

## Magnetic Resonance Imaging of Synovial Sarcoma

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Synovial sarcomas (SS) usually present as a swelling or tumor within the extremities, often associated with pain. Magnetic resonance imaging (MRI) findings in 10 biopsy-proven SS are presented. The MR findings were nonspecific but the appearance indicative of SS was usually a nonhomogeneous, septated, well-circumscribed lesion. Calcifications were often seen on plain radiographs. Lung metastases were common. SS can also present as diffuse infiltrative lesions different from the usual appearance. Subcutaneous location could be at hand. One patient with concomitant, bifocal SS recurrences five years after excision of the primary tumor with extensive bony involvement is presented as an additional variant of SS. Plain radiographs and MRI are recommended as essential for the radiological evaluation of synovial sarcomas.

Synovial sarcomas constitute 8% to 10% of all primary soft tissue sarcomas.<sup>1</sup> In spite of the name, SS do not usually arise from joint or bursal surfaces. The tumors are thought to arise from primitive mesenchymal cells.<sup>1</sup> The usual presenting symptoms in synovial sarcomas are pain (59%) and swelling or palpable mass (97%) and the tumor can become quite large.<sup>1,2</sup> The duration of symptoms can be long, for instance two and one-half years in Cadman's series.<sup>1</sup> The tumor occurs in males in about 60% of the cases and is usually found in young adults but has been reported in all ages. The location of the tumor is usually the extremities.<sup>1</sup>

Synovial sarcomas are usually circumscribed tumors. Hemorrhage and necrosis are not uncommon and foci of calcifications in the tumor can be seen on plain radiographs in about one-third of the cases. The histologic appearance of SS is either biphasic with the presence of both epithelioid and spindle cell components or monophasic with only spindle cell components.<sup>3</sup> Metastases from SS is common and usually occurs to the lungs.<sup>1</sup>

Magnetic resonance imaging is a valuable imaging method in the radiologic evaluation of musculoskeletal soft

tissue tumors including synovial sarcomas.<sup>4-8</sup> We retrospectively analyzed the morphologic MRI appearance in 10 cases of histologically proven synovial sarcomas, some of these exhibiting unusual MRI findings.

### Material and Methods

Nine patients with histologically documented SS were available and retrospectively analyzed. The male/female ratio was 4:5. Age variation was from seven to 65 years with an average of 36 years. The tumor occurred in the following locations: pelvis and thigh,<sup>6</sup> lower leg,<sup>1</sup> elbow<sup>1</sup> and neck.<sup>2</sup> All patients had an MRI examination of the tumor (one patient with two tumors), making a total of 10 MRI examinations. MRI was performed with a 1.5T unit (Picker 2055 HD Vista MR System). Slice thickness varied between 5 mm and 10 mm. T1 and T2 spin echo sequences were used with a repetition time (TR) of 500 to 900 msec and echo time (TE) of 20 msec for T1 weighted images (T1W1) and TR of 1800-2000 msec and TE of 100 msec for T2W1 in at least two orthogonal planes.

Evaluation of lung metastases was done at the time of diagnosis of SS. Tumor calcifications were evaluated on plain radiographs. Bone involvement was defined as erosion - destruction of adjoining bone. Tumor hemorrhage was based on characteristic MR findings with focal areas of high T1 and T2 signals.

### Results

On T1 sequences, all the SS showed mainly intermediate signal intensity similar to surrounding muscles (Figure 1a). Seven of the lesions were nonhomogeneous and three were homogeneous in appearance. On T2 sequences, all lesions were of high signal intensity similar to surrounding subcutaneous fat or greater and usually with a heterogeneous varying appearance of septation-loculation (Figure 1b) with four lesions showing evidence of bleeding (Figure 2). Vessel encasement with no signs of vessel invasion was encountered in one case. The tumors were almost all well-circumscribed (n=7) but three showed a more diffuse infiltrative pattern (Figure 3) with no sign of bleeding.

The tumors were all deeply localized within muscles with only one showing evidence of additional lesions in the subcutaneous fat. There was no joint involvement in any of

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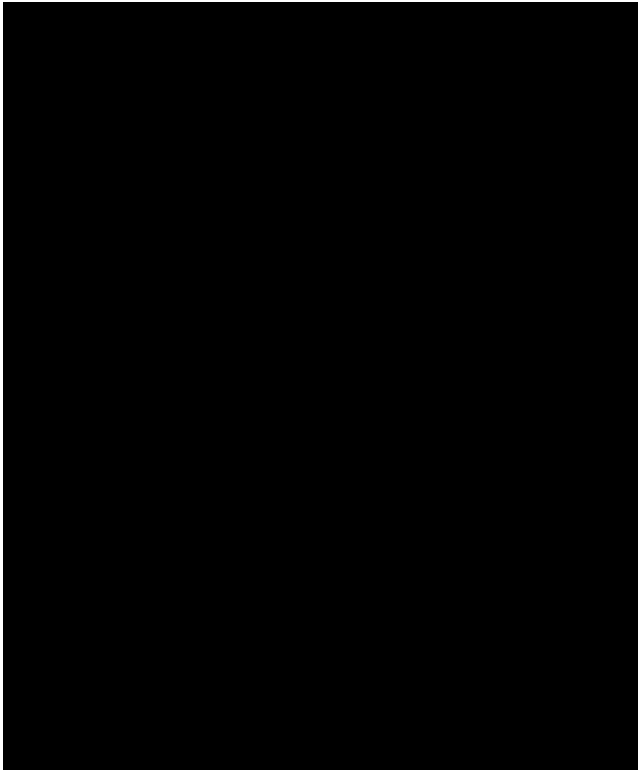


FIGURE 1. Synovial sarcoma in the proximal medial left thigh. (top) Coronal T1W1 with circumscribed tumor with signal intensity similar to surrounding muscles but with focal areas of slightly higher signal, giving a slight nonhomogeneous appearance. (bottom) Coronal T2W1 with signal intensity higher than subcutaneous fat and with evidence of septations and loculations .

the cases. The tumor size as measured by maximum tumor diameter was on the average 8.3 cm.

One patient had a primary SS in the right foot. Five years later there was a recurrence of the tumor in two locations, one in the right tibial shaft and the other in the right femoral shaft. Those two focal lesions were the only two that showed real bony involvement with cortical destruction focally and bone marrow invasion. At the time of the tumor recurrence, this patient also showed multiple lung metastases and possible brain metastasis.

Lung metastases were found in 60% of all cases. Of these, 10% showed focal lymph node enlargement and 20% showed focal bone involvement to a variable degree. Calcifications in the tumor were evident in 30% of the cases as shown on plain x-ray. The calcifications were not obvious on the MRI examinations.

Eight patients were operated upon with very good correlation between preoperative MR result and operative findings. Three of those eight patients received postoperative radiotherapy when there was a suspicion of some remnant tumor. One patient had a large tumor considered inoperable and was treated with palliative radiotherapy.

### Discussion

The MR appearance of the SS was not specific. T1 sequences revealed a mainly nonhomogeneous intermediate signal similar to skeletal muscle signal (Figure 1a). T2 sequences were also nonhomogeneous but with higher signal intensity close to or higher than adjoining subcutaneous fat with a septated and loculated appearance in most of the lesions (Figure 1b). This is in agreement with previous studies.<sup>4-7</sup> The tumors were usually well-circumscribed but focally they could be slightly diffuse. Three SS demonstrated a general diffuse appearance which is not the usual characteristic of this tumor (Figure 3) and has, to the best of our knowledge, not been described before. Neither of those three tumors showed any evidence of bleeding. The histopathologic findings corresponding to the tumors in Figures 1 and 3 correlated well with the MRI appearances, i.e. of a septated lesion and diffuse lesion respectively. This further emphasizes the value of this imaging method in appraisal of tumor morphology.

There was a very good correlation between MR results and operative findings, i.e. tumor size, anatomic location, relation to neurovascular structures, helping the surgeon to excise the tumor as radically as possible. This is in agreement with other studies.<sup>8</sup>

One SS in the proximal thigh was mainly well-circumscribed with deep location in the muscles but with additional lesions in the subcutaneous fat. This could be partly explained by seeding of the tumor due to previous biopsy, but one lesion was located at a distance from the biopsy track and could represent a superficial component of

the primary tumor, which is unusual and not described before.

Our youngest patient (seven years old) with two concomitant tumor recurrences could represent large metastatic lesions or perhaps a multifocal variant of SS with time delay. The two focal recurrences were the only ones in the series penetrating the cortex with extensive infiltration of the medullary space. The cause of this appearance is not known but it could represent either a soft tissue tumor with focal penetration into the shaft or with the origin of the tumor within the intramedullary space growing outward through cortical breakdown to the adjoining soft tissues.

Tumor hemorrhage in SS is not uncommon.<sup>4</sup> This study confirmed this with evidence of hemorrhage in 50% of the cases. Lymph node involvement in other series has been shown to occur in 12% to 23% of patients, bone involvement in 10% to 20% and lung metastases in 74% to 81%.<sup>1</sup> Our corresponding figures were 10%, 20% and 60% and thus in quite good agreement with previous studies. One exceptional case with a probable metastatic brain lesion was encountered together with lung metastases, which is an unusual combination.

In conclusion, the MR imaging of SS is nonspecific but MR is a valuable tool to demonstrate tumor morphology, the extent of the tumor, the relationship to adjoining

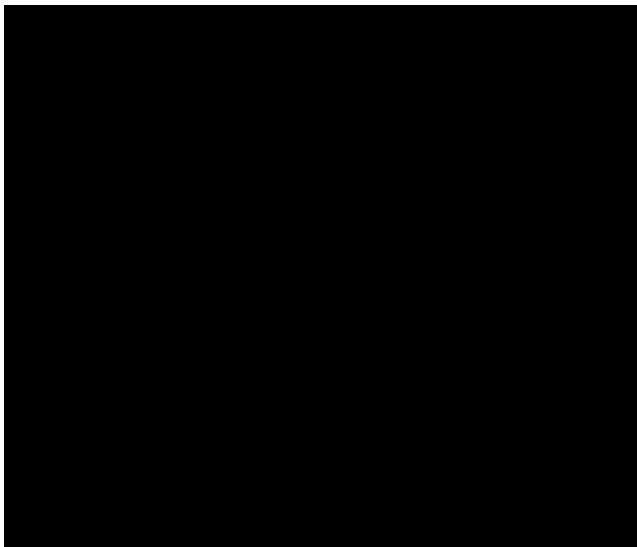
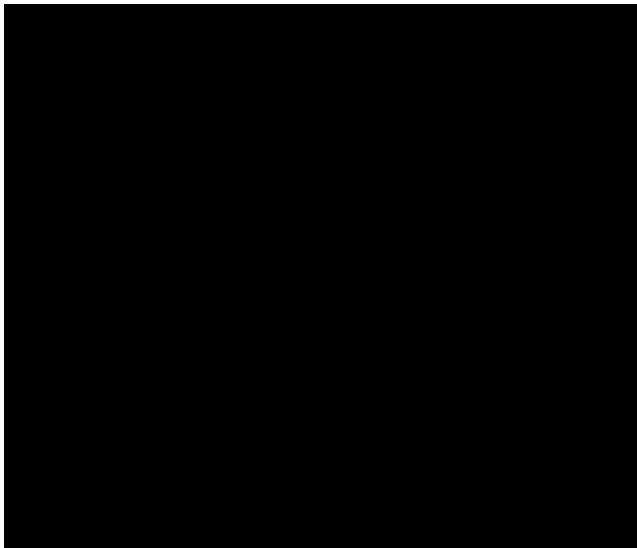


FIGURE 2. Focal bleeding in SS medial left thigh. (top) Axial T1W1 with tumor signal intensities similar to surrounding muscle with focal sedimented bleeding. (bottom) Axial T2W1 with tumor demonstrating slightly higher signal intensity than subcutaneous fat with bleeding in center.

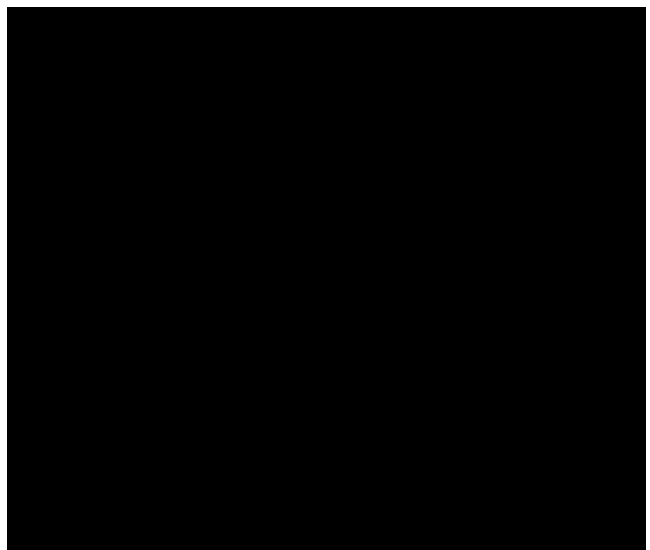


FIGURE 3. Diffuse type of SS, lateral distal aspect, left thigh. (top) Coronal T1W1 demonstrating diffuse infiltration in the subcutaneous fat in the distal lateral aspect of the left thigh. (bottom) Coronal T2W1 showing the diffuse tumor also involving lateral muscles with diffuse infiltration into subcutaneous fat .

neurovascular structures and to demonstrate bone invasion. The tumors are usually well-circumscribed but could be diffusely infiltrative or have other appearances as shown in this study. If the tumor is associated with soft tissue calcifications, the appearance is further suggestive of SS. Lung metastases are common. Plain x-ray for soft tissue calcifications and MRI for morphologic tumor evaluation are recommended as diagnostic and preoperative examinations.

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