Is CT Necessary in the Diagnosis of Soft Tissue Masses?

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Abstract

Background Computed tomography (CT) is still widely used in the diagnosis of soft tissue masses. However, overuse of CT brings increased radiation exposure and increased medical expenditure. The purpose of this study was to evaluate the necessity for CT in comparison with magnetic resonance (MR) imaging in the diagnosis of soft tissue masses.

Methods Forty-seven patients with soft tissue masses who underwent both CT and MR imaging were enrolled in this study. Contrast enhancement was performed in 27 cases out of the total 47 CT studies. Images were analyzed for 1) location; 2) extension; 3) internal structure; 4) benign and malignant differentiation of soft tissue masses. Two musculoskeletal radiologists scored each factor independently.

Results MR imaging scores of all four factors were significantly better than plain CT scores. Administration of contrast material in CT, improved agreement and kappa between CT and MR imaging scores to some extent. Diagnosis of benign and malignant differentiation was equivalent in enhanced CT and MR imaging, whereas CT scores were still inferior to MR imaging in terms of location, extension and internal structure. Compared to MR imaging as the gold standard, the sensitivity and specificity of CT diagnosis in terms of location, extension and internal structure were relatively low, but were high in the diagnosis of benign and malignant differentiation.

Conclusion These results suggest that MR imaging is superior to CT in the diagnosis of soft tissue masses. Use of CT is considered to be redundant when MR imaging is available.

Key words Computed tomography, Magnetic resonance imaging, Soft tissue mass, Diagnosis

Introduction

Before the introduction of magnetic resonance (MR) imaging, computed tomography (CT) was considered to be the most important imaging modality for the evaluation of soft tissue masses because its contrast resolution was better than that of conventional radiography. MR imaging is known to have even better contrast resolution than CT and the signal intensities are occasionally specific. As a result, the role of CT in the diagnosis of soft tissue masses has been diminishing.1–3 Despite this fact, CT is still widely used in the current clinical practice of some institutions depending on the referring physicians. This is probably due at least in part to the introduction of high speed multislice CT, which has improved accessibility. However, overuse or improper use of CT brings increased...
radiation exposure, medical expenditure, and risk of allergic reaction to the iodine contrast. The purpose of this study was to evaluate the indications of CT in the diagnosis of soft tissue masses when MR imaging is available.

**Methods**

Fifty-one cases with soft tissue masses were collected from nine institutions between January and June 2002. They were consecutive cases for which both CT and MR imaging for the diagnosis of soft tissue mass were employed during the study period. In order to avoid bias to malignant tumors, both pathologically unproven materials and those that had been clinically confirmed were included. For example, one case of ganglion, which disappeared during the course of follow-up, was included in this series.

Four cases of those collected were excluded from this study. Two were the joint disorder, pigmented villonodular synovitis, rather than a soft tissue mass. The other two cases were excluded because of the lack of both pathological and clinical diagnoses. A total of 47 cases of soft tissue masses were used in this study. Sixteen were benign masses: schwannoma: 3; lipoma: 2; lymphangioma: 2; elastofibroma dorsi: 2; hematoma: 1; ganglion: 1; atheroma: 1; neurofibroma: 1; hibernoma: 1; fibroma: 1; giant cell tumor of tendon sheath: 1. Of these 16 benign masses, pathological confirmation was not obtained in six cases: lipoma: 2; elastofibroma dorsi: 2; ganglion: 1; lymphangioma: 1. We included these cases because we thought specific diagnosis was obtained based on both imaging findings and clinical course. In the remaining ten cases, pathological diagnosis was obtained. Thirty-one were malignant tumors: liposarcoma: 12; malignant fibrous histiocytoma: 7; synovial sarcoma: 2; leiomyosarcoma: 2; malignant lymphoma: 1; osteosarcoma: 1; malignant hemangio-pericytoma: 1; angiosarcoma: 1; rhabdomyosarcoma: 1; alveolar soft part sarcoma: 1; malignant peripheral nerve sheath tumor: 1; dermatofibrosarcoma protubersans: 1. Pathological proof was obtained in all cases with malignant tumors.

The average age of patients was 52.7 (4–83 years old). There were 20 male and 27 female patients. With regards to the location of the masses, 18 cases were in the thigh, 7 in the shoulder, 7 in the inguinal and hip region, 5 in the lower leg, 4 in the abdominal wall, 2 in the scalp, 2 in the upper extremity, and 2 in the foot. CT without contrast medium was performed in 20 cases and post-contrast CT was performed in 27 cases, while MR imaging without Gd-contrast was performed in 19 cases, and MR imaging after intravenous Gd-contrast in 28 cases.

Since this is a multi-institutional study, images were obtained from different CT and MR units. CT was performed with either multislice CT or single helical CT. However, CT analysis was performed only on transverse images without 3-dimensional reconstruction. MR imaging was performed with either 1.0-Tesla or 1.5-Tesla field strength MR system. MR imaging was analyzed using both T1-weighted fast spin-echo image and T2-weighted fast spin-echo image. Fat suppressed image was also included if available. No dynamic CT or dynamic MR imaging was performed after contrast injection.

**Image interpretation**

Images were analyzed for: 1) anatomic location; 2) local extension; 3) internal structure; 4) benign and malignant differentiation. Each factor was scored on a four-point scale. For anatomic location, local extension, and internal structure, a score 4 lesion was characterized by clear delineation; a score 3 lesion was partly obscured but possible to determine; a score 2 lesion was partly obscured and difficult to determine; and for a score 1 lesion no determination was possible. As for benign and malignant differentiation, a score 4 meant definite differentiation; a score 3 was probable; a score 2 was difficult to determine; and for a score 1 no determination was possible. Two musculoskeletal radiologists, K.F. and S.E., evaluated the images independently without knowledge of the final diagnosis. K.F. viewed CT first and MR imaging later, and S.E. viewed the same images in the reverse order. If their scores were different, consensus between them was obtained through discussion.

**Statistical analysis**

Mean and standard deviation (SD) of each score derived from MR imaging and CT were calculated and analyzed as to whether there was significant difference between them using Wilcoxon rank sum test. In addition, scores of MR imaging and CT were also analyzed in the cases where contrast enhanced CT was
performed to evaluate the usefulness of contrast enhancement in CT.

**Results**

Scores of MR imaging and CT were compared for anatomic location, local extension, internal structure, and benign and malignant differentiation with Wilcoxon rank sum test (Table 1). MR imaging scores were significantly superior to CT in all four categories. Contrast enhancement was performed in 27 cases out of 47 CT studies, and similarly scores of MR imaging and CT were compared (Table 2). For benign and malignant differentiation, the CT scores improved and became equivalent to the MR imaging scores. However, the CT scores for anatomic location, local extension, and internal structure of the masses remained significantly inferior to the MR imaging scores.

**Discussion**

Although MR imaging is an excellent diagnostic modality for soft tissue masses, there are some limitations in its clinical usage when compared with CT. The number of CT units in Japan was 12,868 in 2003 and that of MR imaging units was 4,350 in 2004. Consequently, patient access to CT is much better than MR imaging, and CT is almost always available in most institutions in Japan. Furthermore, the patient throughput of CT is faster than MR imaging per unit. While it is ideal to make an accurate diagnosis with the most informative examination available, it is not uncommon to perform CT after plain radiography and before MR imaging. In addition, the CT examination fee is 5,700 Japanese yen (approximately US$ 50) in Japan, which is cheaper than MR imaging by 5,900 Japanese yen (US$ 52). In addition, there are a number of contraindications for MR imaging examinations, including cardiac pacemaker implantation, artificial cochlea implant, and ocular prosthesis. Metallic artifacts cause severe degradation of image quality in MR imaging but have a limited influence in CT, especially in reconstruction images from thin slice CT data-set. Furthermore, longer scan time occasionally causes motion artifacts in MR imaging, which does not occur in CT.

In this study, scores of location, local extension, and internal structure of soft tissue masses were significantly higher in MR imaging.
than CT. Moreover, there was no case where the CT score was higher than MR imaging score, even after contrast administration. Moderate improvement was noted in scores for location and mild improvement was present in scores for local extension and internal structure after contrast administration. However, if increased risk such as allergic reaction and nephrotoxicity, increased medical expenditure, increased workload for radiologists including obtaining informed consent, needle placement, and contrast injection in cases with contrast enhancement is taken into account, there is little advantage of post-contrast CT over MR imaging (Fig. 1).

It has been reported that CT is superior to MR imaging in delineating subtle calcification and ossification. Zone pattern with peripheral calcification is a characteristic feature of myositis ossificans. This calcification can be shown by CT at an earlier stage than by plain radiography. Previous trauma episodes are present in about 40–60% of cases with myositis ossificans. Marginal mineralization is rapid and progressive, and can even be seen on plain radiography within 4–6 weeks. T2-weighted MR image shows mixed moderate and high intensity mass lesion with extensive perifocal edema. In most cases, the characteristic low intensity ring-like area, corresponding to marginal mineralization, is seen along the margin of the mass lesion at an early stage. In this way, diagnosis of myositis ossificans is correctly achieved through the combination of clinical course, plain radiography, and MR imaging in most cases.

Other soft tissue tumors with potential mineralization include synovial sarcoma and epithelioid sarcoma. Incidence of mineralization on radiography is reported as 30% and
10–20%, respectively. The important point is that mineralization is a characteristic feature if present, but is not specific enough for diagnosis. Soft tissue osteosarcomas and chondrosarcomas may also contain mineralization, but the incidence of those tumors is low. Also, further examination is required for patients in such cases as when MR imaging shows features of either an active or aggressive nature, regardless of the presence of mineralization or ossification on plain radiography (Fig. 2).

Differentiation between benign and malignant based on shape and internal structure is difficult. Many attempts to differentiate those entities have been made and reported through dynamic MR imaging, MR spectroscopy, and Tl-scintigraphy. However, there has been no satisfactory imaging method to accomplish this purpose. On the other hand, it is generally accepted that soft tissue tumors situated deeper than the fascia and larger than 5 cm in diameter are more likely to be malignant. It is also known that some superficial tumors, such as dermatofibrosarcoma protuberans, are malignant and some deep-seated tumors, such as lipoma and lymphangiomia/hemangioma, are benign. However, lipoma and lymphangiomia/hemangioma are characteristic findings on both CT and MR imaging (Fig. 3). Furthermore, there are a number of soft tissue masses in which specific diagnosis can be obtained because their location and appearance are typical on both CT and MR imaging. Morton neuroma is a reactive neuroma located in the sole of 2nd and 3rd interdigital area of the foot. Baker cyst is a synovial cyst located in the medial aspect of the popliteus fossa, projecting between hamstring...
Fig. 3  A 51-year-old man with lymphangioma of the left axilla

Although this tumor is deep-seated, its appearance in both CT and MR imaging is that of either lymphangioma or cavernous hemangioma.

3-A: Enhanced CT. A lobulated soft tissue mass with low attenuation. There is no apparent contrast enhancement within the mass lesion.

3-B: T1-weighted MR image. A low signal intensity mass with intervening fat tissue gives the appearance similar to that of a bunch of grapes.

3-C: T2-weighted MR image. The mass has very high signal intensity with low signal septa.

(Courtesy of Dr J Aoki MD, Gunma University)

Fig. 4  A 54-year-old woman with elastofibroma dorsi of the right dorsal chest wall

Both CT and MR imaging show typical location and characteristic appearance of elastofibroma dorsi.

4-A: Enhanced CT. A soft tissue mass is located deep to the right rhomboid muscle. Fine linear areas of translucency are seen within the mass lesion.

4-B: T1-weighted MR image. Characteristic linear areas of mixed high and intermediate signals in the mass are also present.

(Courtesy of Dr T Aoki MD, University of Occupational and Environmental Health)
and medial head of the gastrocnemius muscle. Elastofibroma dorsi is a soft tissue mass located in the subscapular region between thoracic wall and the serratus muscle with characteristic strand-like fat infiltration within the soft tissue mass on both CT and MR imaging (Fig. 4).

Therefore, the basic concept for the differential diagnosis between benign and malignant soft tissue tumors depends on the location, whether deep or superficial to the fascia, and on size of the tumor, larger or smaller than 5 cm, rather than on internal structure, except for certain tumors where specific appearances are known. This is probably the reason why the agreement rate in score concerning benign and malignant differentiation between CT and MR imaging was high in this study.

There were some limitations in this study. First, the subjects constituting this study were collected from nine different institutions and there was no uniform imaging protocol such as scan parameters, indication of contrast injection, and filming process. All examinations were performed as a part of each institution’s routine work. However, all contributing institutions were university hospitals where musculoskeletal radiologists were present at the examinations. Therefore, image quality and indication of contrast injection were thought to have been reasonably well controlled. Second, since the introduction of multislice CT, fine images in any direction can be obtained using multiplanar reconstruction on CT. Therefore, evaluation of tumor location and local extension by CT may now actually be more accurate than is indicated by this particular study.

Conclusion

This study shows no superiority of CT in the diagnosis of soft tissue mass lesions over MR imaging, especially in the evaluation of anatomical location, local extension, and internal structure. Some improvement can be expected by use of contrast enhancement in CT diagnosis, but even contrast enhanced CT remains inferior to MR imaging. Therefore, the use of CT is impractical rather than complementary, when MR imaging is available for the diagnosis of soft tissue masses.

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References