MAGNETIC RESONANCE IMAGING IN SOFT TISSUES MASSES OF THE MUSCULOSKELETAL SYSTEM

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ABSTRACT

The MR images of 27 soft tissue lesions were retrospectively reviewed to assess the accuracy of MR in distinguishing benign from malignant lesions based on their morphological characteristics. Gadolinium-DTPA was also given in 16 and the pattern of enhancement was evaluated to determine whether this was helpful. Results were correlated with histological findings. 81.5% of lesions were correctly classified and the MR features were sufficiently characteristic to allow a specific diagnosis in 13 (48.0%) lesions (including cysts) and 7 (33.3%) tumours.

Key Words: MRI, soft tissue tumour, benign, malignant, enhancement.

INTRODUCTION

Magnetic resonance (MR) imaging has become the investigation of choice for the evaluation of soft tissue masses. This is due to its superior lesion definition and therefore more accurate assessment of size and extent as compared to computed tomography (CT). It has also been said that in many cases, the nature of the lesion can be reliably predicted by morphologic features noted on the MR examination. It is controversial whether MR imaging can reliably differentiate benign from malignant lesions.

Our aim was to review the MR findings in extremity soft tissue tumours to determine whether benign and malignant lesions can be reliably differentiated based on morphological characteristics and pattern of enhancement and to ascertain the reliability of tissue characterization based on MR.

MATERIALS AND METHODS

We retrospectively reviewed the MR images of 27 patients with extremity soft tissue masses diagnosed clinically who came for MR between October 1991 and September 1992. There were 14 male patients and 13 females with ages ranging from 11 years to 75 years. 4 of the masses were located in the upper extremity, 22 in the lower extremity and 1 in the buttocks. 3 were recurrent tumours but assessment was made without knowledge of the previous histology. 22 were proven to be benign on histology and 5 were malignant.

All MR scans were performed with a 1.0 Tesla Siemens Magnetom Impact scanner. Both T1-weighted and T2-weighted conventional spin-echo sequences were performed in all cases and intravenous contrast (7-10 mls of Gadolinium-DTPA) was given only when deemed necessary.

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Differentiation of malignant and benign lesions was predicted based on the morphologic appearances (signal homogeneity, margin definition and involvement of neuovascular structures and bone). After Gadolinium-DTPA, lesions were assessed for the presence of enhancement and the enhancement pattern.

All cases had histological confirmation except case 4. This case had needle aspiration which yielded gelatinous liquid and a presumptive diagnosis of a bursal cyst was made.

In our study, we found that MR was able to tissue characterize 13 out of 27 (48.0%) lesions and this made it possible to suggest the final diagnoses. Of these, there were 4 lipomas, 1 well-differentiated liposarcoma, 3 bursal cysts, 1 meniscal cyst, 2 haemangiomas and 2 ganglion cysts. When cystic lesions were excluded specific diagnoses were possible in 7 out of 21 cases (33.3%).

Classification of the masses into benign and malignant categories was correctly made in 22 out of 27 cases (81.5%). However, 1 case which was classified by the pathologist as a benign granular cell tumour with malignant potential presented 4 years later with 3 soft tissue masses in the ipsilateral thigh and calf plus inguinal lymphadenopathy. Histology of the tumour in the thigh showed groups of cells with abundant cytoplasm and occasional mitoses consistent with a granular cell tumour. The histology was similar to that of the previous tumour. However, based on the evidence of tumour recurrence and the size of the tumour, the pathologist concluded that the tumour behaviour was malignant.

Intravenous contrast was given in 16 cases. We found that the presence of enhancement alone did not help in differentiating benign from malignant lesions. We feel it is necessary to assess the pattern of enhancement together with the morphologic appearance. Enhancement was present in 10 out of 11 (90.9%) benign lesions and 4 out of 5 (80.0%) malignant lesions. Of the 10 benign lesions which showed enhancement, 3 showed minimal enhancement, 2 showed peripheral enhancement (1 bursal cyst and 1 case of chronic synovitis), 2 homogeneous enhancement (1 false aneurysm and 1 neurilemmoma) and 3 showed patchy enhancement (1 hamartoma, 1 granular cell tumour and 1 aggressive fibromatosis).

1 malignant lesion showed no enhancement. This was a recurrent malignant fibrous histiocytoma. In the 4 malignant lesions which enhanced, all showed a patchy pattern.

DISCUSSION

There have been a number of previous reports concerning the value of MR in the evaluation of soft tissue tumours. The ability to characterize lesions and to differentiate benign and malignant lesions has been assessed. It remains controversial whether MR imaging can differentiate benign from malignant masses reliably.

Kransdorf et al[1] retrospectively studied 112 soft tissue masses by MR and conclude that MR was sufficiently characteristic to allow a specific diagnosis in 27 (24%) of cases but was incapable of reliably distinguishing between benign and malignant soft tissue tumours. However, I note that this group of authors studied MR characteristics (margin definition, signal intensity, inhomogeneity, surrounding soft tissue oedema and involvement of neurovascular structures and bone) independently rather than in concert when attempting to differentiate benign from malignant lesions and it would therefore be more accurate to conclude from their study that no one criteria was reliable in differentiating benign from malignant lesions.

On the other hand, Berquist et al,[2] using the same criteria with the addition of lesion size, studied 95 lesions and found that the specificity and accuracy of diagnosis averaged 90% for both benign and malignant lesions and the negative predictive value for malignancy averaged 94%. They confirmed that benign lesions tended to be well-marginated, have homogenous signal intensity and do not encase neurovascular structures or invade bone. Malignant lesions generally have irregular margins and inhomogeneous signal and more often encase neurovascular structures and involve bone. In their series, they noted that the benign lesions that were often classified incorrectly were desmoid tumours (also called aggressive fibromatosis) and necrotic benign neoplasms (e.g. neurofibromas). The malignant lesion most commonly misdiagnosed as benign was synovial sarcoma.

Our results support previous authors findings that MR can often successfully characterize soft tissue masses allowing a specific diagnosis. With the availability of fat suppression techniques, this will be even more reliably achieved. The lesions we were able to characterize successfully were benign cysts, haemangiomas and benign and malignant lipomatous lesions. Benign cysts showed low to intermediate signal on T1-weighted sequences and high signal intensity on T2-weighted sequences. They show either no enhancement or a thin rim of peripheral enhancement in the wall of the lesion. Soft tissue haemangiomas may be hyperintense on

RESULTS

Case No.	Actual Histology	Tissue Characterisation	Correct Classification into Benign and Malignant	Specific Diagnosis	I/V Gd-DTPA	Enhancement Pattern
1	Intramuscular lipoma	Yes	Yes	Yes	No	—
2	Metastatic adenocarcinoma	No	Yes	No	Yes	Marked, Patchy
3	Bursal cyst	No	Yes	No	No	—
4	Bursal cyst	Yes	Yes	Yes	No	—
5	Ganglion	Yes	Yes	No	No	—
6	Hamartoma	No	No	No	Yes	Marked, Patchy
7	Bursal cyst	Yes	Yes	Yes	Yes	Yes, peripheral
8	Granular cell tumour	No	No	No	Yes	Yes, slightly patchy
9	Chronic synovitis	No	Yes	No	Yes	Yes, peripheral
10	Well-differentiated liposarcoma	Yes	Yes	Yes	Yes	Yes, patchy
11	Intramuscular lipoma	Yes	Yes	Yes	No	—
12	False aneurysm	No	No	No	Yes	Yes, homogeneous
13	Haematoma	No	Yes	No	No	—
14	Meniscal cyst	Yes	Yes	Yes	Yes	No
15	Intramuscular rupture of adductor longus	No	Yes	No	Yes	Yes, minimal
16	Neurilemmoma	No	Yes	Yes	Yes	Yes, homogeneous
17	Haemangioma	Yes	Yes	Yes	No	—
18	Capillary haemangioma	Yes	Yes	Yes	Yes	Yes, minimal
19	Benign fibrous proliferation	No	Yes	No	Yes	Yes, minimal
20	Ganglion	Yes	Yes	Yes	No	—
21	Lipoma	Yes	Yes	Yes	No	—
22	Low grade fibrosarcoma	No	Yes	No	Yes	Yes, patchy
23	Ganglion	Yes	Yes	Yes	No	—
24	Intramuscular lipoma	Yes	Yes	Yes	No	—
25	Recurrent aggressive fibromatosis	No	No	No	Yes	Marked, patchy
26	Recurrent malignant fibrous histiocytoma	No	Yes	No	Yes	No
27	Recurrent low grade myxoid liposarcoma	No	Yes	No	Yes	Yes, patchy

T1-weighted sequences due to the presence of fat. They showed high signal on T2-weighted sequences. They can be definitively diagnosed by the presence of flow voids due to vascular channels. Lipomatous lesions showed high signal intensity on both T1-weighted and T2-weighted spin echo sequences similar to the subcutaneous fat. However, it is worthwhile noting that the absence of fat signal on the MR examination did not exclude a liposarcoma as evidenced by case 27, a recurrent myxoid liposarcoma. This has been noted by previous authors.[1,3,4] Although we had no cases of pigmented villonodular synovitis, it is said to have fairly typical MR features. It shows a heterogeneous pattern of varied signal intensities on T1-weighted and T2-weighted images which is dependent on the relative proportion of lipid, haemosiderin, fluid, cellular elements and fibrous stroma. A low signal intensity rim may be produced by a fibrous capsule or peripheral haemosiderin.[5]

In our study we could not reliably distinguish between malignant and benign lesions based on MR characteristics and the contrast enhancement pattern. We note that it is worthwhile to take into account the plain radiographic findings when interpreting the MR. Take for example case 6 : the presence of phleboliths and organized periosteal reaction on the plain radiograph would point to a benign lesion. It is well known that MR is not sensitive for detecting calcification and does not show periosteal changes well. In some cases such as this, CT may provide additional information with regard to periosteal changes and calcifications that may not be shown on MR.

Herrlin et al[6] has suggested that T1-weighted Gadolinium sequences may be of value in differentiating benign from malignant lesions. However, in their series there were relatively few benign tumours. Our series on the other hand has few malignant lesions. We found that the presence of enhancement alone was not a useful criterion as many benign lesions showed enhancement. However, we found that patchy enhancement was a useful finding as this was present in 4 out of 5 the malignant lesions but only 3 out of 11 benign lesions. Peripheral and homogeneous enhancement was only seen with benign lesions in our study. However, our sample group was small so it is not possible to generalize. Indeed, it has been reported that neurogenic tumours (benign or malignant) have a varied appearance on post-contrast T1-weighted sequences. Their enhancement pattern may be homogeneous, inhomogeneous or peripheral depending on the degree of cystic degeneration.[7] In view of the additional cost of contrast administration, it would be important to do further studies to determine whether routine administration of contrast in patients with soft tissue tumours is justified.

More recent literature suggests that phosphorus-31 (^{31}P) MR spectroscopy may improve the diagnostic specificity of MR imaging in differentiating benign from malignant soft tissue tumours. Negendank et al[8] and Zlatkin et al[9] have found that malignant lesions can be distinguished from benign lesions on the basis of significantly higher mean peak ratios of phosphomonoester to ß-nucleoside triphosphate and phosphodiester to nucleoside triphosphate (NTP), a significantly lower mean peak ratio of phosphocreatine to NTP and a higher mean pH.

SUMMARY

In our small study, we have found that although MR can suggest whether a soft tissue lesion is benign or malignant, it is not reliable. Lesions in which a specific diagnosis can be made include benign cystic lesions, lipomatous lesions and haemangiomas.

Contrast enhancement may be a helpful adjunct to T1 and T2-weighted imaging but is again not reliable in differentiating benign from malignant lesions.

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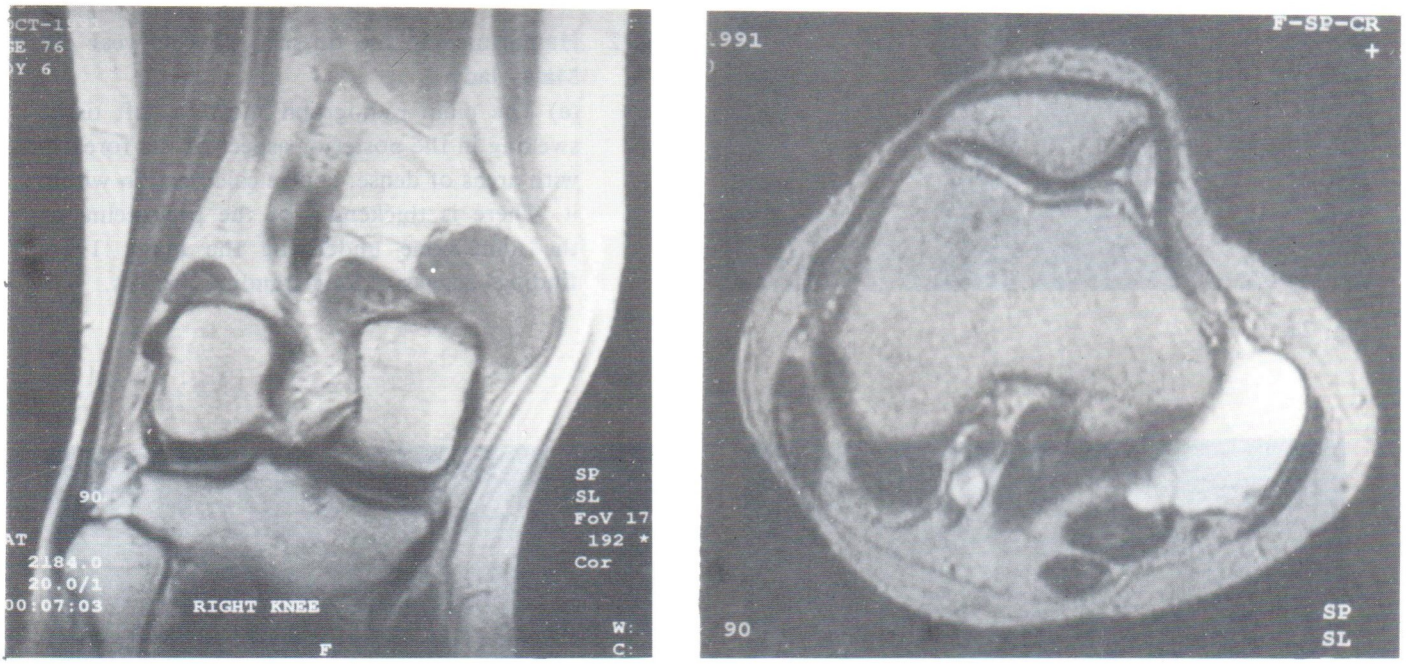

Fig. 1 Gastrocnemius-semimembranosus bursal cyst in a 86 year old Chinese lady. MR shows a well-defined mass of low signal intensity on the (a) intermediate-weighted coronal image and homogeneous high signal intensity on the (b) T2-weighted transaxial image, suggesting it is cystic. It is located deep to the semimembranosus and sartorius muscles and lateral to the medial head of the gastrocnemius muscle and has fine septations within it.

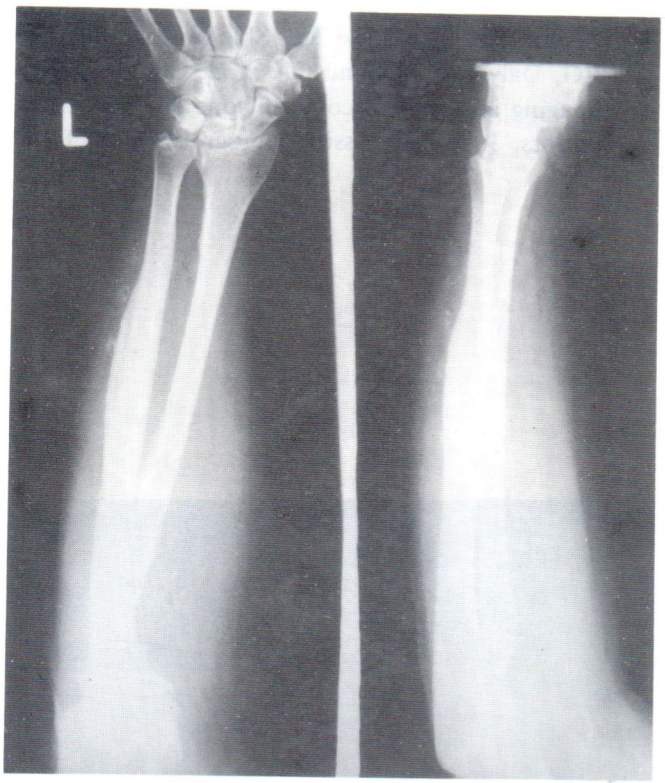

Fig. 2 a

Fig. 2 Hamartoma in the forearm of a 49 year old Malay lady.
(a) The plain radiograph shows a soft tissue swelling in the posterior aspect of the forearm with areas of dense, coarse calcification within it. There is thickening of the periosteum of the ulna bone underlying the mass. These findings suggest a long-standing process.

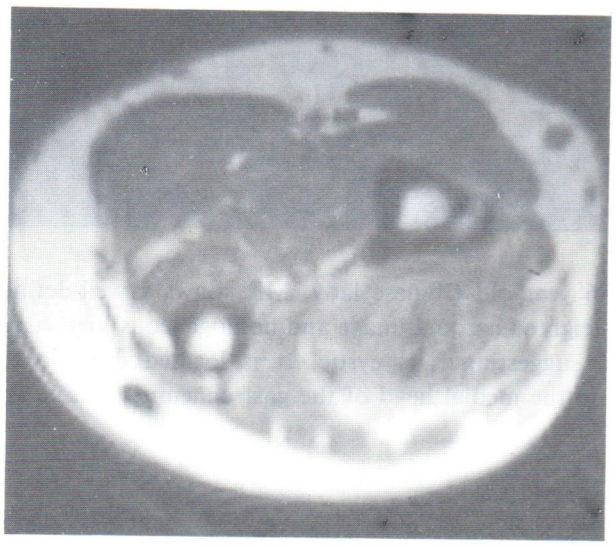

Fig. 2 b

(b) Axial T1-weighted spin echo image shows a mass in the posterior compartment which has poorly-defined margins.

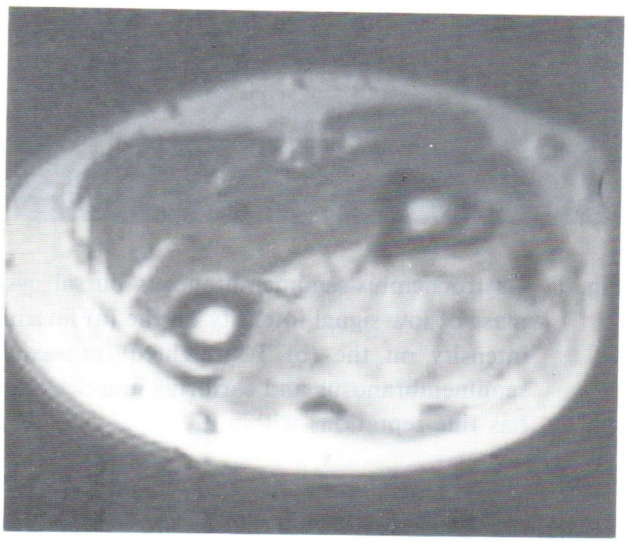

Fig 2 c

(c) Post-Gadolinium axial T1-weighted scan shows avid but patchy uptake of contrast. This was thought to be a malignant soft tissue tumour.

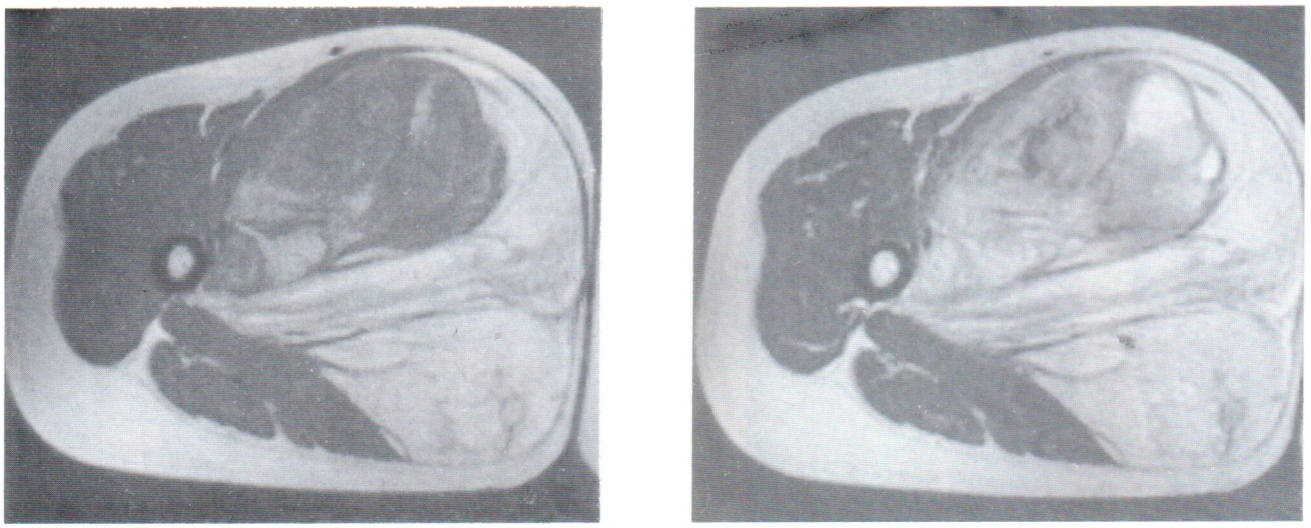

Fig. 3 Liposarcoma in the thigh of a 45 year old Chinese female. MR shows a large mass involving the adductor compartment which has heterogeneous signal characteristics. There are large areas of high signal on the (a) axial T1-weighted sequence (SE 750/15) and intermediate to high signal on (b) T2-weighted (SE 2024/60) sequences similar to the signal seen in the subcutaneous fat. In addition, there is an area which is of low signal on T1-weighted sequences and high signal on T2-weighted sequences. The findings were highly suggestive of a liposarcoma.

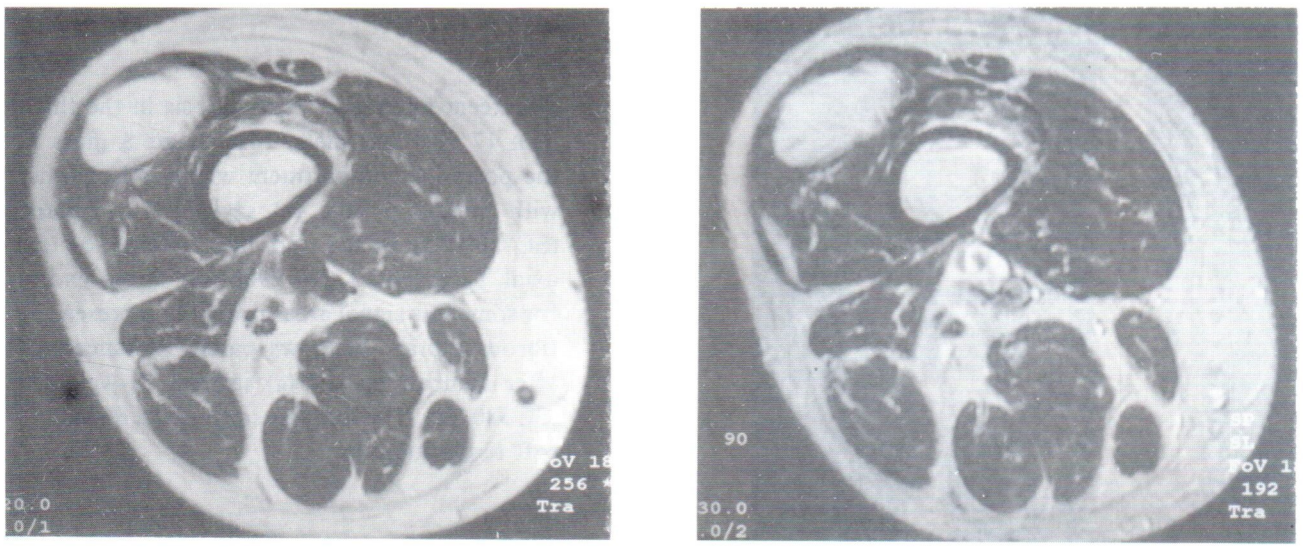

Fig. 4 Intramuscular lipoma in the thigh in a 45 year old Chinese lady (a) Axial T1-weighted and (b) axial T2-weighted MR images shows a well-defined mass in the vastus lateralis. It displays high signal on both the T1-weighted and T2-weighted spin-echo sequences with signal characteristics similar to that of the subcutaneous fat. There are fine septae within it. The features are suggestive of a lipomatous lesion, most likely an intramuscular lipoma.

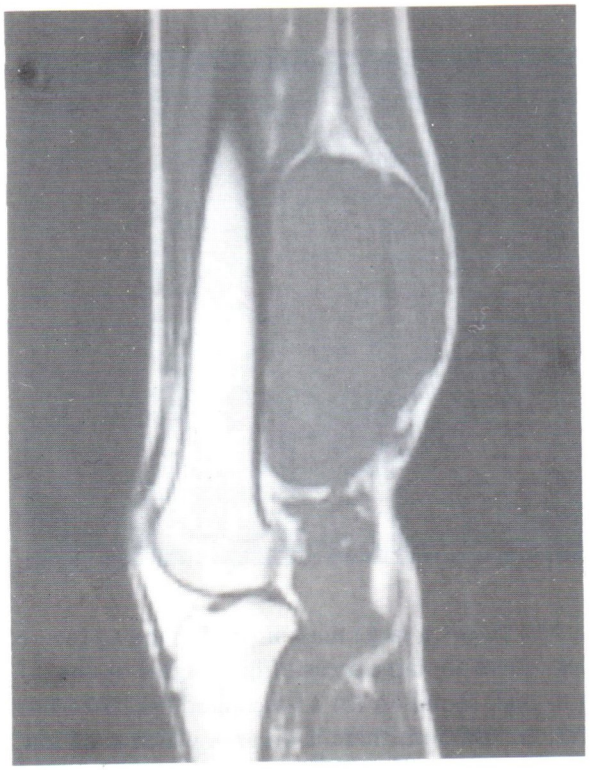

Fig. 5a

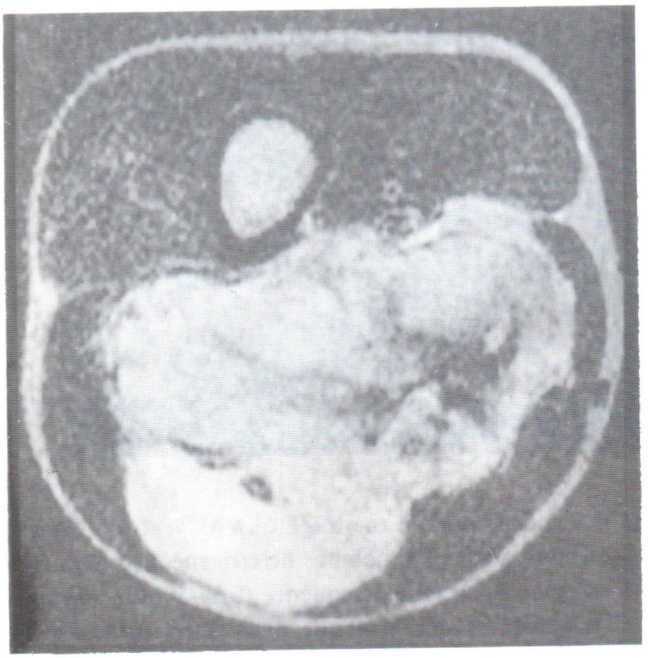

Fig. 5b

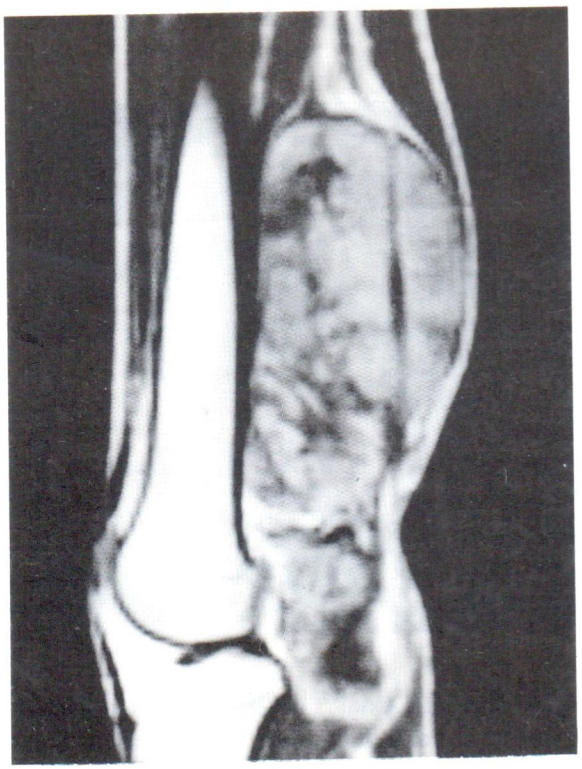

Fig. 5c

Fig. 5 Recureent aggressive fibromatosis in the thigh in a 17 year old male. MR shows a mass in the posterior compartment which is isointense with muscle on the (a) sagittal T1-weighted (SE 580/15) image and hyperintense on (b) axial T2-weighted (SE 2900/80) image except for some low signal areas probably representing fibrous septae. It shows patchy enhancement after contrast on the (c) sagittal T1-weighted (SE 580/15). The findings suggested a malignant soft tissue tumour.