ISSN: 0976-3031

*Available Online at http://www.recentscientific.com*

**CODEN: IJRSFP (USA)**

*International Journal of Recent Scientific Research*
*Vol. 9, Issue, 10(E), pp. 29391-29394, October, 2018*

**International Journal of Recent Scientific Research**

**DOI: 10.24327/IJRSR**

**Research Article**

# EFFICACY OF DWI OF SPINE TO QUANTITATIVELY DIFFERENTIATE BENIGN AND MALIGNANT FRACTURES

**Jeevika M.U., Niveditha Kodali*., Rajkeerthi.N., Chetana Kalburgi and Mahesh B.G**

Department of Radiodiagnosis, JJMMC, Davangere

**DOI: http://dx.doi.org/10.24327/ijrsr.2018.0910.2853**

**ARTICLE INFO**

***Article History:***

Received 4th July, 2018
Received in revised form 25th August, 2018
Accepted 23rd September, 2018
Published online 28th October, 2018

***Key Words:***

MRI-Magnetic Resonance Imaging
DWI-Diffusion weighted Imaging
ADC-Apparent diffusion coefficient
ROI-Region of Interest
HPE-Histopathological Examination

**ABSTRACT**

Magnetic resonance imaging has established a role in diagnostic work up of patients presenting with various spinal pathologies. DWI is a powerful adjunct to routine magnetic resonance evaluation, providing confidence in lesion detection and tissue characterization. Our present study focuses on diagnostic accuracy of diffusion weighted imaging technique in detection and characterization of traumatic versus pathological fractures using apparent diffusion coefficient maps..In this prospective study of 25 people, there were 13 malignant fracture/infiltration, 12 benign fractures . The malignant fracture/infiltration cases had low mean ADC value of 0.6 x 10-3mm2/s with restriction on DWI+ADC. A mean ADC value of 1.57 x 10-3mm2/s was seen in benign fractures cases with no obvious restriction .A diagnostic accuracy of 88% in malignant vs benign fractures was obtained. We conclude that DWI sequence with ADC mapping when added to routine array of MRI spine with analysis of DW images(qualitative study) and ADC values(quantitative study) enhanced the effectiveness and accuracy of MRI in the differentiation of benign vs malignant fractures



## INTRODUCTION

Conventional magnetic resonance (MR) imaging have shown good results in the differentiation of benign and malignant fractures. Differentiating benign and malignant vertebral compression fractures is very important in daily clinical practice Recent literature have shown addition of DWI showed promising results. DW-MRI and ADC values will increase diagnostic confidence in doubtful cases and decrease the need for biopsy .One of the unique advantages of DW-MRI is that the technique enables the quantitative ADC measurements of tissues. The majority of radiological tools for disease assessment are qualitative, relying on the visual interpretation of imaging features. However, quantitative imaging techniques are becoming increasingly important. The diffusion coefficients in lesions caused by malignant infiltrations are significantly lower than in benign osteoporotic and traumatic fractures. This difference can be explained by the structure of the cancerous tissue, containing a dense network of tumor cells, which restricts the self-diffusion of the water molecules. In benign lesions the interstitial volume in the edema is expected to be increased, leading to an increase of the self-diffusion in the lesion.[2]

## MATERIALS AND METHODS

### *Source of Data*

The main source of data for the study is patients from the following teaching hospital attached to Bapuji Education Association J.J.M. Medical College, Davangere.

- Bapuji Hospital
- Chigateri General Hospital
- Women and Child Health Care Hospital

Appropriate MR sequences and multiplanar imaging will be performed for every patient.

### *Technique*

Imaging will be done with 1.5 Tesla Philips Achieva Magnetic resonance imaging machine. Diffusion weighted imaging will be added to all the routine sequences done.

## METHOD OF COLLECTION OF DATA

***Study Period*:** 1year.

All patients referred to the department of Radio diagnosis with clinical history suspicious of fracture in a period of 1 year from

**Corresponding author:* **Niveditha Kodali**
Department of Radiodiagnosis, JJMMC, Davangere

October 2017 to October 2018 are subjected for the study. Based on our previous hospital records we got 20 cases of spinal fractures per year so we have included 25 cases as our study sample

***Inclusion Criteria***

***All age group patients suspected with***

- Patients presenting with acute neurological spinal deficit
- Suspected cases of spinal cord injuries/lesions

***Exclusion Criteria***

***The Study will Exclude***

***Patients with***

- Intracranial aneurysm clips or Intra-orbital metal fragments.
- Any electrically, magnetically or mechanically activated implants (including cardiac pacemakers, bio stimulators, neurostimulators, cochlear implants, and hearing aids).

***Mri Protocol***

- T1 W and T2W in 3 planes-AXIAL, SAGITTAL AND coronal Stir coronal
- T1 post contrast Dwi with adc

Patients diagnosed on MRI with DWI with benign r malignanat fracture will be subjected to HPE r followed up clinically to confirm the diagnosis

***Objective of Study***

To study the sensitivity and diagnostic accuracy of diffusion weighted imaging technique in detection and characterization of benign versus malignant fractures using apparent diffusion coefficient maps

***Interpretation***

DW-MRI gives unique information that reflects microstructural and functional alterations in tissues.[4] DWI provides a contrast that reflects the degree of self-diffusion of water molecules in a tissue. DW-MRI performed using b-values of 800-1,000 s/mm2 usually results in significant signal suppression of normal tissues or the background signal intensity, allowing foci of high signal intensity impeded diffusion of tumours to be more readily identified. ADC values are a measure of diffusion ability of molecules in the given tissue and give an idea of the composition of the given tissue. Typical values of the ADC in normal bone marrow are 0.2 to 0.5 x 10-3 mm2 /s.[3]A high ADC value means increased Brownian movement of molecules (which means no restriction), thereby suggesting less compactness of the given tissue.[1] . As the lesion contour can be more difficult to define on the ADC map, we draw the ROI on the b-value image, and then copy this onto the ADC map to record their values.

## RESULTS

In this prospective study of 25 people, there were 13 malignant fracture/infiltration, 12 benign fractures .The malignant fracture/infiltration cases had low mean ADC value of 0.6 x 10-3mm2/s with restriction on DWI+ADC.A mean ADC value of 1.57 x 10-3mm2/s was seen in benign fractures cases with no obvious restriction .A diagnostic accuracy of 88% in malignant vs benign fractures and 85% in infective spinal pathologies was obtained

**Table 1** Age Distribution of Type of Fractures

| Age groups (Yrs) | MMF | Benign | |
|---|---|---|---|
| | | BFOF | BFTF |
| 16 - 20 | 0 | 0 | 0 |
| 21 - 30 | 0 | 0 | 1 |
| 31 - 40 | 0 | 0 | 2 |
| 41 - 50 | 1 | 0 | 1 |
| 51 - 60 | 3 | 1 | 1 |
| 61 - 70 | 7 | 3 | 0 |
| 71 & above | 2 | 3 | 0 |
| Total | 13 | 7 | 5 |

***Age Distribution*:** The malignant and osteoporotic spinal pathologies were predominantly seen in the elderly i.e. 61-70 yrs. Traumatic spinal pathologies were seen more in the middle aged adults between 31-40 yrs.

**Table 2** Adc Values In Fractures

| | Mean ± SD | Range | Significance |
|---|---|---|---|
| MF | 0.68 ± 0.12 | 0.4 - 0.8 | MF v/s BF |
| BF | 1.58 ± 0.12 | 1.3 - 1.7 | MF v/s BF |

*Mean Adc Value:* In this study the mean ADC values for malignant spinal pathologies were arrived at 0.68, for benign spinal conditions it was 1.58

**Table 3** Dignostic Value of Adc With Hpe In Benign And Malignant Fractures

| Radiological diagnosis-adc | Hpe or clinical follow up | | Total |
|---|---|---|---|
| | BF | MF | |
| BF | 9 | 1 | 10 |
| MF | 2 | 13 | 15 |
| Total | 11 | 14 | 25 |

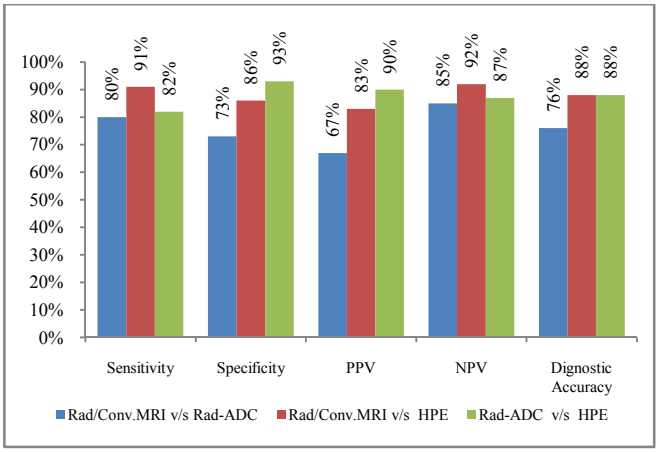
| Sensitivity | 9/11 | 82% |
|---|---|---|
| Specificity | 13/14 | 93% |
| PPV | 9/10 | 90% |
| NPV | 13/15 | 87% |
| Dignostic Accuracy | 22/25 | 88% |

Diagnostic accuracy of DWI with ADC values is arrived at 88% when ADC diagnosis is compared with gold standard HPE r clinical follow up

**Table 4** Diagnostic Accuracy Comparing Three Methods

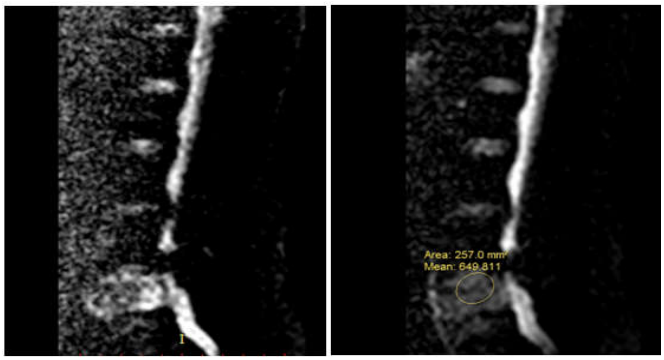
| | Rad/Conv.MRI v/s Rad-ADC | Rad/Conv.MRI v/s HPE | Rad-ADC v/s HPE |
|---|---|---|---|
| Sensitivity | 80% | 91% | 82% |
| Specificity | 73% | 86% | 93% |
| PPV | 67% | 83% | 90% |
| NPV | 85% | 92% | 87% |
| Dignostic Accuracy | 76% | 88% | 88% |

***Graph Showing Diagnostic Accuracy Comparing 3 Methods***



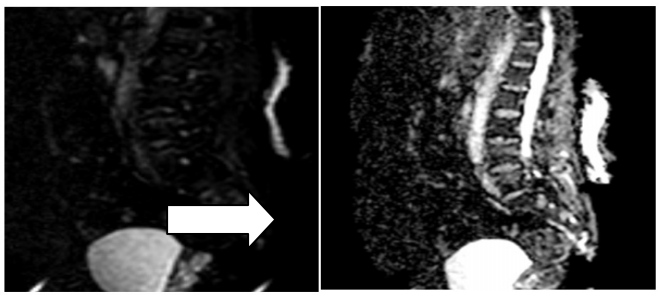

**Diagnostic Accuracy of Dwi With Adc And Conventional Mri Both values arrived at 88% but specificity and PPV of DWI came to be 93% and 90% respectively which is higher than of conventional MRI**

***Image of Dw Ss (Epi) With Adc Mapping***



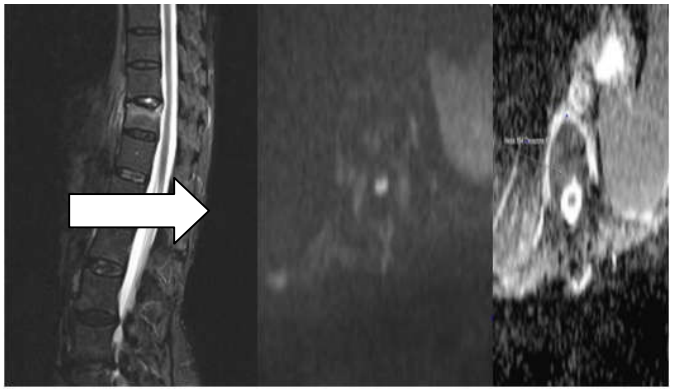

**Malignant Metastasis Sagittal section- DWI of dorsolumbar spine with b-value 1000s/mm2shows hyperintensity in vertebral bodies as discussed above with corresponding ADC mapping image shows invertion at the similar areas with low mean ADC values of 0.6 x 10-3 mm2/s**

***Image of Dw Ss (Epi) With Adc Mapping***



**Benign (traumatic fracture) sagittal section DWI of dorso-lumbar spine with b-value 1000s/mm2 shows no restriction, corresponding ADC mapping image shows no inversion at the similar area with high mean ADC value of 1.6 x 10-3 mm2/s**

***Image of Dw Ss (Epi) With Adc Mapping***



**Benign acute osteoporotic fracture Sagittal section DWI image of dorso-lumbar spine with b-value 1000 s/mm2 shows hyperintensity, corresponding ADC mapping image shows inversion at the similar area with mean ADC value of 1.6x10-3 mm2**

## DISCUSSION

***Benign Fracture***

In this category the peak age group incidence is seen between 31-40 yrs with male (4 cases) predominance in traumatic fractures. In osteoporotic fractures the peak age group incidence is seen in 61-70 years with female (5 cases) predominance .Out of 12 people with no history of malignancy, 5 cases of traumatic fracture with acute/chronic h/o trauma fractures were diagnosed on conv MRI and included in the study. 7 cases of osteoporotic fractures were diagnosed based on clinical / routine MRI are included in the study

***Dwi+Adc Imaging*:** (qualitative analysis) alone showed no restriction in benign fracture cases with diagnostic accuracy of 88% in differentiating benign vs malignant fractures

Coming to final statement Conv MRI was unable to diagnose 1case and ADC was unable to diagnose 2 cases proved on HPEr clinical follow up as benign entity. Conv MRI over diagnosed 2 cases and ADC overdiagnosed 1 case of benign fracture as malignant fracture.

***Mean Adc Value*:** (quantitative analysis) of **1.57 x 10-3 mm2/s** was derived by statistical analysis in these cases

***Malignant Fracture / Infiltration***

In this category the peak age group incidence was seen in 61-70 yrs with male (7) predominance. All cases with history of suspicious and known primary (ca lung, ca breast, ca prostate, ca thyroid, lymphoma etc) malignancies and follow up cases with metastasis to spine with or without associated compression fractures were proceeed with routine MRI (**13 cases** were diagnosed as malignant infiltration) with DWI sequence + ADC mapping (qualitative) and quantitative ADC value estimation from Region Of Interest (ROI) of involved/ fractured vertebra bodies of spine.

***Dwi+Adc Imaging***: (qualitative) analysis alone demonstrated restriction in **15 cases** where as HPE r clinical follow up showed positivity in only **14 cases** with diagnostic accuracy of **88%** in diagnosing benign vs malignant fractures

Coming to final statement conv MRI was unable to diagnose 2 cases proved on HPE r clinical follow up..ADC was unable to diagnose 1 case proved on HPE to be malignant infiltration. Conv MRI over diagosed 1 case ,ADC over diagnosed 2 cases of benign fracture as malignanat infiltration

Mean ADC value of 0.69 x 10-3 mm2/s was derived by statistical analysis in these cases

## CONCLUSION

In conclusion, DWI sequence with ADC mapping when added to routine array of MRI spine with analysis of DW images(qualitative study) and ADC values(quantitative study) will enhance the effectiveness and accuracy of MRI in the diagnosis of benign or malignant fractures .Hence, DW-MRI which is noninvasive and non ionizing modality plays a very important role in early and accurate diagnosis and tissue characterization of various spinal lesions and will be most useful in patients in whom HPE is not possible which is crucial for successful management of patients

## Bibilography

1. Palle L, Reddy MCH. B, Reddy K.J. Role of magnetic resonance diffusion imaging and apparent diffusion coefficient values in the evaluation of spinal tuberculosis in Indian patients. IJRI 2010; Vol 20; (4): 279-83.
2. Biffar A. Quantitative Analysis of Diffusion-weighted Magnetic Resonance Imaging in the Spine (Dissertation), Munchen, Ludwig-Maximilians-University, 2010

3. Dietrich O, Biffar A, Reiser MF, and Baur-Melnyk A. Diffusion-weighted imaging of bone marrow. Semin Musculoskelet Radiol 2009, 13(2):134-144.
4. Koh DM, Thoeny HC: Diffusion Weighted MR Imaging-Applications in the Body, Germany: Springer; 2010
5. Khaled Abdel Wahab Abo Dewan, *et al*. Evaluation of benign and malignant vertebral lesions with diffusion weighted magnetic resonance imaging and apparent diffusion coefficient measurements. The Egyptian *Journal of Radiology and Nuclear Medicine* 2015;46:423-33
6. T.Moritani, Kim J, Capizzano AA, Kirby P, Kademian J, Sato Y. Pyogenic and non pyogenic infections: Emphasis on diffusion weighted imaging for the detection of abscess and pus collections.Br J Radiology, 2014 September; 87(1041).
7. Tanenbaum L, *et al*. Diffusion imaging in spine. Applied radiology 2011; 9-15
8. Spuentrup E, Buecker A, Adam G, Van-Vaals JJ, and Guenther RW. Diffusion weighted MR imaging for differentiation of benign fracture edema and tumor infiltration of the vertebral body. AJR Am J Roentgenol 2001;176(2):351-58.
9. Herneth AM, Naude J, Philipp M, Beichel R, Trattnig S, and Imhof H. The value of diffusion- weighted MRT in assessing the bone marrow changes in vertebral metastases. Radiologe 2000, 40(8):731-736.
10. Biffar A. Quantitative Analysis of Diffusion-weighted Magnetic Resonance Imaging in the Spine (Dissertation), Munchen, Ludwig-Maximilians-University, 2010
11. Park SW, Lee JH, Ehara S *et al*. Single shot fast spin echo diffusion-weighted MR imaging of the spine; is it useful in differentiating malignant metastatic tumor infiltration from benign fracture edema? Clin Imaging 2004, 28(2):102-108.
12. Herneth AM, Ringl H, Memarsadeghi M *et al*. Diffusion weighted imaging in osteoradiology. Top Magn Reson Imaging 2007, 18(3):203-212.
13. Koh D, Takahara T, Imai Y, and Collins DJ. Practical aspects of assessing tumors using clinical diffusion-weighted imaging in the body. Magn Reson Med Sci 2007, 6(4):211- 224.
14. Ward R, Caruthers S, Yablon C, Blake M, DiMasi M, and Eustace S. Analysis of diffusion changes in posttraumatic bone marrow using navigator-corrected diffusion gradients. AJR Am J Roentgenol 2000, 174(3):731-734.
15. Dietrich O, Herlihy A, Dannels WR, Fiebach J, Heiland S, Hajnal JV and Sartor K. Diffusion-weighted imaging of the spine using radial k-space trajectories. MAGMA 2001, 12(1):23-31
16. Oner AY, Tali T, Celikyay F, Celik A, and Roux PL. Diffusion-weighted imaging of the spine with a non-carr-purcell-meiboom-gill single-shot fast spin-echo sequence: initial experience. AJNR Am J Neuroradiol 2007, 28(3):575-580.
17. Raya JG, Dietrich O, Birkenmaier C, Sommer J, Reiser MF, and Baur-Melnyk A. Feasibility of a RARE-based sequence for quantitative diffusion-weighted MRI of the spine. Eur Radiol 2007, 17(11):2872-2879.
18. Herneth AM, Philipp MO, Naude J *et al*. Vertebral metastases: assessment with apparent diffusion coefficient. Radiology 2002, 225(3):889-894.
19. Yeung D.K.W, Wong S.Y.S, Griffith JF, and Lau E.M.C. Bone marrow diffusion in osteoporosis: evaluation with quantitative MR diffusion imaging. J Magn Reson Imaging 2004, 19(2):222-228.
20. Hatipoglu HG, Selvi A, Ciliz D, and Yuksel E. Quantitative and diffusion MR imaging as a new method to assess osteoporosis. AJNR Am J Neuroradiol 2007, 28(10):1934-1937.
21. Maeda M, Sakuma H, Maier SE, and Takeda K. Quantitative assessment of diffusion abnormalities in benign and malignant vertebral compression fractures by line scan diffusion-weighted imaging. AJR Am J Roentgenol 2003, 181(5):1203-1209.
22. Balliu E, Vilanova JC, Pelaez I *et al*. Diagnostic value of apparent diffusion coefficients to differentiate benign from malignant vertebral bone marrow lesions. Eur J Radiol 2009, 69(3):560-566.
23. Dietrich O, Raya JG, Sommer J, Deimling M, Reiser MF, and Baur-Melnyk A. A comparative evaluation of a RARE-based single-shot pulse sequence for diffusion weighted MRI of musculoskeletal soft-tissue tumors. Eur Radiol 2005; 15(4):772-783.
24. Oner A.Y, T. Tali F, Celikyay A, . Diffusion Weighted imaging of the Spine with a Non Carr Purcell Meiboom Gill Single Shot Fast Spin Echo Sequence: Initial Experience. AJNR Am J Neuroradiol Mar 2007; 28: 575- 80
25. Castillo M. Diffusion-weighted imaging of the spine: is it reliable? AJNR AmJ Neuroradiol 2003;24: 1251-53
26. Nakanishi K and Gutzeit A . Evaluation of Malignant Bone Disease Using DW-MRI. In:Diffusion-Weighted MR Imaging Applications in the Body. Heidelberg: Springer, 2010,216:208-226



**How to cite this article:**

Jeevika M.U *et al*.2018, Efficacy of Dwi of Spine to Quantitatively Differentiate Benign and Malignant Fractures. *Int J Recent Sci Res.* 9(10), pp. 29391-29394. DOI: http://dx.doi.org/10.24327/ijrsr.2018.0910.2853


*******