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Evaluation of Primary Bone Tumors with Plain Radiograph, CT, MR and Correlation with Surgical and Histo-Pathological Findings.

Einstien A[1]*, Praveen Kumar[1], and Dinisha Einstien[2].

[1]Department of Radiology, Chettinad Hospital & Research Institute, Kelambakkam, Chennai, Tamil Nadu, India.
[2]Department of Pathology, SreeBalaji Medical College & Hospital, Chromepet, Chennai, Tamil Nadu, India.

ABSTRACT

Bone tumors may be benign or malignant. The need for accurate preoperative local staging techniques to allow planning of limited or limb-saving surgery in patients with primary bone sarcoma has fostered an interest in radiologic staging techniques.The modalities used in analyzing bone tumors include: a) conventional radiography, b) computed tomography (CT), c) magnetic resonance imaging (MRI) andd) surgical/histo-pathological examination. In this study, the role of imaging modalities and various MRI sequences in evaluating primary bone tumors were analysed. 1) To compare the role of plain radiograph, CT and MRI in the evaluation of bone tumors and correlate with the surgical and histo-pathological findings. 2) To determine the role of various MR sequences in primary bone tumors. In this five year study, 50 patients who had strongly suspected (clinically or radiographically) primary malignant neoplasm arising from bone underwent the following procedures : Plain radiograph, CT and MR. All the imaging findings were recorded and compared with the surgical / histopathological examination. Statistical analyses were made with IBM SPSS software version 20.0. Conventional radiography yielded the most useful information about the location and morphology of a lesion, whereas, CT was excellent in demonstrating the type of bone destruction, calcifications, ossifications and periosteal reaction and MRI was crucial in the evaluation of intraosseous and extraosseous extensions of a tumor. Both MRI and CT have advantages and disadvantages, and circumstances exist in which either can be the preferential or complementary study.

Keywords: Bone tumours, primary, imaging, plain radiograph, CT, MR sequences.

***Corresponding author**

INTRODUCTION

Bone tumors may be benign or malignant. The differential diagnosis of most primary bone tumors is generated based on features detected on radiographs. Radiographs provide critical information regarding lesion location, margin, matrix mineralization, cortical involvement and adjacent periosteal reaction. Such features suggest either benignity or malignancy and allow one to decide whether additional imaging examinations, if any, should be performed. The need for accurate preoperative local staging techniques to allow planning of limited or limb-saving surgery in patients with primary bone sarcoma [1] has fostered an interest in radiologic staging techniques.

Cross-sectional imaging has extraordinarily improved the ability to characterize tumors. CT is excellent for demonstrating bone destruction and mineralization and MR is the best modality for focal extent and local staging [2]. The excellent contrast resolution and multiplanar capabilities of MR lead to improvesevaluation of both intra-compartmental and extra-compartmental extent of bone. This is particularly true with regards to invasion of muscle, neurovascular structures and adjacent fat planes and degree of marrow involvement [3,4,5]. MR has been shown to be superior in assessing intra-articular extension and the presence of intra-tumoral necrosis and hemorrhage [6]. MR is the best technique to detect skip lesions which are often missed by other imaging means [7]. However, MR imaging features are usually nonspecific in differentiating benign from malignant processes [5,8]. MR imaging may not be as sensitive as CT to cortical disruption, fine periosteal reactions and small calcifications;but, with proper imaging planes and resolution, early endosteal and cortical erosions as well as periosteal changes can be detected on MR images [5, 9, 10]. MR imaging is important in the evaluation of tumor extent, staging and response to therapy [2].

Aims and Objectives

1) To compare the role of plain radiograph, CT and MR in the evaluation of bone tumors and correlate with the surgical and histo-pathological findings.
2) To determine the role of various MR sequences in primary bone tumors.

MATERIALS AND METHODS

This prospective study was conducted in Department of Radio-diagnosis and Modern Imaging of SMS Medical College, Jaipur, India from August 2008 through July 2009 and in the Department of Radiology, Chettinad Hospital and Research Institute from June 2010 to May 2014. Patients who had strongly suspected (clinically or radiographically) primary malignant neoplasm arising from bone were included in the study. Patients in whom MRI is contraindicated, surgery was deferred, previous procedure had been done were excluded from the study.

The study patients underwent the following investigations –

Plain radiograph: at least two views of the concerned part.

CT protocol: All CT examinations were performed using GE lightspeed 16 Slice CT scanner with Advantage Workstations with slice thickness of 3.25 mm and inter-slice gap of 5 mm, with 0.4 s scan time. Axial images was taken, coronal and sagittal reformatting, volume rendered 3D formatting done, and thin collimation with reconstruction was done with bone algorithm to improve spatial resolution.

MR protocol: Multiplanar MR imaging of the concerned part was done with 1.5 Tesla signa Excite MRI machine. Spin-echo and inversion recovery sequences were used to obtain axial/coronal/sagittal planes of T1W (repetition time (TR) of 500 ms and time echo (TE) of 20 ms), T2W (TR of 5000 ms and TE of 100 ms), STIR (T1W – TR 500 ms and TE of 20 ms, inversion recovery 140 ms; T2W – TR of 4000-5000 ms and TE of 50 ms, inversion recovery 140 ms) and proton-density (TR of < 1000ms and TE of < 50 ms) images with slice thickness of 5 mm and interslice gap of 1 mm.

All the imaging findings were recorded and reviewed by two radiologists and presumptive diagnosis was made. The findings were compared with the surgical / histopathological examination. Sensitivity, specificity, positive predictive value and negative predictive value of various modalities were calculated and Chi-Square test was applied to determine the statistical significance.

OBSERVATIONS AND RESULTS

50 cases of primary bone tumors – 28 males and 22 females, aged between 18 and 50 years (mean age – 32.4 years) were studied. Majority of the patients (60%) were between 25 and 44 years.

The distribution of cases according to the tumors diagnosed were as follows:

Osteosarcoma – 22, Giant cell tumor – 16, Chondrosarcoma – 8, Chondroblastoma – 2,
Malignant fibrous histiocytoma – 2.

The results observed are presented in Tables – 1,2,3& 4.

Table 1: Comparison of Imaging findings on Radiographs, CT and MRI with Surgico-Pathology:

Feature	Radiograph	CT	MRI	Surgico-Pathology
Cortical Erosion / Break	38	38	36	38
Matrix Mineralisation / Sclerosis	32	32	28	32
Periosteal / Endosteal reaction	28	28	26	28
Marrow involvement	-	42	46	46
Soft tissue involvement	-	30	38	36
Neurovascular bundle involvement	-	6	16	14

Table 2: Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of Radiograph:

Feature	Sensitivity	Specificity	PPV	NPV
Cortical Erosion / Break	100	100	100	100
Matrix Mineralisation / Sclerosis	100	100	100	100
Periosteal / Endosteal reaction	100	100	100	100

Table 3: Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of CT:

Feature	Sensitivity	Specificity	PPV	NPV
Cortical Erosion / Break	100	100	100	100
Matrix Mineralisation / Sclerosis	100	100	100	100
Periosteal / Endosteal reaction	100	100	100	100
Marrow involvement	91	100	100	50
Soft tissue involvement	83	100	100	70
Neurovascular bundle involvement	42	100	100	81

Table 4: Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of MR:

Feature	Sensitivity	Specificity	PPV	NPV
Cortical Erosion / Break	95	100	100	86
Matrix Mineralisation / Sclerosis	87	100	100	81
Periosteal / Endosteal reaction	92	100	100	91
Marrow involvement	100	100	100	100
Soft tissue involvement	100	85	94	100
Neurovascular bundle involvement	100	94	87	100

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DISCUSSION

The modalities used in analyzing bone tumors include: a) conventional radiography, b) computed tomography (CT), c) magnetic resonance imaging (MRI) and d) surgical/histo-pathological examination. This study was undertaken with the aim of evaluating the role of imaging modalities in bone tumors and various MRI sequences in primary bone tumors.

In most instances, the standard radiographic views specific for the anatomic site under investigation, in conjunction with conventional tomography was suffice to make a probable diagnosis. In our study, conventional radiography yielded the most useful information about the location and morphology of a lesion, particularly concerning the type of bone destruction, calcifications, ossifications and periosteal reaction (sensitivity and specificity of 100%). In a case of osteosarcoma of right ilium plain radiograph, albeit showed hyperostosis, was not able to give the morphological detail of the underlying periosteal reaction but CT clearly delineated the tumor.

Figure 1: a) Plain radiograph of right proximal femur shows grossly expansile lytic lesion centered in greater trochanter.

b) Axial T1 weighted MRI image shows expansile, homogeneous, intermediate intense lesion in proximal femur.
c) Axial T2 weighted MRI image shows multiple fluid-fluid levels - Giant Cell Tumor.

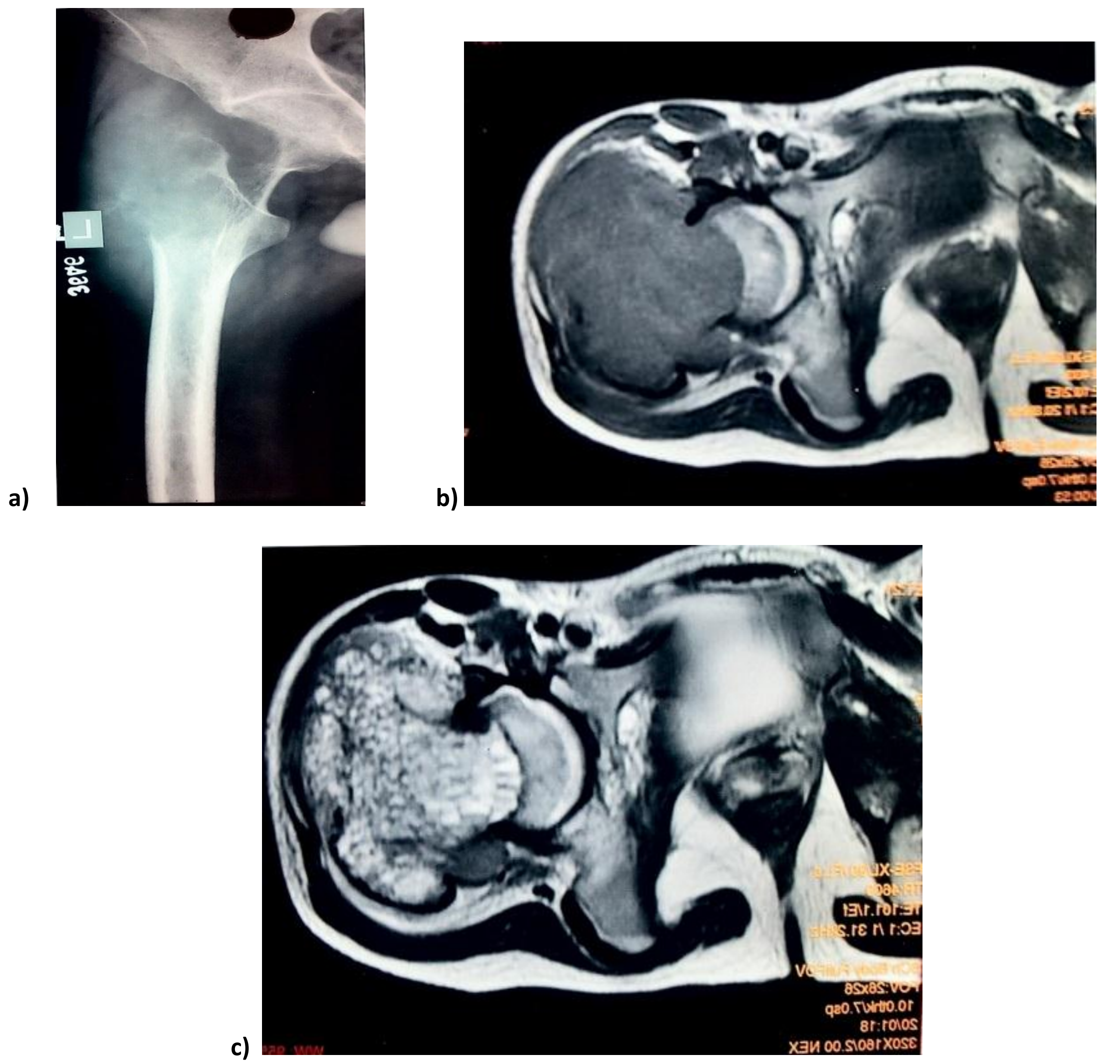

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Figure 2 : a) Coronal T1 weighted MRI image shows destructive, lytic, heterointense (scattered areas of hyperintnesity) lesion arising from distal fibula with adjacent tibial involvement and large soft tissue component.

a) Coronal T2 weighted MRI image of corresponding region shows multiple fluid-fluid levels. -Telengectatic osteosarcoma.

b) Coronal T2 weighted MRI image shows eccentric, heterointense lesion in distal femur with large cortical breech, Codman triangle and soft tissue component.

c) Coronal STIR MRI image shows high signal intensity representing marrow infiltration. There is wide zone of transition.

d) Axial T2 weighted MRI image shows multiple fluid-fluid levels.

e) Coronal section of post-surgical specimen. - Osteosarcoma.

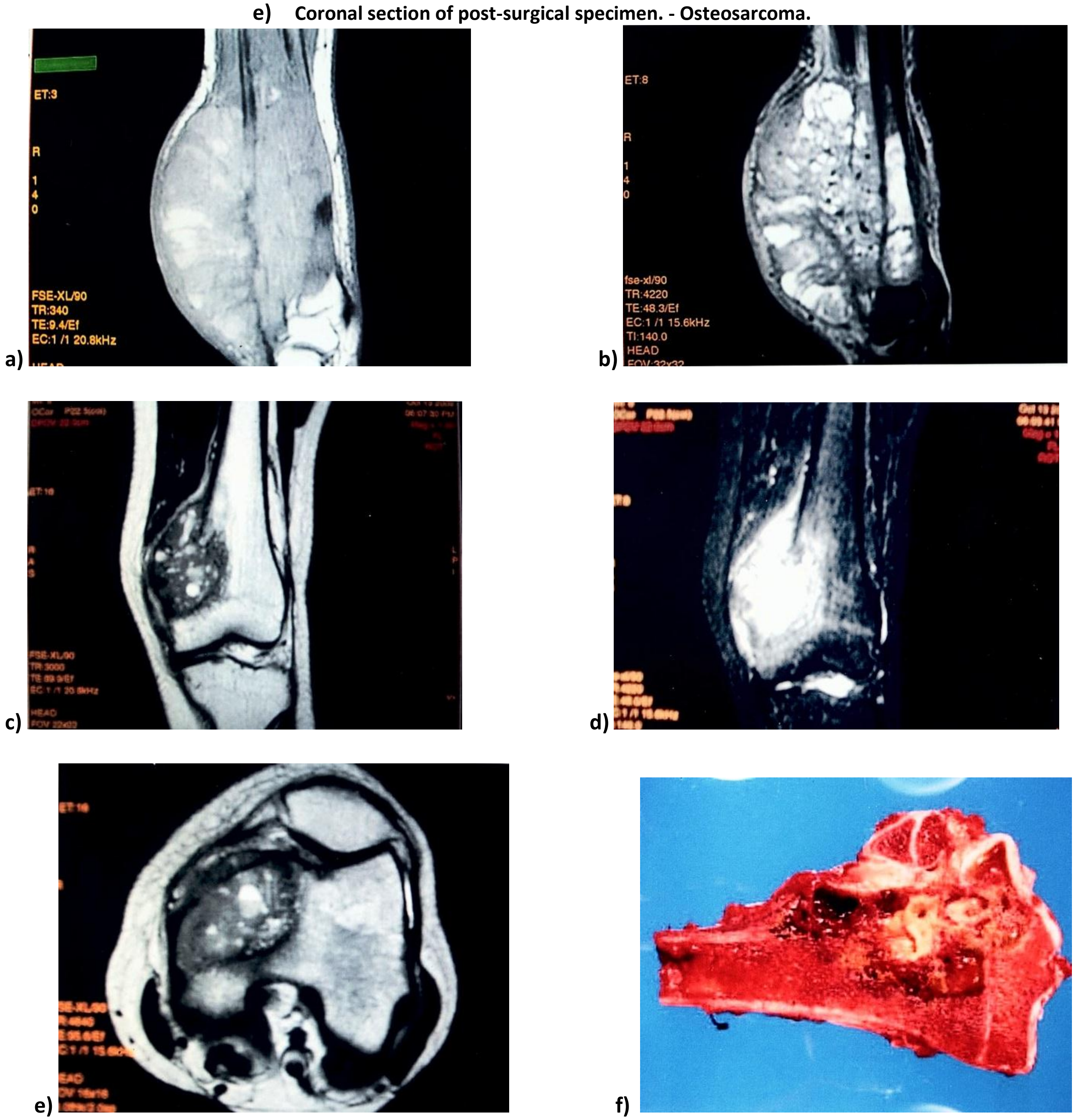
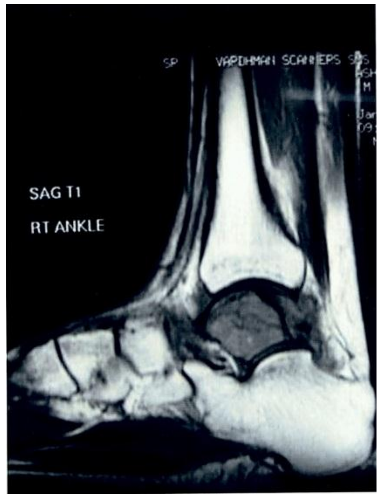
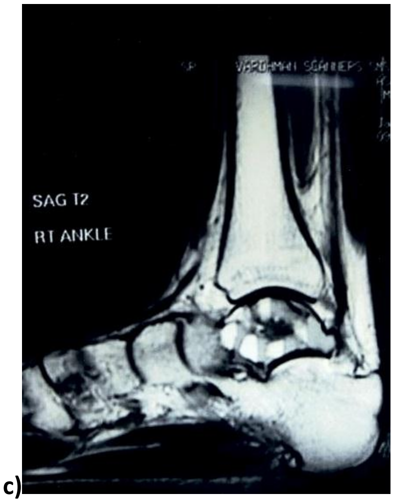


Figure – 3 :a) Plain radiograph of right ankle in AP view shows lytic lesion without cortical break in talus.
b) Sagittal T1 weighted image shows intermediate intense lesion involving entire talus.
C) Axial T2 weighted MRI image shows multiple fluid-fluid levels. - Giant Cell Tumor.

a) 

b) 

c) 

Plain radiograph and CT were clearly ahead of MRI (P < 0.001) in demonstrating cortical erosion / break, matrix mineralization / sclerosis and endosteal / periosteal reaction. The classic ring and arc calcification of chondroid matrix demonstration was far superior in CT as compared to MR with good spatial resolution in a case of chondrosarcoma of femur. MRI failed to demonstrate chondroid calcification in a case of chondrosarcoma proximal humerus and chondrosarcoma of proximal femur and minimal periosteal erosion in cases of periosteal osteosarcoma of distal femur and clear cell chondrosarcoma of proximal humerus. CT was more specific, but less sensitive in demonstrating marrow involvement (sensitivity 91%, specificity 100%) and neurovascular (NV) involvement (sensitivity 42%, specificity 100%) compared to MRI (sensitivity 100%, specificity 85% and sensitivity 100%, specificity 94% respectively) with p < 0.001.

Extraosseous involvement was best shown by T2W axial images in the study. However, the low signal intensity of tumor on T1 weighted images was shown in sharp contrast with high signal intensity of fatty bone marrow which helped in evaluating the marrow involvement. STIR sequence had a higher sensitivity in displaying marrow involvement. MRI was able to demonstrate soft tissue involvement in all cases. The relationship of NV bundle to the tumor was best shown on T2W axial images and T1W post contrast axial sections. 2 cases were detected falsely positive on MRI. In the evaluation of intraosseous (sensitivity 91%) and extraosseous (sensitivity 83%) extensions of a tumor, CT was always less sensitive as compared to MRI. Also, CT failed to demonstrate marrow involvement in osteosarcoma of pelvis and clear cell chondrosarcoma of proximal humerus and periosteal osteochondroma of distal femur. CT also missed soft tissue involvement in clear cell chondrosarcoma of proximal humerus, osteosarcoma of ilium, GCT of distal ulna and GCT of proximal tibia.

Despite great value of MR imaging in the staging of bone lesions, it was of relatively little value in specific histological diagnosis. There were specific diagnoses however that had a relatively characteristic MR appearance. We observed a distinctive MR appearance in chondroid lesions containing a matrix of hyaline cartilage. The unique pattern consisted of homogenous high signal in a discernible lobular configuration on T2 weighted spin echo images. This MR appearance reflects underlying high ratio of water content to mucopolysaccharide component within hyaline cartilage[7]. MR imaging demonstrated fluid – fluid level in 6 cases of GCT and 6 cases of osteosarcoma more vividly in T2 weighted spin echo images. Cysts of different signal intensities and fluid – fluid levels are caused by blood products in different stages of degeneration [8].

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CONCLUSION

Conventional radiography yielded the most useful information about the location and morphology of a lesion, particularly concerning the type of bone destruction, calcifications, ossifications and periosteal reaction. CT was excellent in demonstrating the type of bone destruction, calcifications, ossifications and periosteal reaction with exquisite morphological detail. MRI is crucial in the evaluation of intraosseous and extraosseous extensions of a tumor, particularly of extremities – reliably identifies the spatial boundaries of tumor masses, the encasement and displacement of major neurovascular bundles, and the extent of joint involvement. It is important to realize that both MRI and CT have advantages and disadvantages, and circumstances exist in which either can be the preferential or complementary study.

REFERENCES

[1] Prilio F, Cerase A. Eur J Radiol 1998; 27 Suppl1: S77-85.
[2] Hogeboom WR1, Hoekstra HJ, Mooyaart EL, Freling NJ, Veth RP, Postma A, SchraffordtKopps H. Eur J Surg Oncol 1992;18(1):67-72.
[3] Rafique MZ, Bari VJ. Coll Physicians Surg Pak 2004; 14(1):10-13.
[4] S Baweja, R Arora. IJRI 2006,16 (4):611-618.
[5] Petterson et al. RSNA 1987;164 (1) : 237.
[6] Wolfgang Schima, Gabriele Amann. AJR 1994; 163: 1171-1175.
[7] O’Flanagan SJ, Stack JP, McGee HM, Dervan P, Hurson B. J Bone Joint Surg Br. 1991;73(6):998-1001.
[8] Cohen EK, Kressel HY, Frank TS, et al. Radiol 1988;167:477-481
[9] Sullivan RJ, Meyer JS, Dormans JP, Davidson RS. Clin Orthop Relat Res 1999; (366): 186-190.
[10] Tehranzadeh J, Mnaymneh W, Ghavam C, Morillo G, Murphy BJ. J Comput Assist Tomogr 1989;13(3):466-472.
[11] Ella Onikul, Barry D Fletcher. AJR 1996;167:1211-1215.
[12] M Sundaram, AA McLeod. AJR 1990;155:817-824.
[13] R Golfieri, H Baddeley. BJR 1990;63:251-256.
[14] Herman M Kroon. Skeletal Radiol J MR 1994;23(4).
[15] Suzanne A Gronemeyer, William M Kauffman. J Magn Res Imag 1997;7:585-589.