ORIGINAL ARTICLE

Diagnostic Accuracy of Qualitative Diffusion Weighted MRI of Spine in Differentiating between Benign and Malignant Vertebral Fractures Taking Histopathology as Gold Standard

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ABSTRACT

Background: Qualitative diffusion weighted magnetic resonance imaging of spine can be used to determine the nature of lesion. Current study was carried out to find the diagnostic accuracy.
Aim: To determine the diagnostic accuracy of qualitative diffusion weighted magnetic resonance imaging of spine in differentiating between benign and malignant vertebral fractures.
Study duration: 1st July 2016 to 30th June 2017.
Methods: 280 patients with vertebral fractures on digital x ray of spine showing decreased vertebral body height, reduced disc intervertebral disc space or collapsed vertebra as reported by a radiologist were included. Magnetic resonance imaging of spine both plain and diffusion weighted Imaging was carried out. A single consultant radiologist reported the Vertebral Fracture as benign or malignant lesion without prior knowledge of biopsy results.
Results: Mean age was 42.61 ± 11.79. 156 patients (55.7%) were male and rest of 124 patients (44.3%) were female. 25 patients (8.9%) showed up with malignant lesion on MRI whereas 255 patients (91.1%) had benign lesion. 32 patients (11.4%) showed up with malignant lesion on histopathology whereas 248 patients (88.6%) had benign lesion. For whole cohort, we came up with sensitivity53.12%, specificity 96.77%, positive predictive value 68%, negative predictive value 94.11% and diagnostic accuracy 91.78%.
Conclusion: This study concluded that diagnostic accuracy of qualitative diffusion weighted magnetic resonance imaging of spine in differentiating malignant and benign vertebral fractures is acceptable at current sample size.
Keywords: Magnetic resonance imaging, vertebral fractures, sensitivity.

INTRODUCTION

Magnetic resonance imaging (MRI) is the mainstay of diagnosis, staging and follow-up of many musculoskeletal disorders[1-3]. Conventional spin-echo, proton density and short tau inversion recovery (STIR) MRI sequences rely on the differing T1 and T2 relaxation characteristics of various pathological processes[4-7]. Interpretations of the images are done qualitatively with analyses of signal intensity and morphology of anatomical structures on each of these sequences. However, some musculoskeletal diseases may have similar imaging characteristics, limiting the specificity of analyses, which can reduce diagnostic confidence[8]. Diffusion-weighted magnetic resonance imaging (DWI) is a recent addition to the musculoskeletal MR sequences[9].

First described by Baur, vertebral compression fractures can be differentiated on DWI by qualitative assessment of the signal characteristics, with benign osteoporotic fractures returning a hypo- or isointense signal compared to hyperintense signal from fractures secondary to tumor or metastases.[10-12] The signal intensity of DWI relies on the stochastic Brownian motion, or self-diffusion, of water molecules at a microscopic level within tissues[13].

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Benign osteoporotic compression fractures are common in elderly patients and also occur in one third (33%) of cancer patients. Differentiation between benign and malignant vertebral compression fractures is a problem commonly encountered in daily clinical practice. Particularly in elderly patients who only have a minor trauma history or who withhold any trauma history, it is important to differentiate between malignant and acute osteoporotic compression fractures. The results of current study will help us to determine the better modality for defining metastatic bone lesion by magnetic resonance imaging of spine.

As there was no local study available, this study will generate baseline data for local population. This study will provide us the evidence that should DW sequences be added to conventional imaging protocols in clinical routine to help less experienced radiologists differentiate between acute osteoporotic and malignant spinal fractures or not.

MATERIALS AND METHODS

This descriptive, cross sectional study was done on 280patients with vertebral fractures on digital x ray of spine showing decreased vertebral body height, reduced disc intervertebral disc space or collapsed vertebra as reported by a radiologist and age between 16-60 years of both genders, who were referred by clinician to the Radiology department of Military Hospital, Lahore for diffusion

weighted magnetic resonance imaging were selected for the study. Patients with history of caries spine, claustrophobic patients and prosthesis/metal implants were excluded from the study.

After taking informed consent and relevant history, all the subjects were undergone magnetic resonance imaging of spine both plain and diffusion weighted Imaging with a 1.5-T MR unit and a spine-array surface coil. The conventional MR imagingprotocols included a sagittal T1-weighted turbo spin-echo sequence, sagittal T2- weighted turbo spin-echo sequences with and without fat suppression, and an axial T2-weighted turbo spin-echo sequence. An axial T1- weighted turbo spin-echo sequence and axial and sagittal fat-suppressed contrast material–enhanced T1-weighted sequences was performed. A single consultant radiologist reported the vertebral Fracture as benign or malignant lesion without prior knowledge of biopsy results. Data was collected on structured proforma.

Data collected was entered and analyzed in the SPSS version 20. Mean with standard deviation was calculated for quantitative variables like age, and frequency and percentage in case of categorical variables like gender and benign & malignant lesions. A 2 × 2 table was generated and sensitivity, specificity, PPV, NPVand accuracy were labeled for diffusion weighted MRI in differentiating benign and malignant lesions taking histopathology as gold standard. Comparison was made using chisquare test. A p value < 0.05 was considered significant.

RESULTS

Age range in this study was from 16 to 60 years with mean age of 42.61 ± 11.79years. Majority of the patients 151 (53.9%) were below 45 years of age. In our study population 156 patients (55.7%) were male and rest of 124 patients (44.3%) were female. In our study group 227 patients (81.1%) had duration of disease 6 to 12 months while 53 patients (18.9%) had 13 to 24 months. 25 patients (8.9%) showed up with malignant lesion on MRI whereas 255 patients (91.1%) had benign lesion. 32 patients (11.4%) showed up with malignant lesion on histopathology whereas 248 patients (88.6%) had benign lesion. When we cross tabulated results of lesion on MRI and lesion on histopathology, results came up significant with p value 0.001. 17 patients were malignant and 15 were benign on both MRI and histopathology (Table I).We came up with sensitivity 53.12%, specificity 96.77%, positive predictive value 68%, negative predictive value 94.11% and diagnostic accuracy 91.78% (Figure I).

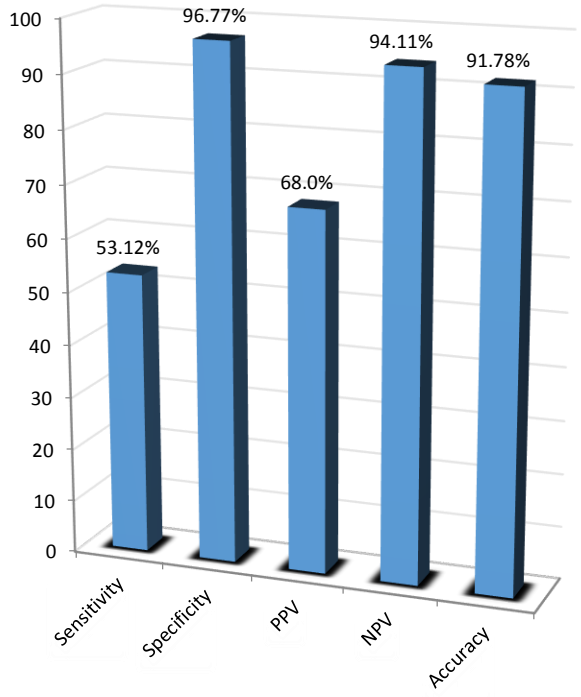
Table-I: MRI and histopathology findings.

	Positive result on Histopathology	**Negative result on Histopathology**
Positive result on MRI	17**(TP)***	08**(FP)*****
Negative result on MRI	15**(FN)****	240**(TN)******

P VALUIE 0.0001

*-TP=True positive **-FP=False positive ***-FN=False negative ****-TN=True negative

Figure I: Diagnostic accuracy of qualitative diffusion weighted magnetic resonance imaging of spine in differentiating between benign and malignant vertebral fractures



DISCUSSION

Magnetic resonance imaging (MRI) is the mainstay of diagnosis, staging and follow-up of many musculoskeletal disorders.[1-3] Differentiation between benign and malignant vertebral compression fractures is a problem commonly encountered in daily clinical practice. Particularly in elderly patients who only have a minor trauma history or who withhold any trauma history, it is important to differentiate between malignant and acute osteoporotic compression fractures.

In our study to determine the diagnostic accuracy of qualitative diffusion weighted magnetic resonance imaging of spine in differentiating between benign and malignant vertebral fractures taking histopathology as gold standard, for whole cohort, sensitivity was 53.12%, specificity 96.77%, positive predictive value 68%, negative predictive value 94.11% and diagnostic accuracy was 91.78%. It implies that results are highly specific but have lesser sensitivity.

Our results are comparable with previous studies. Another study showed With conventional and DW MR imaging combined, sensitivity, specificity, and accuracy were 100%, 97%, and 98% for all three readers.[9] an older study by Park et al has labeled the sensitivity 42% while specificity 95%[14]. In a study, qualitative DWI showed the best performance for distinguishing between benign and malignant fractures showing sensitivity of 100%; specificity, 88.5%; accuracy, 93.5%[13].

280 patients were included in our study population with mean age of 42.61±11.79 ranged from 23 to 60 years. 151 patients (53.9%) had age below 45 years while remaining 129 patients (46.1%) had age either 45 years or above. It implies that spine diseases are common even in younger population. In our study population 156 patients (55.7%) were male and rest of 124patients (44.3%) were female. The difference may be due to health seeking behavior or hormonal protection. For age below 45 years, sensitivity was 70.58%, specificity 94.03%, positive predictive value 60%, negative predictive value 96.18 and diagnostic accuracy 91.39% for qualitative diffusion weighted magnetic resonance imaging of spine. Similarly for duration of disease less than 12 months, sensitivity was 51.72%, specificity 95.95%, positive predictive value 65.21%, negative predictive value 93.13% and diagnostic accuracy 90.31%.

In recent years, investigators have evaluated the role of diffusion-weighted (DW) imaging in the assessment of musculoskeletal disorders. One of the most widely researched disorders is vertebral compression fracture.[15] There have been inconsistent reports with regard to the differentiation of benign from malignant compression fractures with 1.5-T sagittal DW imaging[16]. In these studies, qualitative analysis for the evaluation of signal intensity characteristics at DW imaging was performed with or without quantitative analysis with measurement of apparent diffusion coefficients (ADCs)[17,18]. On study has shown the prevalence of osteoporotic compression fractures as 30.30% and sensitivity and specificity of diffusion weighted magnetic resonance imaging in differentiating osteoporotic and malignant compression fractures as 95.60% and 90.0% respectively[19]. Another study has shown the shown the sensitivity and specificity of diffusion weighted magnetic resonance imaging in differentiating osteoporotic and malignant compression fractures as 92% and 90% respectively[20].

CONCLUSION

It is concluded that diagnostic accuracy of qualitative diffusion weighted magnetic resonance imaging of spine in differentiating malignant and benign vertebral fractures is acceptable at current sample size. So, we recommend that magnetic resonance imaging (MRI) should be used as primary modality for differentiating malignant and benign vertebral fractures pre-operatively and thus proper management could be taken in these patients in order to reduce the morbidity and mortality of these particular patients.

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