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Original Research Article

A Retrospective Study of Role of MRI in Diagnostic Evaluation of Soft Tissue Tumours

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Abstract:

Introduction: A soft tissue mass, also known as a soft tissue tumor is a neoplastic growth that forms in the non-epithelial extra skeletal connective tissue, soft tissues of the body such as the muscles, tendons and blood vessels which usually mesodermal in origin. Considered a rare condition, there are a variety of soft tissue masses which may be diagnosed in any part of the body. Despite the diversity associated with soft tissue tumor development, all diagnoses carry similar symptoms and treatment options. By systematically using clinical history, lesion location, mineralization on radiographs and signal intensity characteristics on magnetic resonance images, one can determine the diagnosis for the subset of determinate lesions that have characteristic clinical and imaging features and narrow the differential diagnosis for lesions.

Results: MRI is the modality of choice for evaluation of soft tissue tumors & highly sensitive in detection of soft tissue tumors all most 100%. It is a well-established imaging tool for the detection and local staging of soft-tissue tumors & determining the location, nature and characteristics of the lesion & their extent and relation to adjacent structures, Sensitivity of MRI to diagnose malignant lesions as malignant is 86.7% and sensitivity of MRI to diagnose benign lesions as benign is 90%. In this study MRI has slightly higher sensitivity to diagnose benign lesion as benign.

Conclusion: MRI is the modality of choice for evaluation of soft tissue tumors & highly sensitive in detection of soft tissue tumors all most 100% with accuracy in determining the location, nature and characteristics of the lesion. Sensitivity of MRI to diagnose malignant lesions as malignant is 86.7% and sensitivity of MRI to diagnose benign lesions as benign is 90%.

Keywords: Soft tissue tumors, MRI, Benign, Malignant.

Introduction

Soft tissue tumors are lesions originating from non-epithelial (primarily mesenchymal) extra-skeletal tissues of the body, including fat, muscle, tendons, peripheral nerves, blood vessels, and fibers (ligament, fascia).[1] Benign STTs are several folds more common than malignancies, with an annual clinical incidence of 300 per 100,000. [1] Soft tissue sarcoma (STS) is relatively rare and accounts for only about 1% of malignancies. [2,3]

They arise most commonly in the extremities, chest wall and retroperitoneum and are more common in older people and males, although age and gender vary for the various histological types. In comparison to benign tumors that require only monitoring and sometimes surgery, malignant tumors require surgery and other modalities such as radiotherapy, chemotherapy, and targeted therapy. Late detection of STS negatively affects the prognosis of patients, [4] so it is vital to diagnose the tumor as benign or malignant. The radiological methods used to investigate STTs include X-ray, ultrasound, computed tomography, positron emission tomography, and magnetic resonance imaging (MRI). Of these, MRI is the modality of imaging to evaluate STTs.[5] It determines the anatomy of the tumor, the characterization of the lesion depending on its signal properties, as well as the evaluation of the exact extent of the tumor and its relationship with the surrounding structures. It also helps in surgical planning and follow-up after treatment. However, the accurate histopathological diagnosis of STTs is tough. A study by Gielen et al.[6] reported that the accurate prediction of diagnostic histology by MRI was only possible in about 50% of cases.

Patients are commonly referred for imaging to evaluate a soft-tissue mass in the trunk or extremities. These lesions range from non-neoplastic conditions to benign and malignant tumors. Presently imaging provides a limited ability to reliably distinguish between benign and malignant soft-tissue lesions. Thus, the primary goal for the imaging referral is to confirm the presence of a mass and to assess its extent for management plan. In an important subset of cases, characteristic clinical and imaging information can help to narrow the differential diagnosis. These characteristics include clinical history, lesion location, mineralization on radiographs and signal intensity (SI) characteristics on magnetic resonance (MR) images.

Many studies worldwide are there on the imaging features of STT on magnetic resonance and the relationships of single or combined features of the tumor, such as age, gender, size, depth, border, signal uniformity, and necrosis, with its benign or malignant nature. [3,4,7–10] However, the results of these studies were inconsistent. Therefore, we carried out this study to evaluate the role of magnetic resonance in the differential diagnosis of benign and malignant STTs.

Materials and Methods

During the period of May 2011 to November 2013, a retrospective study of 100 patients was carried out.

Study population: The study population consisted of patients referred from peripheral centres in Gujarat and neighbouring states of Madhya Pradesh and Rajasthan with suspected soft tissue tumor who came to our MRI centre. Many patients had already been investigated with x-ray, CT scan or ultrasonography.

Patient preparation and history: All patients were seen by appointment, except for the emergency cases. Relevant history of illness and significant clinical findings of all patients were recorded. Previous investigations (x-rays, CT-Scans etc.) were reviewed. Most of the patients were taken for examination without any pre-medication. In cases of uncooperative patients and young children sedatives were used under the supervision of the anesthetist. Relevant history regarding allergies and fitness for contrast study was obtained; the renal function tests were evaluated. For contrast injection the antecubital vein was cannulated with a 18 G intravenous catheter.

Consent: All patients were subjected to scanning after explaining the entire procedure and the risks involved. All patients were subjected to sign on consent form. They were made aware of the methodology in their own language and their queries answered. All studies were done in the presence of a radiologist with stand by anesthetic support.

Contrast: Patients were scanned on 0.4 Tesla Hitachi APERTO MRI Scanner. Contrast enhanced scans were performed in every cases. The contrast used in the study was Gadolinium-DTPA with dose of 0.1 ml mol/kg. In paediatric patients non-ionic MR contrast agent Omniscan (Gadodiamide injection) was used as intravenous injection at a dose of 0.2 mL/kg

Patient Inclusion and Exclusion Criteria: All patients diagnosed as having soft tissue tumors were included in this study. These included lesions of primary neoplastic etiology of soft tissue of whole body.

Following subsets were excluded.

1. Soft tissue tumors with inconclusive or inappropriate histological diagnosis.
2. Patients who already had taken treatment.
3. Patients who had recurrent or residual lesion after surgery.
4. Soft tissue lesions not included in WHO classification, like ganglion, abscess, neurogenic tumours.

MR characteristics of different sequences including the contrast-enhanced sequences were noted and recorded. The management decision, follow up, outcome and histopathological diagnosis whenever available were recorded.

The results of this study were analyzed and compared with other available studies in literature.

Results:

Table 1: Types of The Lesion

Type of tumor	No. of patients	Percentage
Benign	32	32%
Malignant	68	68%

In my study out of 100 patients, 68% cases were malignant and 32% cases were benign. More number of malignant lesions is due to our tertiary cancer institute.

Table 2: Final Diagnosis and Frequency of Distribution

Sr. No.	Final diagnosis	Total No. (%) of patients (n=100)	No. (%) in benign (n = 32)	No. (%) in malignant (n =68)
1.	Synovial sarcoma	23 (23%)	-	23 (33%)
2.	Liposarcoma	9 (9%)	-	9 (13.2%)
3.	Malignant fibrous hystiocytoma	6 (6%)	-	6 (8.8%)
4,	Epitheloid sarcoma	3 (3%)	-	3 (4.4%)
5.	Desmoids tumor	5 (5%)	5 (15.6%)	0 (0%)
6.	Planter fibromatosis	2 (2%)	2 (6.2%)	0 (0%)
7.	Fibroma	1 (1%)	1 (3.1%)	0 (0%)
8.	Pleomorphic sarcoma	7 (7%)	-	7 (10.3%)
9.	Myxoid sarcoma	4 (4%)	-	4 (5.8%)
10.	Lipoma	11 (11%)	11 (34.3%)	-
11.	Lymphangioma	1 (1%)	3.1%	-
12.	Haemangioma	3 (3%)	9.3%	-
13.	Leomyosarcoma	6 (6%)	-	8.8%
14.	Myxoma	2 (2%)	6.2%	-
15.	Leomyoma	2 (2%)	6.2%	-
16.	Dermatofibrosarcoma	3 (3%)	-	4.4%
17.	Fibrosarcoma	3 (3%)	-	4.4%
18	Angiofibroma	2 (2%)	6.2%	-
19	Glomus tumor	1 (1%)	3.1%	-
20.	Benign fibrous hystiocytoma	1 (1%)	3.1%	-
21	Rhabdomyosarcoma	3 (3%)	-	4.4%
22	Clear cell sarcoma	1 (1%)	-	1.4%

Most frequent malignant tumor was synovial sarcoma 21% and most frequent benign tumor was lipoma 11%.

Intramuscular Liposarcoma (Case-44)

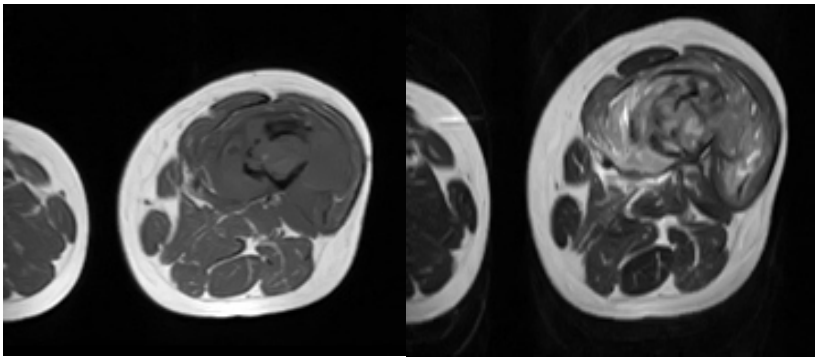

Figure 1: T1W-AXIAL Bone involvement T2W-AXIAL

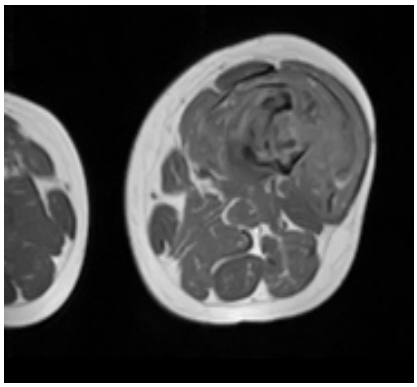

Figure 2: T1w AXIAL heterogeneous enhancement

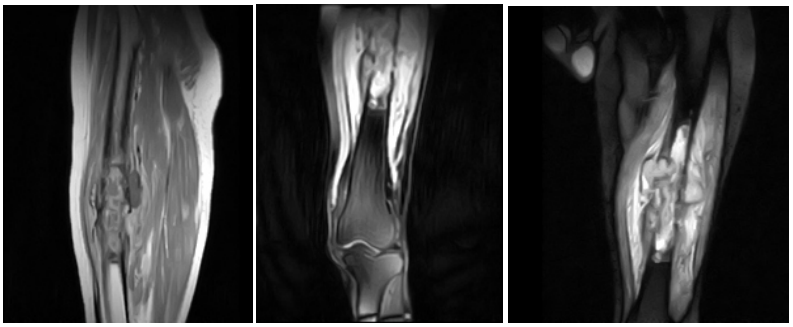

Figure 3: T1W-SAG CONTRAST COR contrast FAT SAT STIR-COR

Malignant Fibrous Hystiocytoma MFH (Case-96)

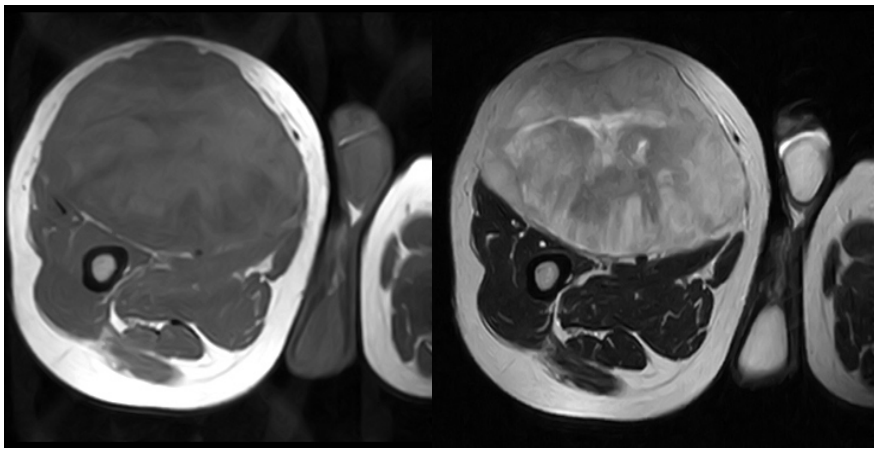

Figure 4: T1W-AXIAL T2W-AXIAL

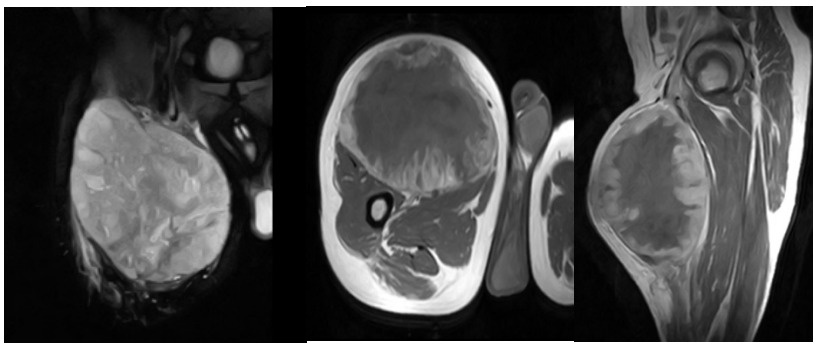

Figure 5: STIR-CORONAL T1W AXIAL (post contrast) T1W-SAG (Post contrast) Arrow showing necrosis and Intralesional necrosis

Table 3: Symptoms Distribution

Symptoms	Benign No/percentage of benign	Malignant No/percentage of malignant	Total No/percentage of total
Pain	8(25%)	63(92%)	71(71%)
Swelling	26(81.2%)	33(48%)	59(59%)
Other	5(15.6%)	22(32%)	27(27%)

Most common symptom was pain followed by swelling. Pain is more common in malignant lesion 95% as compared in benign 25%. Other symptoms include numbness, parasthesia, heaviness and discoloration. Sensitivity and specificity of most common symptom (pain) in malignant lesion were described as below.

Table 4: Age Distribution

Age In Years	Malignant		Benign		
	M	F	M	F	Total
0-1		0	0	1	1
1-10	5	0	1	1	7

11-20	7	1	2	1	11
21-30	5	7	2	0	14
31-40	10	6	3	5	24
41-50	5	3	5	1	14
51-60	5	1	5	2	13
61-70	4	1	1	1	7
71-80	5	3	1	0	9

In demographic study youngest age was 1 year female having angiofibroma and oldest was 80 years male having synovial sarcoma. Most common age group over all was 31-40 years 24%. Among malignant and benign most common age group was 31-40 years, 13% among malignant and 11% among benign. Benign lesions were more common in female and malignant lesions were more common in male.

Table 5: Site Distribution

Site	Benign NO/percentage of benign	Malignant no/percentage of malignant	Total
Upper limb	7(21.8%)	16(23.5%)	23(23%)
Lower limb	16(50%)	48(70%)	64(64%)
Adbomen	-	1(1.4%)	1(1%)
Back	3(9.3%)	-	3(3%)
Head and neck	6(18.7%)	3(4.4%)	9(9%)

Tumors are more common in lower limb 64%. Both malignant and benign tumors are more common in lower limb, 48% and 16% respectively. Least common site is abdomen 1%.

Table 6: Margins of The Tumor

Margins	Benign No/percentage of benign	Malignant No/percentage of malignant	Total cases no/percentage of total		
Well-defined	27(84%)	28(41.1%)	55(55%)	49%	NPV
Ill-defined	5(15.6%)	40(58.8%)	45(45%)	89%	PPV
	84%	59%			
	Specificity	Sensitivity			

Statistics shows that ill-defined margins has higher sensitivity, specificity, PPV and NPV predicting malignancy and p value suggest there is significant difference among the malignant and benign lesions(P value=0.001)

Table 7: Extent of the Lesion

Extension and involvement of lesion	Benign No/percentage of begin	Malignant No/percentage of malignant	Total cases no/percentage of total
Osseous	2(6.2%)	15(22.05%)	17(17%)
Neurovascular bundle	4(12.5%)	25(36.7%)	29(29%)
Joint	1(3.1%)	8(11.7%)	9(9%)

Table 8: Osseous involvement

Osseous involvement					
	Malignant	Benign			
Yes	15	2	17	88%	PPV
No	53	30	83	36%	NPV
	68	32	100		
	22%	94%			
	Sensitivity	Specificity			
P=0.049622(significant)					

Table 9: Neurovascular Bundle Involvement

Neurovascular bundle involvement					
	Malignant	Benign			
Yes	25	4	29	86%	PPV
No	43	28	71	39%	NPV
	68	32	100		
	37%	88%			
	Sensitivity	specificity			
P=o.012615(significant)					

Osseous and neurovascular involvement is more common in malignant tumors that are 22% and 36.7% respectively among the malignant. Total osseous involvement in study was 17% and neurovascular involvement was 29%.Statistics shows that osseous and neurovascular involvement have higher specificity and PPV predicting malignancy and p value suggest there is significant difference among the malignant and benign lesions.

Table 10: Peritumoral Edema

Peritumoral Edema	**Malignant**	**Benign**	**Total cases no/percentage of total**		
	No/percentage of malignant	**No/percentage of benign**			
Positive	48	7	55(55%)	87%	PPV
Negative	20	25	45	56%	NPV
	68	32			
	71%	78%			
	Sensitivity	Specificity			

Statistics shows peritumoral edema is more common in malignant lesions and has higher sensitivity, specificity, PPV and NPV predicting malignancy and p value suggest there is significant difference among the malignant and benign lesions.(P=<0.001(significant).

Table 11: Size of the Lesion

Size Of The Lesion	**Malignant**	**Benign**	**Total cases no/percentage of total**		
	No/percentage of malignant	**No/percentage of benign**			
≥ 8CM	40(58.8%)	10(31.2%)	50(50%)	73%	PPV
<8 CM	28(42.2%)	22(68.7%)	50(50%)	44%	NPV
	68	32			
	59%	69%			
	Sensitivity	**Specificity**			
P=0.01					

50% tumors were >8 cm in size and 50% were <8 cm size. Size >8 cm is more frequently seen in malignant than in benign that are 58.8% and 42.2% respectively. Size > 8 cm has higher specificity and PPV suggesting malignancy and p value suggest that size >8 cm shows significant difference among the malignant and benign lesion.

Table 12: Multiplicity

Multiplicity of lesion	**Malignant**	**Benign**	**Total cases no/percentage of total**		
	No/percentage of malignant	**No/percentage of benign**			
Yes	4(5.8%)	6(18.7%)	10(10%)	40%	**PPV**
No	64	26	90	28%	**NPV**
	68	32			
	5%	81%			
	Sensitivity	Specificity			
P=0.045412133(significant)					

Multiplicity is more commonly seen in benign lesions than malignant 18.7% and 5.8% respectively. Very low sensitivity predicting malignancy but higher negative predictive value (NPV).

Table 13: Intralesional Necrosis

Malignant	**Benign**	**Total cases no/percentage of total**		
No/percentage of malignant	**No/percentage of benign**			
27	5(15.6%)	32	84%	PPV
41	27(39.7%)	68	40%	NPV
68	32(32%)			
40%	84%			
Sensitivity	**Specificity**			

Intralesional necrosis more frequently seen in malignant than in benign that are 39.7% and 59.6% respectively. Necrosis has higher specificity and PPV suggesting malignancy and p value suggest that size >8 cm shows significant difference among the malignant and benign lesion.

Table 14: Intralesional Haemorrhage

Intralesional Haemorrhage	Malignant	Benign	Total cases no/percentage of total		
	No/percentage of malignant	No/percentage of benign			
Yes	20(29.4%)	6(18.75%)	26(26%)	77%	**PPV**
No	48	26	74	35%	**NPV**
	68	32			
	29%	81%			
	Sensitivity	**Specificity**			
P=0.2568 (not significant)					

Total 26% cases showed Intralesional haemorrhage 18.75% benign and 29.4% malignant, though higher frequency in malignant lesion it has lower sensitivity predicting malignancy and p value suggest that haemorrhage has no significant difference among the malignant and benign lesions.

Table 15: Intralesional Fat

Intralesional Fat	Malignant	Benign	Total cases no/percentage of total		
	No/percentage of malignant	No/percentage of benign			
Yes	14(20.5%)	10(31.25%)	24(24%)	58%	**PPV**
No	54	22	76	29%	**NPV**
	68	32			
	21%	69%			
	Sensitivity	**Specificity**			
P=0.24 (not significant)					

Total 24% case showed Intralesional fat. This feature not significantly associated with malignancy and p value suggest that they do no showed significant difference in malignant and benign lesions.

Table 16: Intralesional Calcification

Intralesional Calcification	Malignant	Benign	Total cases no/percentage of total		
	No/percentage of malignant	No/percentage of benign			
Yes	5(7.3%)	4(12.5%)	9(9%)	55.6%	**PPV**
No	63	28	91	31%	**NPV**
	68	32			
	7%	88%			
	Sensitivity	**Specificity**			
P=0.1404 (not significant)					

Total 9% cases showed Intralesional calcification. These two features not significantly associated with malignancy and p value suggest that they do no showed significant difference in malignant and benign lesions.

Table 17: Capsule

Capsule	Malignant	Benign	Total cases no/percentage of total		
	No/percentage of malignant	No/percentage of benign			
Yes	7(10.2%)	12(37.5%)	19(19%)	13%	PPV
No	61	20	81	25%	NPV
	68	32			
	10%	63%			
	Sensitivity	Specificity			
P=0.0012 (significant)					

Capsule is more commonly observed in benign lesion than in malignant lesion and significant difference among them. It has low sensitivity and specificity in predicting malignancy.

Discussion

In this study, most common age group over all was 31-40 years (24%). Among malignant and benign most common age group was 31-40 years, 13% among malignant and 11% among benign. Benign lesions were more common in female and malignant lesions were more common in male. In study by Chen et al [8] benign were in < 20 year & malignant were in >20 years & study by Kransdorf MJ [5] et al it was in 16-20 years age group. In our study most common site both for benign & malignant was upper limb, In study by Chen et al [8] benign tumors were more common in lower

limb & malignant were in upper limb. In our study ill-defined margins has higher sensitivity, specificity, PPV and NPV predicting malignancy and p value suggest there is significant difference among the malignant and benign lesions (P value=0.001), in study by Bongartz et al [11], Benign tumors are well delineated and, malignant tumors have rather ill-defined margins, however, reported that aggressive sarcomas may have a pseudo capsule, whereas benign lesions, such as desmoid tumors may invade neighboring tissues. They concluded that the margin (well-defined vs infiltrating) of soft tissue mass on MRI was of no statistical relevance in the prediction of malignancy.

In our study osseous involvement was 6% in benign & 22% in malignant, in a study by crim et al [12] it was 2% in benign & 6 %in malignant. In study by Berquist et al [13] it was 47% in benign & 43%in malignant. This difference may be attributed to selection bias. In our study Neurovascular bundle involvement predicting malignancy was having 37% sensitivity & 88% specificity, which was correlating with study by Chen et al [8] with 37.1% sensitivity & 73% specificity. In our study Peritumoral edema predicting malignancy was having 71% sensitivity & 78% specificity, in a study by Chen et al [8] with 88% sensitivity & 36.4% specificity. In a study by Detir et al [10] with 95% sensitivity & 50% specificity, Finding did not much correlate with other studies because peritumoral edema is quite subjective and has more inter observer bias.

In our study Size(>8cm) of the lesion predicting malignancy was having 59% sensitivity & 69% specificity, which was correlating with study by Chen et al8 with 83% sensitivity & 72% specificity & study by Tung et al [14] with 74% sensitivity & 59% specificity. In our study necrosis predicting malignancy was having 40% sensitivity & 84% specificity, which was correlating with study by Chen et al [8] with 45.9% sensitivity & 90.9% specificity. In our study intralesional hemorrhage was seen in 19% benign & 29 % malignant tumours, which was correlating with study by Chen et al [8] with 13% benign & 29 % malignant tumors with intralesional hemorrhage.

As per Kransdorf et al [15] Intratumoral hemorrhage is a rare finding, which can be observed in both benign and malignant lesions, and is difficult to differentiate from nontumoral soft tissue hematoma. In our study capsule predicting malignancy was having 10% sensitivity & 90% specificity, which was not correlating with study by Chen et al [8] with 27.4% sensitivity & 71.4% specificity , it may be due to inter observer bias or tumor related factors.

Parameters which are most consistently associated with malignancy with higher sensitivity, specificity and PPV are size >8cm, T2w heterogeneous hyperintensity, heterogeneous contrast enhancement, osseous and neurovascular involvement, peritumoral oedema, Intralesional necrosis and ill-defined margins. Parameters which are not significantly associated with malignancy are capsule, Intralesional haemorrhage, fat, calcification, septations and multiplicity.

Conclusion:

MRI is the modality of choice for evaluation of soft tissue tumors.& is highly sensitive in detection of soft tissue tumors all most 100%.It is a well-established imaging tool for the detection and local staging of soft-tissue tumors. It is highly accurate in determining the location, nature and characteristics of the lesion MR imaging has an important role in determining the origin of these lesion in defining their extent and relation to adjacent structures.

It is excellent modality to assess operability by identifying osseous, neurovascular bundles and joint space involvement by soft tissue tumors. Sensitivity of MRI to diagnose malignant lesions as malignant is 86.7% and sensitivity of MRI to diagnose benign lesions as benign is 90%. In this study MRI has slightly higher sensitivity to diagnose benign lesion as benign.

MR images can be particularly useful for characterizing lesions that do not require imaging follow-up or biopsy by pattern recognition such as lipoma and haemangioma. No single characteristic consistently allowed distinction of benign from malignant tumors. MRI findings of soft tissue tumors not correlated well with histopathological findings. It must be emphasized that MR imaging cannot completely distinguish benign and malignant lesions and when radiologic evaluation is nonspecific.

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