Pravara Med Rev; June 2022, 14 (02), 69 – 75
DOI: 10.36848/PMR/2022/60100.51115

Original article

Role of Magnetic Resonance Imaging in differentiating benign from malignant vertebral compression fractures - can biopsy avoided?

[1]Dr. Shweta Shendey, [2]Dr. Ibrahim Ansari*, [3]Dr. Sunil Patil

[1]ASSISTANT PROFESSOR, B.J. GOVT MEDICAL COLLEGE AND SASSOON GENERAL HOSPITALS, PUNE, INDIA.
[2]ASSOCIATE PROFESSOR, B.J. GOVT MEDICAL COLLEGE AND SASSOON GENERAL HOSPITALS, PUNE, INDIA.
[3]ASSOCIATE PROFESSOR, B.J. GOVT MEDICAL COLLEGE AND SASSOON GENERAL HOSPITALS, PUNE, INDIA.
Corresponding author*

Abstract:

Aims and objectives: Our aim was to evaluate utility of MRI in differentiating benign and malignant vertebral compression fracture with routine MRI sequences and correlate the MRI findings with histopathology reports.

Material and Methodology: 50 patients with 76 vertebral compression fractures were imaged using conventional T1WI, T2WI, contrast enhanced T1WI, STIR images on 1.5T MR scanner. Signal intensities were analysed qualitatively for all the sequences by comparison to adjacent normal marrow. Qualitative data variables were expressed by using frequency and Percentage (%). p-value < 0.05 was considered as significant. The diagnosis was confirmed on histopathology reports.

Results : A total of 76 vertebral compression fractures; 29 malignant compression fractures and 47 benign compression fractures including osteoporotic as well as potts disease were evaluated. T1W and T2W images had overlapping features in both groups.MR imaging characteristics favouring malignant vertebral compression fracture were convex posterior border, involvement of the pedicle or posterior element, epidural mass/ paraspinal mass and destruction of bony cortex. In our study 70.58 % of malignant vertebral compression fracture showed convex posterior border and 76.4% malignant cases had pedicle destruction with expansile soft tissue.

Conclusion: MRI in vertebral compression fractures provides vital diagnostic information in differentiating benign from malignant compression fractures. Conventional T1-weighted, T2-weighted images have ambiguous features and does not help in diagnosis However, additional contrast-enhanced T1-weighted imaging and associated features like convex posterior border, abnormal signal intensity and enhancement of the pedicle or posterior element, epidural and/ or paraspinal mass are reliable features favoring metastatic compression fracture over benign etiology hence avoiding the unnecessary biopsies.

Keywords: Benign vertebral compression fracture, malignant vertebral compression fracture, Magnetic Resonance Imaging

Introduction:

In our part of world vertebral collapse as a result of osteoporosis, infection or malignant disease either primary or metastases are common. Most bony metastases are haematogenous in origin, the axial skeleton is the most common site of skeletal metastases initially due to abundant vascularization and red bone marrow. However, osteoporotic compression fractures are also a common occurrence in the spine in elderly and can be confused with metastatic compression fracture in the acute phase. Benign vertebral lesions occur in approximately one-third of cancer patients[(1)] while metastatic vertebral lesions account for 39% of bony metastases in patients having primary neoplasm[(2).] Since the prognosis and management differs in these three entities, accurate diagnosis is important.[(3)]

Differentiating malignant from a benign compression fracture with clinical information, plain radiographs, bone scans and computed tomography may not always be sufficient, particularly for those without a history of obvious trauma or known malignancy case. Magnetic resonance (MR) imaging is a helpful tool in evaluating disease of bones and bone marrow.

Several MR imaging findings have been known as useful features for differentiating benign and malignant compression fracture[4-7]. Therefore, we have conducted the present study to explore whether the previously published MR imaging features are helpful in differentiating a malignant compression fracture from a benign vertebral compression fracture.

Material & methods:

Total 50 Patients were studied during period of October 2014 to August 2016. Study was carried out on GE 1.5 Tesla Signa Hdxt MR scanner using Spine phased array surface coil.

Inclusion criteria:

All the patients attending the O.P.D. and admitted in the wards referred to the Department of Radiodiagnosis who are symptomatic with back pain and having positive X-ray findings of vertebral compression fracture were included.

Exclusion criteria:

1. Patients unwilling to give consent.
2. Claustrophobic patients
3. Patient not having positive finding of vertebral compression fracture on X-ray
4. Patients having traumatic compression fractures.
5. Patients with MRI noncompatible metallic implants, pacemakers and cochlear implants.

Detailed history was taken, full systemic examination, neurological examination and laboratory investigations were evaluated. Written informed consent was obtained from all the patients to participate in the study.

Diagnosis on MRI was made with background of clinical context. Final diagnosis was reached in consensus with biopsy (wherever applicable) or clinical, laboratory, other imaging modality findings and follow up.

Magnetic resonance imaging protocol

A scout T2W screening sagittal images of entire spine to localize the precise position of vertebral compression fracture was taken followed by conventional multi-section fast spin echo pulse sequences with different repetition time (TR) and echo delay time (TE) to obtain T1 and T2WI in sagittal and axial plane. Coronal and sagittal STIR images were obtained in most of the patients based on pathology. Gd-DTPA was administered by means of intravenous injection at a dose of 0.2 ml/kg. After injection of Gd-DTPA, short TR/TE images (T1W) with fat suppression in at least two orthogonal planes were obtained.

The signal intensity and enhancement patterns of the compressed vertebrae and normal bone marrow signal intensity of the vertebral body were evaluated in detail. Signal intensity in the marrow of abnormal collapsed vertebral bodies was considered hypointense, isointense, hyperintense or heterogenous in comparison with the signal intensity of normal vertebral body in the same patient on T1- and T2-weighted images.

Statistical analysis:

It was a cross sectional analytical study. Qualitative data variables were expressed by using frequency and Percentage (%). p-value < 0.05 was considered as significant.

Results:

Our study constituted total 50 patients out of which 29 were male and 21 patients were female. In the present study there was male preponderance (58%) as compared to females (35%). Male preponderance was consistently seen in all subgroups of vertebral compression fractures i.e. malignant, osteoporotic and pott's spine cases

Patients of all age group were included in the study. maximum number of patients were in the age group 41-60 years followed by patients in the age group of 61-80 years.

Majority of the patients in malignant vertebral compression fracture group (11 out of total 17 cases) were in the age group of 41-60 years of age. Majority of patients (9 out of total 18 cases) in the group of osteoporotic compression fractures were in 61-80 years. While patients in age group of less than 40 years constituted the major bulk of vertebral compression fractures secondary to Pott's spine.

On dividing the data to evaluate multiplicity of compression fractures, Out of total 50 patients 28 patients had single vertebral compression fracture,19 patients had 2 vertebral compression fractures, 2 patients had 3 vertebral compression fractures and only 1 patient had 4 vertebral compression fracture.Multiplicity of the compression fractures was seen in majority of cases of pott's spine (11 out of 15

cases) with predominant involvement of contiguous vertebrae. However multiple compression fractures were also seen in osteoporotic (6 out of 17 cases) as well as malignant group (5 out of 18 cases) of vertebral compression fractures.

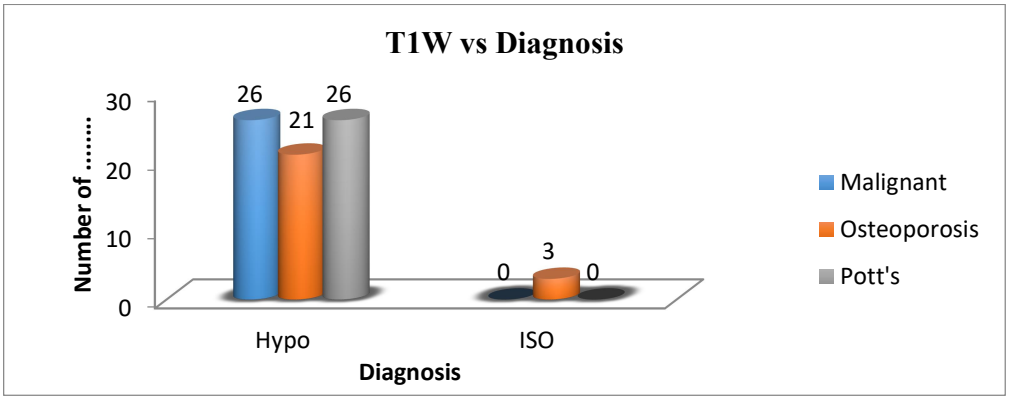
Convex posterior border was seen in majority of cases of malignant vertebral compression fractures i.e.12 out of total 17 cases of malignant vertebral compression fracture showed convex posterior border followed by cases of Pott's spine which showed posterior element involvement in 4 out of 15 cases. Convex posterior border was seen only in one case of osteoporotic vertebral compression fractures in our study. By using Fisher's exact test p-value < 0.05 therefore there is significant association between convex posterior border with diagnosis of malignant collapse.

Posterior element involvement was seen in majority of cases of malignant vertebral compression fractures i.e.13 out of total 17 cases of malignant vertebral compression fracture showed involvement of posterior elements of vertebra followed by cases of Pott's spine which showed posterior element involvement in 6 out of 15 cases. Posterior element involvement was absent in all cases of osteoporotic vertebral compression fractures in our study. By using Fisher's exact test p-value < 0.05 therefore there is significant association between post element involvement with diagnosis.

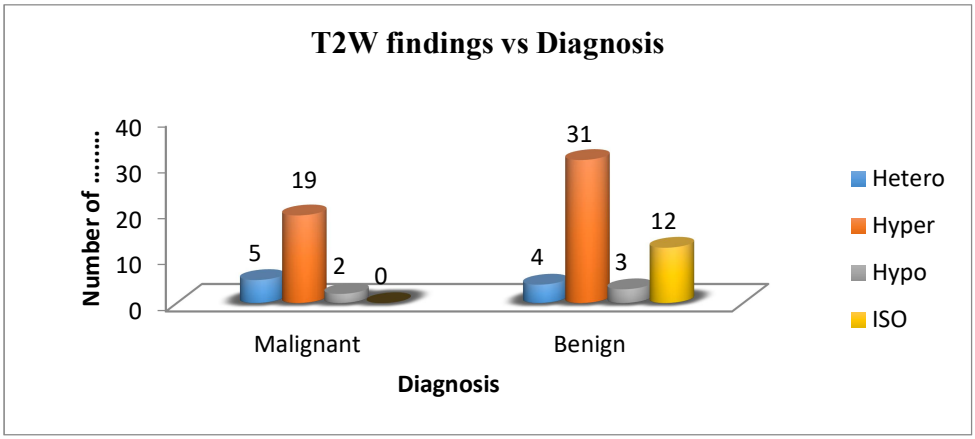
Paravertebral mass/collection was seen in majority cases of Pott's spine (11 out of 15 cases) causing vertebral compression fractures followed by cases of malignant vertebral compression fractures (7 out of 17 cases).Paravertebral soft tissue/ collection was absent in all cases of osteoporotic vertebral compression fractures. By using Fisher's exact test p-value < 0.05 therefore there is significant association between Para vertebral mass/collection with diagnosis.

Out of 76 vertebral compression fractures seen in 50 patients, 26 were confirmed to be malignant, 24 as osteoporotic and 26 as vertebral compression fractures secondary to Pott's spine.

On T1W images all the cases of malignant and pott's vertebral compression fractures showed hypointense signal intensity on T1W images. While 21 out of 24 osteoporotic vertebral compression fractures showed hypointense signal intensity on T1W images



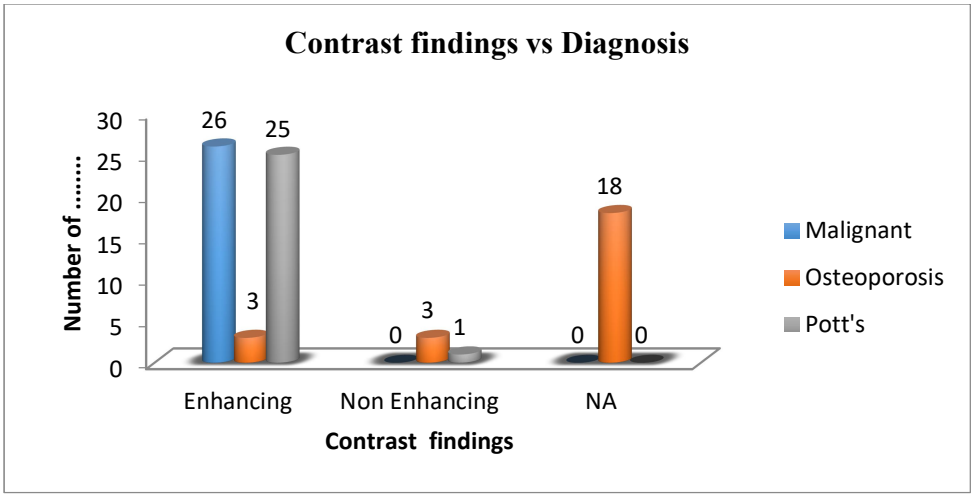
On T2W images, in malignant group majority of vertebral compression fractures were hyperintense (19 out of 26 vertebral compression fracture) followed by heterogenous signal intensity (5 out of 26 cases). In osteoporotic group majority of the cases (12 out of 24) were isointense on T2W images followed by hyperintense and hypointense signal intensity. Vertebral compression fractures in cases of Pott's spine revealed hyperintense signal intensity in majority of cases (22 out of 26 cases), however 4 cases showed heterogenous signal intensity on T2W images. Hyperintense signal intensity was seen in majority cases of malignant as well as benign vertebral compression fractures as described in above table followed by heterogenous signal intensity in malignant group and isointense signal intensity in benign group of vertebral compression fractures.



All the malignant as well as tubercular vertebral compression fractures revealed hyperintense signal intensity on STIR images while majority of osteoporotic vertebral compression fractures (11 out of 24) were isointense on STIR images followed by hyperintense signal intensity (8 out of 24 cases). While heterogenous (2 cases) and hypointense (3 cases) signal intensity was also seen in cases of osteoporotic vertebral compression fractures.

In malignant group of vertebral compression fractures all the involved vertebrae showed enhancement on postcontrast T1W images. In vertebral compression fracture cases of Pott's spine all but one case of collapsed vertebra showed enhancement on postcontrast T1W images. In group of osteoporotic compression fractures contrast was given only to 6 cases out of total 24 cases of osteoporotic collapse of which only 3 showed enhancement on postcontrast T1W images.

.



DISCUSSION

Study patients were divided in two groups i.e. malignant and benign group; benign group further comprised of osteoporotic vertebral compression fractures and fractures due to infective spondylodiscitis i.e. Potts spine.

Imaging findings were confirmed with histopathological diagnosis in all malignant and infective cases of vertebral collapse (17 malignant and 15 pott's spine cases). However out of 18 patients having osteoporotic collapse biopsy was done only for 10 cases hence histological diagnosis

could not be confirmed in all patients as it was not possible to obtain consent for biopsy especially in few of the patients of osteoporotic compression fractures. However with follow-up of those without biopsies this limitation could be overcome. On follow up these remaining 8 cases showed improvement with symptomatic management without any progression of symptoms.

Our study comprised of total 50 patients, out of which 29 patients were male and 21 patients were female, showing male predominance. Patients of all age group were included in the study. Majority of the patients of malignant and osteoporotic vertebral compression fractures were in 40-80 years age group. While vertebral compression fractures secondary to tubercular spondylodiscitis were in young age group i.e. below age of 40 yrs.Multiple vertebral involvement was seen in 35.3% cases of malignancy while it was seen in 73.3% cases of pott's spine with characteristically showing contiguous involvement of adjacent vertebral bodies. Only 27% cases of osteoporosis showed multiple vertebral involvement.In our study: we found that, all vertebral compression fractures in malignant cases were hypointense on T1W images, in benign group all cases of tubercular vertebral compression fractures were hypointense on T1W images while among osteoporotic group 87.5 % cases (21out of 24 osteoporotic vertebral compression fractures) showed hypointense signal and 12.5 % cases showed isointense signal on T1W images (Image 3). In malignant group On T2W images, 73% showed hyperintense signal intensity, 7.6 % showed hypointense signal while another 19 % cases showed heterogenous signal intensity. In benign group on T2W images 62% cases showed hyperintense signal intensity, 24 % cases showed isointense signal intensity and remaining cases showed hypo and heterogenous signal intensity.

In our study there was considerable overlap of signal intensities noted in both malignant and benign group of vertebral compression fractures on both T1W and T2W images which is consistent with the findings of the study done by Baur et al[8], zhou et al[9] and bhugaloo et al[10] who also concluded that signal intensity changes can be similar in both malignant and benign cases hence T1 and T2 weighted images cannot only be used for differentiation of malignant and benign vertebral compression fractures.In our study all malignant and tubercular vertebral collapse showed hyperintense signal intensity on STIR images, however only 33% osteoporotic collapse showed hyperintense signal intensity on STIR images with rest of the showing variable signal intensities.

Convex posterior border was seen in majority of cases of malignant vertebral compression fractures i.e. 70.58 % of malignant vertebral compression fracture showed convex posterior border (Image 1) followed by cases of Pott's spine which showed posterior element involvement 26.66 % cases. Convex posterior border was seen only in one case of osteoporotic vertebral compression fractures in our study the findings are consistent with the study done by Cuenod CA et al[11] and Jung HS et al [12]In our study 76.4% malignant cases had pedicle destruction with expansile soft tissue. On the other hand 40% benign cases (osteoporotic+Pott's) had pedicle involvement, but this could be seen only after Gd-DTPA enhancement. Hence this finding appears to be significant in predicting malignancy which is consistent with findings of study done by Tsai Sheng-Fu et al[13] and Pongpornsup S. et al[14] who also found significant association of posterior element involvement with malignancy. Our study objects to findings of the study done by Ishiyamaa et al[15] which stated that: Pedicle involvement was seen frequently in patients with osteoporotic compression fractures and was not specific for malignancy.

In our study we found that 41% cases of malignant collapse had paravertebral soft tissue. However in benign group, 73.3 % cases of potts spine showed paravertebral soft tissue/collection (image 2) while paravertebral soft tissue/ collection was absent in all cases of osteoporotic collapse, these findings are consistent with several studies like Rupp et al[16], Fu TS et al[17], Moulopoulos et al[18] and Laredo et al[19] which mentioned that the presence of an associated paraspinal soft tissue mass is indicative of malignancy.

Contrast-enhanced MRI is commonly used in the evaluation of tumors. In our study, all malignant (100%) cases had gadolinium enhancement. In benign group, 96.1 % cases of tubercular vertebral collapse had gadolinium enhancement. 50% cases of osteoporosis showed contrast enhancement. Our

findings matches with the study done by An et al. who reported that contrast enhancement is very sensitive in detecting malignant lesions, with a sensitivity of 100%, but its specificity could be compromised by misinterpretation of benign lesions as malignant especially during the healing process of benign fractures Bhugaloo et al[10] stated that; the absence of enhancement makes the likelihood of benign fractures high. These observations are consistent with findings of our study.

There were few limitations to our study first is although patients who satisfied the inclusion criteria were recruited, there is still the possibility of selection bias. Second, histopathological confirmation was not available in all cases. However, we believed that clinical follow up and imaging criteria of our study would be sufficient to conclude the benignity and malignancy of the fracture in such cases. Third, being the relatively smaller study population.

Conclusion:

Contrast enhanced MRI is the reliable modality to differentiate between benign and malignant compression fracture. Benign compression fractures cannot be unambiguously distinguished from metastatic lesions on the basis of only conventional T1-weighted, T2-weighted images however additional contrast-enhanced T1-weighted imaging characteristics and associated MR imaging features like convex posterior border, abnormal signal intensity and enhancement of the pedicle or posterior element, epidural and/ or paraspinal mass and destruction of bony cortex are suggestive of metastasis compression fracture over benign etiology. Hence Tissue diagnosis is not always necessary in the patient having predominant benign features of vertebral compression fractures and unnecessary intervention or biopsy can be avoided in such cases.

References:

1. Fornasier VL, Czitrom AA. Collapsed vertebrae: a review of 659 autopsies. Clin Orthop Relat Res. 1978 Mar-Apr;(131):261-5. PubMed PMID: 657633

2. Ratanatharathorn V, Powers WE. Epidural spinal cord compression from metastatic tumor: diagnosis and guidelines for management. Cancer Treat Rev. 1991 Mar;18(1):55-71. Review. PubMed PMID: 1933911

3.Tehranzadeh J, Tao C. Advances in MR imaging of vertebral collapse. Semin Ultrasound CT MR 2004; 25: 440-60.

4.Cuenod CA, Laredo JD, Chevret S, Hamze B, Naouri JF, Chapaux X, et al. Acute vertebral collapse due to osteoporosis or malignancy: appearance on unenhanced and gadolinium-enhanced MR images. Radiology 1996; 199: 541-9.

5.Laredo JD, Lakhdari K, Bellaiche L, Hamze B, Janklewicz P, Tubiana JM. Acute vertebral collapse: CT findings in benign and malignant nontraumatic cases. Radiology 1995; 194: 41-8.

6.Jung HS, Jee WH, McCauley TR, Ha KY, Choi KH. Discrimination of metastatic from acute osteoporotic compression spinal fractures with MR imaging. Radiographics 2003; 23: 179-87.

7.Shih TT, Huang KM, Li YW. Solitary vertebral collapse: distinction between benign and malignant causes using MR patterns. J Magn Reson Imaging 1999; 9: 635-42..

8. Baur A, Stäbler A, Arbogast S, Duerr HR, Bartl R, Reiser M. Acute osteoporotic and neoplastic vertebral compression fractures: fluid sign at MR imaging.Radiology. 2002 Dec;225(3):730-5. PubMed PMID: 12461253.

9. Zhou XJ, Leeds NE, McKinnon GC, Kumar AJ. Characterization of benign and metastatic vertebral compression fractures with quantitative diffusion MR imaging. AJNR Am J Neuroradiol. 2002 Jan;23(1):165-70. PubMed PMID: 11827890

10. Bhugaloo A(1), Abdullah B, Siow Y, Ng Kh. Biomed Imaging Interv J. 2006 Apr;2(2):e12. doi: 10.2349/biij.2.2.e12. Epub 2006 Apr 1. Diffusion weighted MR imaging in acute vertebral compression fractures: differentiation between malignant and benign causes.

11.Cuenod CA, Laredo JD, Chevret S, Hamze B, Naouri JF, Chapaux X, et al. Acute vertebral collapse due to osteoporosis or malignancy: appearance on unenhanced and gadolinium-enhanced MR images. Radiology 1996; 199: 541-9.

12. Jung HS, Jee WH, McCauley TR, Ha KY, Choi KH. Discrimination of metastatic from acute osteoporotic compression spinal fractures with MR imaging. Radiographics 2003; 23: 179-87.

13. Fu TS, Chen LH, Liao JC, Lai PL, Niu CC, Chen WJ. Magnetic resonance imaging characteristics of benign and malignant vertebral fractures. Chang Gung Med J. 2004 Nov;27(11):808-15. PubMed PMID: 15796256.

14. Pongpornsup S(1), Wajanawichakorn P, Danchaivijitr N. J Med Assoc Thai. 2009 Jan;92(1):64-72.Benign versus malignant compression fracture: a diagnostic accuracy of magnetic resonance imaging.

15. Ishiyama M, Fuwa S, Numaguchi Y, Kobayashi N, Saida Y. Pedicle involvement on MR imaging is common in osteoporotic compression fractures. AJNR Am J Neuroradiol. 2010 Apr;31(4):668-73. doi: 10.3174/ajnr.A1905. PubMed PMID: 20019106.
16. Rupp RE, Ebraheim NA, Coombs RJ. Magnetic resonance imaging differentiation of compression spine fractures or vertebral lesions caused by osteoporosis or tumor.Spine (Phila Pa 1976). 1995 Dec 1;20(23):2499-503; discussion 2504. PubMed PMID: 8610244.
17. Fu TS(1), Chen LH, Liao JC, Lai PL, Niu CC, Chen WJ. Chang Gung Med J. 2004 Nov;27(11):808-15.
18. Moulopoulos LA, Yoshimitsu K, Johnston DA, Leeds NE, Libshitz HI. MR prediction of benign and malignant vertebral compression fractures. J Magn Reson Imaging. 1996 Jul-Aug;6(4):667-74. PubMed PMID: 8835961.
19. Laredo JD, Lakhdari K, Bellaïche L, Hamze B, Janklewicz P, Tubiana JM. Acute vertebral collapse: CT findings in benign and malignant nontraumatic cases. Radiology. 1995 Jan;194(1):41-8. PubMed PMID: 7997579