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To Assess The Value Of Diffusion Weighted MR Imaging Over Standard MR Imaging At 3.0 Tesla In Differentiating A Malignant From Benign Soft Tissue Tumours Of Extremities Taking Histopatholgy As Gold Standard Findings In SMS Medical College, Jaipur In 2018-2019

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Abstract

Background: The purpose of this study was to assess soft tissue tumour of the extremities with diffusion-weighted echo-planar MR imaging at 3.0 T

Methods: Hospital based cross-sectional and quantitative study conducted on Department of Radiodiagnosis, Department of Orthopaedics, Department of Surgery, Department of Oncology and Department of Medicine, SMS Hospital, Jaipur, Rajasthan. After approval from institutional ethical committee. Patient selected after applying inclusion and exclusion criteria. Prior to examination, written and informed consent was taken from the patient/guardian. Prior to MRI and biopsy of soft tissue tumours, a proper precaution was taken and patient was excluded from study if MRI is contraindicated due to any reason. All data were analyzed by EPI-info software.

Results: According to the final pathology results, the best cutoff for the mean ADC value was calculated as 950mm^2/s with a sensitivity of 100.00%, a specificity of 100%.

Conclusion: We concluded that addition of DWI to standard MRI improves the diagnostic accuracy for differentiation of malignant from benign soft tissue tumours at 3.0 T.

Keywords: MRI, DWI, ADC, Benign, Malignant.

Introduction

Diffusion-weighted MR imaging has been performed to evaluate musculoskeletal tumours.[1] These studies indicate that diffusion-weighted MR imaging may be useful for differentiating between malignant and benign soft tissue tumours[2], evaluating soft tissue infection [3] and monitoring patients with a soft tissue tumours after therapy.[4]

In the case of some soft tissue tumours, such as lipomas, a definitive diagnosis is not difficult using conventional MRI only because of their characteristic fatty component. The diffusion-weighted procedure

provides a different tissue contrast for the diseased tissue as compared from conventional MR techniques.[5]

The random Brownian motion of water protons determines the DWI signal intensity, and the quantitative assessment of water diffusion in the tissues is expressed as apparent diffusion coefficient (ADC) values.[6]

Diagnostic accuracy of standard MRI for distinguishing malignant and benign soft tissue tumours has been reported with a wide range (50–85 %)[7]

Although the usefulness of DWI for assessing soft-tissue tumours have been widely investigated, there are not many publications that separately evaluated the usefulness of DWI for soft tissue tumours.[8]

There have been inconsistent reports using diffusion-weighted imaging (DWI) at 1.5 T for differentiation of malignant from benign soft tissue tumours.[9]

Therefore, correlation of quantitative analysis and qualitative analysis on DWI with standard MRI could help differentiate between malignant and benign soft tissue tumours.

The purpose of this study was to assess soft tissue tumour of the extremities with diffusion-weighted echo-planar MR imaging at 3.0 T

Material & Methods

Study Area: Department of Radiodiagnosis, Department of Orthopaedics, Department of Surgery, Department of Oncology and Department of Medicine, SMS Hospital, Jaipur, Rajasthan

Study Type: Hospital based cross-sectional and quantitative study

Study Design: Validational type of observational study.

Study Duration: Data collection for study was start after approval from the institutional research and review board, up to June 2019 or till sample size is achieved, whichever, is earlier. Then it was take another 2 months to process the data and write the thesis.

Study Tool: Pre-tested, pre-designed proforma will be used to collect data.

Equipment: Phillips MRI 3.0 T Ingenia machine.

Study Universe: Patients presenting with a soft tissue lump and referred to Department of Radiodiagnosis and Modern Imaging for imaging and biopsy.

Sample Size: Sample size is calculated at 0.05 alpha error and 80% power assuming 97% sensitivity of combined diffusion weighted imaging and standard MRI and prevalence of malignancy 35.6% among soft tissue tumours. At 7.5% absolute allowable error sample size is found 35 patients of soft tissue tumours.

So, for study purpose, 35 patients were taken.

Statistical Analysis: Data were expressed in terms of sensitivity and specificity of both modalities with appropriate and necessary tabular presentation.

Diagnostic accuracy of both the modalities was calculated. Quantitative data was analyzed by mean values and SD. Qualitative data was analyzed in terms of percentage and proportion. Difference in proportion was analyzed with Chi Square test and difference in mean will be analysed with unpaired 'T' test. For significance, P value less than 0.05 was considered significant.

Sampling Technique: Every eligible case will be included in the study.

Inclusion Criteria

- Patients suspected to have clinically diagnosed soft tissue tumours.
- Those who give written and informed consent to be included in study.
- Age 18 – 70 years.

Exclusion Criteria

- Patient having contraindications of MRI- Metal or internal metal objects near critical structures, Pacemakers and devices attached to batteries, surgical staples, patients with claustrophobia.
- Patients having contraindications for biopsy.
- Patients unwilling to give consent.
- Bone tumour and lipoma.

Methodology

- After approval from institutional ethical committee,
- Patient selected after applying inclusion and exclusion criteria.
- Prior to examination, written and informed consent was taken from the patient/guardian.
- Prior to MRI and biopsy of soft tissue tumours, proper precautions was taken and patient was excluded from study if MRI is contraindicated due To Any Reason.

Technique

MRI protocols in this study included longitudinal fat suppressed T2-weighted turbo spin-echo (TSE) sequence:

Sagittal/Corona/ Axial T1: weighted TSE sequences with and without contrast and fat suppression

Sagittal/Coronal/ Axial T2: weighted TSE sequences with and without fat suppression

GRE: DWI sequence in the axial plane along with b values of 0/500/1000

Observations

62.86% cases belong to 31-45 years age group, followed by 28.57% in 46-60 years age group, 5.71% in less than 30 years age group and 2.86% in more than 60 years age group. 54.29% cases were male and 45.71% cases were female.

Table 1: Histopathological diagnosis wise distribution

Histopathological diagnosis	No of patients	Percentage
Benign	14	40
Malignant	21	60
Total	35	100

In present study, 60% cases were malignant tumour and 40% cases were benign.

Table 2: MRI findings

MRI finding	T1				T2			
	Benign		Malignant		Benign		Malignant	
	No	%	No	%	No	%	No	%
Hypo-intense	9	64.28	3	14.29	11	78.57	0	0
Hyper-intense	2	14.28	18	85.71	1	7.14	21	100
Iso-intense	3	21.42	0	0.00	2	14.28	0	0
Total	14		21		14		21	
p-value	0.001(S)				0.001(S)			

In present study, on T1 WI out of 14 benign tumour, 9 cases were hypointense, 2 cases were hyperintense and 3 cases were isointense. In malignant tumour 18 cases were hyperintense and 3 cases were hypointense.

On T2 WI out of 14 benign cases 11 cases were hypointense, 2 cases were isointense, 1 case hyperintense and out of 21 malignant cases all cases were seen hyperintense to adjacent muscles.

Table 3 : MRI findings

	T1				T2			
	Benign		Malignant		Benign		Malignant	
	No	%	No	%	No	%	No	%
Homogeneous	12	85.71	6	28.57	4	28.57	2	9.52
Heterogeneous	2	14.28	15	71.42	10	71.42	19	90.48
Total	14		21		14		21	
p-value	0.003(S)				0.314			

In present study, on T1 WI out of 14 benign tumour, 12 cases were homogeneous and 2 cases were heterogeneous. In malignant 6 cases were homogeneous and 15 cases were heterogeneous. On T2 WI out of 14 benign tumour, 4 cases were homogeneous and 10 cases were heterogeneous. In malignant 2 cases were homogeneous and 19 cases were heterogeneous.

Table 4 : MRI finding according intratumoural hemorrhage

Intratumoural hemorrhage	Benign		Malignant	
	No	%	No	%
Present	2	14.29	4	19.04
Absent	12	85.71	17	80.96
Total	14		21	
p-value	0.927			

In present study, out of 14 benign tumour 2 cases and out of 21 malignant tumour 4 cases showed intratumoural hemorrhage on GRE images.

Table 5 : Margin of the lesion on MRI

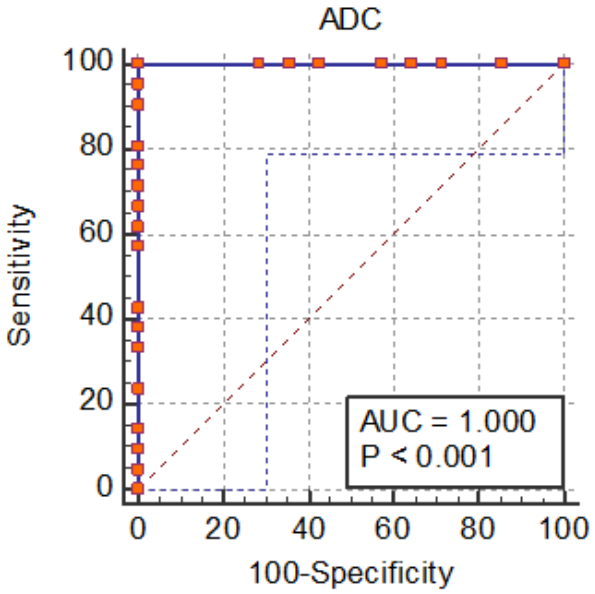
Margin	Benign		Malignant	
	No	%	No	%
Well defined	10	71.42	2	9.52
Ill defined	3	21.42	3	12.5
Partially defined	1	7.14	16	76.19
p-value	0.574			

In present study, out of 14 benign cases, 10 cases were well defined, 3 cases were ill defined and 1 case was partially defined. Out of 21 malignant 2 cases were well defined, 3 cases were ill defined and 16 were partially defined.

Table 6 : ADC level

ADC	Benign	Malignant
Mean	1316	938
SD	446	434
p-value	0.01(S)	

In present study mean ADC level was 1316±446 in benign tumour and 938±434 in malignant tumour.



According to the final pathology results, the best cutoff for the mean ADC value was calculated as 950mm^2/s with a sensitivity of 100%, a specificity of 100%.

Discussion

MRI is a well-established tool for the detection and local staging of soft-tissue tumours. However, its ability to differentiate between benign and malignant soft-tissue lesions has been found to vary widely. Using morphological criteria for benign lesions such as smooth well-defined margins, small size and homogeneous SI, particularly on T_2WI, MRI was reported to be able to differentiate >90% of benign from malignant masses.[10] Another study, however, noted that malignant lesions may appear as smoothly margined homogeneous masses and that MRI could therefore not reliably distinguish benign from malignant processes.[11]

MR findings have been evaluated individually or together for their ability to differentiate benign from malignant lesions. For example, larger size has been associated with greater heterogeneity and a higher likelihood of malignancy, with only 5% of benign soft-tissue tumours >5 cm in diameter. In addition, most malignant tumours are deeply located, compared with only about 1% of all benign soft-tissue tumours.[12]

Evaluation of MR images by experienced radiologists with a centralised approach has been found to yield better diagnoses of soft-tissue tumours. However, many radiologists or clinicians responsible for treating patients with soft-tissue lesions in initial practice may be non-experts in the diagnosis of soft-tissue tumours.

DWI is a functional MRI technique and can be incorporated into routine MRI protocols with little additional scanning time, resulting in a non-invasive method for the evaluation of STTs based on their histological composition[13].

DWI and ADC mapping rapidly produce quantitative information about STT cellularity without contrast administration.

Several studies demonstrated the potential of diffusion weighted MR imaging in evaluation of soft tissue masses. One study reported that the mean ADC value of benign lesions ($1.71\times10^{-3}mm^2/s$) is significantly higher than that of malignant tumours ($1.08 \times 10^{-3}mm^2/s$).[12] Another study added that the mean ADC value of malignant tumours is significantly lower than that of benign tumours. On the other hand, another study conducted on 29 lesions found no significant difference between these two groups.[13] The mean ADC value of chronic haematoma was significantly higher than that of malignant soft tissue tumours (P=0.01) without any overlap . In this work, the mean ADC value of benign soft tissue masses was significantly higher than that of malignant tumours, despite there being some overlap in their ADC values. The difference in the ADC values is attributed to the size of the extracellular space. Malignant soft tissue tumours tend to have a lower ADC value due to increased tumour cell packing, resulting in restriction of Brownian motion in the extracellular space. On the other hand, benign soft tissue masses have less restricted extracellular space, allowing spin dephasing and loss of signal on diffusion weighted images.

The mean ADC level 1316±446 in benign tumour and 938±434 in malignant tumour. The mean ADC values of malignant STTs were significantly lower than those of benign STTs. These results are consistent with those of Van Rijswijk [14], who found that benign lesions have a mean ADC value of 1.71×10^{-3} mm^2/s, which was significantly higher than that of malignant tumours (1.08×10^{-3} mm^2/s).

Similarly, Neubauer et al.[15] reported ADC values of $0.78\pm0.45\times10^{-3}$ mm^2/s and $1.71\pm0.75\times10^{-3}$ mm^2/s in malignant and benign tumours, respectively ($P<.001$).

According to the final pathology results, the best cutoff for the mean ADC value was calculated as 950 mm^2/s with a sensitivity of 100%, a specificity of 100% in our study.

Neubauer et al.[15] reported an area under the ROC curve of 0.89 with a specificity of 91% and a sensitivity of 90%.

Conclusion

We concluded that addition of DWI to standard MRI improves the diagnostic accuracy for differentiation of malignant from benign soft tissue tumours at 3.0 T.

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