralis muscle.

Figure 9. A 23-year-old woman with a history of swelling of her right lower extremity. (a) Anteroposterior radiograph of both lower legs demonstrates medullary expansion and sclerosis (arrowheads) of the diaphysis of the right fibula. (b) Anteroposterior radiograph of both lower legs demonstrates a periosteal reaction (black arrows), cortical thickening (white arrowheads) and medullary sclerosis (asterisks) of the right tibia. Note the extensive soft tissue involvement.

superficial or deeply located [4]. Venous haemangiomas are made up of clusters of large venous vessels with thick walls [11]. These lesions are typically located deep in the retroperitoneum, mesentery and the extremities [4]. Mixed haemangioma is, microscopically, a mixture of capillary and cavernous haemangioma [4, 11].

Superficial haemangiomas are diagnosed easily because they cause discolorations of the skin and rarely require imaging techniques [1]. However, lesions deep in the tissues are not diagnosed easily because they grow slowly and do not cause discolorations of the skin. Imaging techniques are necessary to differentiate such haemangiomas from malignant lesions [1, 2, 7].

Figure 10. A 42-year-old woman with a history of knee pain. Sagittal proton density weighted MR image (repetition time/echo time 2800/15) shows intermediate signal intensity and a soft-tissue mass in the infrapatellar bursa (arrow). Pathological diagnosis was a synovial haemangioma.

MRI is the standard imaging technique for diagnosing soft-tissue haemangioma [4]. On T_1 weighted images, compared with muscle tissue, intensities of the lesions are isointense or hyperintense with unclear margins [6, 7, 11–13]. In the present study, in keeping with the literature, T_1 weighted images showed haemangiomas to be isointense or hyperintense in 20 patients; however, in contrast with the literature, we found that two lesions were diffuse hyperintense and one was hypointense on T_1 weighted images. On T_2 weighted images, haemangiomas are typically hyperintense and have clear margins and lobulated contours. Although these signs are characteristic of haemangiomas, they are not pathognomonic [7]. As previously reported, the present study demonstrates hyperintensity on T_2 weighted images in all cases. In addition, all lesions had clear margins and most possessed lobulated contours. Marked hyperintensity of the lesions on T_2 weighted images is due to increased fluid content secondary to stagnant blood flow in large vessels [12, 13]. Ehara et al [14] reported five cases with a fluid–fluid level in haemangioma. In the present study, two patients with intramuscular haemangioma located in the forearm had a fluid–fluid level.

Thin, linear, hypointense structures inside the lesions on T_2 weighted images result from fibrous septa between the vessels [12]. Moreover, occasional punctuate or reticular hypointense areas might be due to fibrous tissue, fast blood flow in vessels, calcification, ossification, haemosiderin, smooth muscle components or a thrombosis in vascular structures [2, 11, 13]. In such cases, plain radiographs and CT can be useful in differentiating calcification from ossification. In this study, 13 patients (56%) had nodular hypointense areas on T_2 weighted MRI images. Only eight of these patients had phleboliths on plain radiographs, a finding that led us to believe that not all nodular hypointensities on T_2 weighted images corresponded to phleboliths.

Intramuscular haemangiomas contain various amounts of fat, smooth muscle, myxoid stroma, thrombi and haemosiderin [11, 12]. In some cases, haemangiomas contain so much fat that they can be mistaken for lipomas [4]. Lesions larger than 2 cm typically have different kinds of tissues and, therefore, have heterogeneous signals [4].

Deeply located, large haemangiomas sometimes cause changes in the neighbouring bone [1, 3, 8, 10]. Ly et al [1] divided bone changes into three categories: periosteal, cortical and medullary. These authors classified the cortical changes into erosion, thickening, tunnelling and osteopenia; medullary changes were classified into osteosclerosis and trabecular coarsening. A correlation was indicated between bone changes and the distance between the lesion and the bone. Moreover, the authors reported medullary changes to be correlated not only with the proximity of the lesion to the bone, but also with the lesion's size [1]. Sung et al [8] classified bone changes into periosteal reaction, osteopenia, bone enlargement, cortical erosion, trabecular coarsening and a combination of all these. Some authors emphasise an enlargement in the neighbouring bone in cases of diffuse haemangiomas [8, 15]. In the present study, four patients had atrophy in the neighbouring bone. The precise mechanism of reactive bone changes in soft-tissue haemangioma remains unknown. Several factors could contribute to the development of such bone changes, including an extrinsic pressure effect of the lesion, dilated vessels and hyperaemia secondary to vascularity of the tumour [16]. In our opinion, the mechanism for the development of bone atrophy might be related to the size, formation and duration of development of the mass prior to completion of bone growth. We believe that hypervascularity in the large and deeply seated soft-tissue haemangiomas might have caused disturbance of bone nutrition. In this study, in three of the four cases of bone atrophy, insufficiency of bone vascularisation could have resulted from the fact that the lesion was present in both subcutaneous and intramuscular compartments. Histopathological studies were undertaken of three of the four cases of bone atrophy; all three revealed cavernous haemangioma.

To our knowledge, in the English literature, there have been no reports of soft-tissue haemangioma associated with bone atrophy.

Although some researchers have noted that small haemangiomas rarely cause a periosteal reaction [7, 10], Goto et al [3] claim this is not rare. These authors also proposed that a periosteal reaction could result from passive hyperaemia caused by a tumour, retraction or irritation of a tumour. Goto et al [3] claimed that a periosteal reaction was not stimulated by the size of the lesion, but that the distance between the lesion and the bone played an important role [3]. De Filippo et al [10] hypothesised that the periosteal reaction results from increased local vascularity caused by the tumour. There have been conflicting comments on the relationship between bone changes and pain. Ly et al [1] found no relation between pain and bone changes, whereas Goto et al [3] reported that patients with haemangiomas associated with periosteal reaction more frequently had pain. None of the four patients with bone changes in our study complained of pain.

Deeply located haemangiomas are mostly intramuscular, but they can also be synovial [13]. Intramuscular haemangiomas are frequently located in the trunk and lower extremities; these lesions rarely appear in the upper extremities [10]. Synovial haemangiomas are rare and almost always involve the knee joint; patients with synovial haemangiomas complain about pain,

swelling and effusion; these lesions most frequently appear in the suprapatellar region [13]. Rare vascular tumours such as haemangioendothelioma and angiosarcoma, arteriovenous malformation, lymphangioma, lipoma, liposarcoma and other soft-tissue sarcomas might mimic haemangiomas [10, 12, 13].

Biopsy of soft-tissue haemangiomas can cause bleeding. In the present study, one patient with intramuscular haemangioma located in the forearm developed a spontaneous haematoma.

As for treating haemangiomas, symptomatic cases are treated with surgical resection or a laser [4, 9, 10]. Haemangioma has been reported to recur in 18% of patients who undergo surgery [5]. Mixed haemangioma tends to recur most frequently, followed by capillary and cavernous haemangiomas. In our study, haemangioma recurred in one patient 3 years after surgery. When excision is not appropriate, radiotherapy or embolisation can be useful [9]. We treated 15 patients with surgery, 3 with sclerotherapy under angiography and 1 with embolisation.

In conclusion, MRI is the most useful imaging technique for diagnosing soft-tissue haemangiomas and for determining tumour margins in that it provides multiplanar images and has excellent soft-tissue contrast enhancement. The presence of lobulation, septation and nodular hypointense foci on T_2 weighted images makes the diagnosis easier. The presence of hypointense signals on T_1 weighted images should not rule out haemangioma. In the present series, four patients with haemangioma had bone atrophy. This has not been reported previously in the literature. It should be kept in mind that soft-tissue haemangioma can be accompanied by bone atrophy as well as reactive bone changes, which has previously been reported.

References

1. Ly JQ, Sanders TG, Mulloy JP, Soares GM, Beall DP, Parsons TW, et al. Osseous change adjacent to soft-tissue hemangiomas of the extremities: correlation with lesion size and proximity to bone. *Am J Roentgenol* 2003;180:1695–700.
2. Teo EL, Strouse PJ, Hernandez RJ. MR imaging differentiation of soft-tissue hemangiomas from malignant soft-tissue masses. *Am J Roentgenol* 2000;174:1623–8.
3. Goto T, Kojima T, Iijima T, Yokokura S, Kawano H, Yamamoto A, et al. Soft-tissue haemangioma and periosteal new bone formation on the neighbouring bone. *Arch Orthop Trauma Surg* 2001;121:549–53.
4. Olsen KI, Stacy GS, Montag A. Soft-tissue cavernous hemangioma. *Radiographics* 2004;24:849–54.
5. Allen PW, Enzinger FM. Hemangioma of skeletal muscle. An analysis of 89 cases. *Cancer* 1972;29:8–22.
6. Hawnaur JM, Whitehouse RW, Jenkins JP, Isherwood I. Musculoskeletal haemangiomas: comparison of MRI with CT. *Skeletal Radiol* 1990;19:251–8.
7. Greenspan A, McGahan JP, Vogelsang P, Szabo RM. Imaging strategies in the evaluation of soft-tissue hemangiomas of the extremities: correlation of the findings of plain radiography, angiography, CT, MRI, and ultrasonography in 12 histologically proven cases. *Skeletal Radiol* 1992;21:11–18.
8. Sung MS, Kang HS, Lee HG. Regional bone changes in deep soft tissue hemangiomas: radiographic and MR features. *Skeletal Radiol* 1998;27:205–10.

9. Wild AT, Raab P, Krauspe R. Hemangioma of skeletal muscle. *Arch Orthop Trauma Surg* 2000;120:139–43.
10. DeFilippo JL, Yu JS, Weis L, Lucas J. Soft tissue hemangioma with adjacent periosteal reaction simulating a primary bone tumor. *Skeletal Radiol* 1996;25:174–7.
11. Memis A, Arkun R, Ustun EE, Kandiloglu G. Magnetic resonance imaging of intramuscular haemangiomas with emphasis on contrast enhancement patterns. *Clin Radiol* 1996;51:198–204.
12. Buetow PC, Kransdorf MJ, Moser RP Jr, Jelinek JS, Berrey BH. Radiologic appearance of intramuscular hemangioma with emphasis on MR imaging. *Am J Roentgenol* 1990;154:563–7.
13. Vilanova JC, Smirniotopoulos JG, Perez-Andres R, Villalon M, Barcelo J, Martin F, et al. Hemangioma from head to toe: MR imaging with pathologic correlation. *Radiographics* 2004;24:367–85.
14. Ehara S, Sone M, Tamakawa Y, Nishida J, Abe M, Hachiya J. Fluid-fluid levels in cavernous hemangioma of soft tissue. *Skeletal Radiol* 1994;23:107–9.
15. Letts RM. Orthopaedic treatment of hemangiomatous hypertrophy of the lower extremity. *J Bone Joint Surg Am* 1977;59:777–83.
16. Resnick D. Soft tissues. In: Resnick D, Niwayama G, editors. *Diagnosis of bone and joint disorders*, 3rd edn. Philadelphia, PA: Saunders, 1995; 4237, 4491–8.