DIAGNOSTIC ACCURACY OF DWI IN DIFFERENTIATION OF OSTEOPOROTIC COMPRESSION FRACTURE VS MALIGNANT COMPRESSION FRACTURE

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ABSTRACT:

Objective: To determine the value of adding diffusion weighted images DWI to a standard MRI protocol to differentiate acute osteoporotic and malignant compression fractures of spine at 1.5T MR Machine.

Methods: The study was conducted at the Radiology Department of Khyber teaching hospital, Peshawar from 1st January 2014 to 31st December 2015. Fifty patients with vertebral compression fractures who were diagnosed on X-ray were included. Diffusion weighted sequences and apparent diffusion coefficient images on a 1.5 T MR scanner were obtained in all patients to identify the cause of the vertebral compression fracture as benign or malignant. The observation was compared to histopathological findings.

Results: Diffusion weighted MR imaging was found to be 90% sensitive, 76% specific with positive predictive value of 97% and negative predictive value of 85% in differentiation of benign and malignant vertebral compression fractures.

Conclusion: DWI is a noninvasive accurate method to differentiate between benign and malignant compression fractures of spine.

Key Words: Osteoporotic compression fracture spine, Malignant Compression fracture, DWI, MRI.

INTRODUCTION

Non traumatic osteoporotic vertebral compression fractures are the most common clinical problem, especially in elderly population[1]. Most of them are asymptomatic and are detected incidentally[2,3,4]. Osteoporosis is the most common cause in this age group5. On the other hand, spine is also a common site of metastasis due to abundant vascularization and red bone marrow[6], resulting in pathological compression fracture[7].

Compression fractures due to malignant causes are also frequently seen in elderly population and differentiation between them is necessary for proper treatment planning and prognosis[8].

Baur and colleagues[9] introduced Diffusion Weighted MR imaging as non-invasive technique to differentiate between malignant and benign vertebral compression fractures by showing differences in signal intensities on T2 Weighted and diffusion weighted images.

The primary objective of this study was to evaluate the diagnostic value of diffusion weighted MR imaging (DWI) in differentiation between benign osteoporotic and malignant compression fractures, when added to standard MR protocol for imaging spine.

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MATERIAL AND METHODS

This prospective study was conducted at the Radiology Department of Khyber teaching hospital, Peshawar from 1st January 2014 to 31st December 2015. All patients presenting with radiological evidence of compression fracture of spine were included while patients with history of trauma, patients with clinical or radiological suspicion of infection of the spine and those with metal implants or cardiac pacemakers were excluded from the study. All patients were scanned in 1.5 Tesla MRI machine (Achieva, Phillips). Conventional MR sequences of spine (axial T1 and T2, saggittal T1 and T2, saggittal PD / fat saturation T2 sequences) and spin-echo DWI - saggittal sections were undertaken.

MR Images were interpreted by consultant radiologist. Diffusion weighted images were analyzed only qualitatively by comparing DWI signals in collapsed vertebra with normal bone marrow of other uninvolved vertebrae on all sequences. The lesions were characterized as focal or multiple with or without involvement of posterior element and soft tissue component. The signal intensities of fractured vertebra were visually compared with that of presumed normal vertebra on all sequences. (T1WI, T2WI, Fat suppressed sequences and DWI).

Signals were characterized as hypo-, iso-, or hyperintense relative to the presumed normal marrow of the adjacent vertebrae. The presence of iso or low signal in compressed vertebra is suggestive of a be-

nign cause, whereas hyper intense signal are highly suggestive of malignant lesion, without even taking the quantitative apparent diffusion coefficient (ADC) values. Percentages were calculated. Sensitivity, specificity, positive predictive value and negative predictive value were calculated for accuracy of DWI via SPSS software.

Final diagnosis was confirmed by biopsy (n=9), MRI follow up (n=15), Clinical follow up (n=11) and presence of unequivocal imaging features (n=15) like associated soft tissue mass, posterior elements and pedicles involvement and lesions in other vertebrae.

RESULTS

50 patients with vertebral compression fractures were included in the study. Mean age was 69 years with a range of 50-80 years (Table I). 68% were male and 32% were female as shown in table II. Table III and IV show frequency of distribution and signal intensities of osteoporotic and malignant compression fractures.

In 16/50 cases, an initial diagnosis of osteoporotic compression fracture was made based on DWI signals, appearing iso/hypointense. Later on, one case read as malignant compression (due to high signals on DWI) was found to be osteoporotic compression on follow up MR studies. On the other hand, 30/50 cases were initially diagnosed as malignant compression, appearing hyper intense on DWI; however, later on 3 cases appearing iso- hypointense on DWI were found to be osteoblastic metastasis on bone scan. Table V shows the sensitivity and specificity of DWI.

Fig 1: DW saggittal image showing compression collapse of D5 vertebra with restricted signals in D4, D5 and D6 vertebrae suggesting malignant compression.

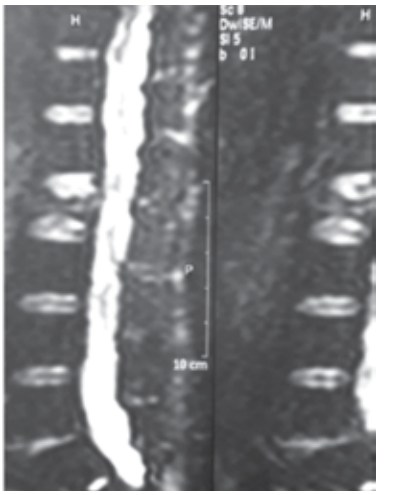

Fig 2: Compression fracture of L2 vertebral body showing facilitated diffusion in DWI images suggesting benign fracture.

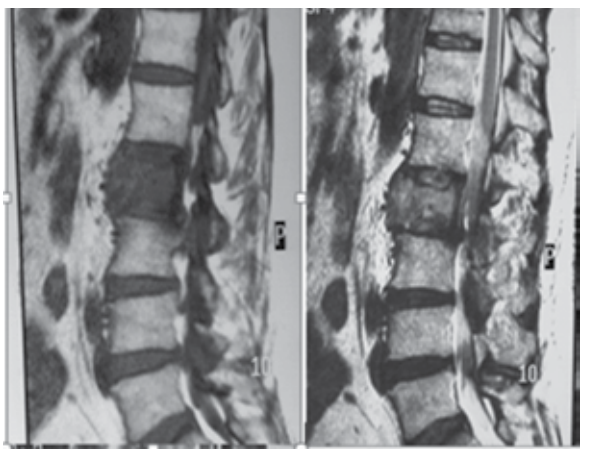

Figure 3 (a, b): T1W (a) and T2W (b) Saggittal Sequences showing hypointense expansile mass in L2 Vertebra with compression;

Figure 3 (c): Saggittal DW image showing restricted diffusion appearing hyperintense in comparison to the adjacent normal marrow of vertebrae.

Table I: Age distribution.

Minimum age (years)	Maximum age (Years)	Mean Age (years)
50	80	69.13

Table II: Gender distribution.

Gender	Frequency	Percentage
Male	34	68%
Female	16	32%
Total	50	100%

Table III: Distribution of type of fracture.

Type of Fracture	Frequency	Percentage
Osteoporotic Compression	17	34%
Malignant Compression	33	66%
Total	50	100%

Table IV: Signal Intensities on DWI.

Diagnosis	Signal Intensities on DWI		
	Hypointense	Isointense	Hyperintense
Malignant (n=33)	2	1	30
Osteoporotic (n=17)	13	3	1

Table V: Sensitivity and Specificity of DWI.

Sensitivity	90%
Specificity	76%
Positive Predictive value (PPV)	97%
Negative Predictive value (NPV)	85%

DISCUSSION

Vertebral compression fractures can be detected on plain radiographs of spine or computed tomography but differentiation between benign osteoporotic and malignant vertebral compression fractures relies mainly on MR Imaging features[10]. Since most bony metastases are hematogenous in origin, axial skeleton is the most common site of skeletal metastasis due to abundant vascularization and red marrow[11]. However, osteoporotic compression fracture is also a common occurrence in the spine in elderly population and can be confused with the metastasis. Since the prognosis and management differs in both cases, accurate diagnosis is important[10,12,13,14].

The primary objective of this study was to evaluate the specificity and sensitivity of adding Saggittal Diffusion Weighted Images to standard MRI Protocol to differentiate between osteoporotic and malignant compression fracture of the spine. Although conventional MR imaging has promising role in differentiating between benign and malignant cause of vertebral collapse, in few cases accurate diagnosis is not always possible especially in elderly population who are predisposed to osteoporotic as well as malignant compression fracture[7,13].

Involvement of posterior elements of vertebrae, multiplicity of the lesions and associated soft tissue masses in malignant disease process, while presence of fracture line and high signals in T2WI in osteoporotic compression fractures are helpful signs used for assessment in conventional MR Imaging[14,15]. However, sometimes confident diagnosis becomes difficult even in the presence of these signs. DWI images provide unique tissue characterization, complimentary to conventional MR sequences. It is sensitive to micro-structural changes, hence reduced mobility of water molecules due to tumor cell infiltration in pathological fracture results in high signal intensity compared with the normal bone marrow. On the other hand free mobility of water molecules in the interstitial space due to edema or hemorrhage in benign fracture results in low signal intensity in osteoporotic fracture[10,16,17,18].

Our study showed a high diagnostic accuracy of DWI in differentiating benign osteoporotic fracture from pathological fractures with sensitivity of 90%, specificity of 76%, PPV of 97% and NPV of 85%.These results were comparable to Bhugaloo et al10 showing sensitivity of 87%, specificity of 92%, PPV of 90% and NPV of 90% and slightly less than Fatima et a19 (sensitivity=92%, specificity=90%, PPV of 78%, NPV of 90%).

Limitations of our study were that:

- Pathological confirmation was not possible in all patients;
- Quantitative DW Analysis (ADC values) was not performed due to patients overload in Government Hospitals and poor technical help; and
- Sample size was small.

CONCLUSION

To conclude, addition of saggittal Diffusion Weighted Images with standard MR protocol improves the diagnostic accuracy to differentiate between osteoporotic and malignant compression fracture of spine.

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