EVALUATION OF VERTEBRAL COLLAPSE BASED ON ANATOMIC SITE AND MAGNETIC RESONANCE IMAGING

Satish Danappa Patil[1], Parth Avinash Vaishnav[2], Vishal Sharanbasappa Nimbal[3], Shivanand Veerupakshappa Patil[4], Veeresh Karibasappa Hanchinal[5]

[1]Assistant Professor, Department of Radiodiagnosis, BLDEA's Shri B. M. Patil Medical College Hospital and Research Centre, Vijayapura.
[2]Postgraduate Student, Department of Radiodiagnosis, BLDEA's Shri B. M. Patil Medical College Hospital and Research Centre, Vijayapura.
[3]Senior Resident, Department of Radiodiagnosis, BLDEA's Shri B. M. Patil Medical College Hospital and Research Centre, Vijayapura.
[4]Assistant Professor, Department of Radiodiagnosis, BLDEA's Shri B. M. Patil Medical College Hospital and Research Centre, Vijayapura.
[5]Assistant Professor, Department of Radiodiagnosis, BLDEA's Shri B. M. Patil Medical College Hospital and Research Centre, Vijayapura.

ABSTRACT

BACKGROUND

Vertebral collapse is the breakdown of a vertebra resulting in a decreased height of its body and can develop anywhere along spinal cord from neck to the lower spine. Magnetic resonance imaging is the gold standard in imaging for suspected vertebral collapse.

MATERIALS AND METHODS

The study is basically a prospective observational study conducted on 50 cases from December 2014 to June 2016. The group comprised of patients who were referred to Department of Radiodiagnosis with complaint of back pain, lower limb weakness and generalised body ache.

RESULTS

The study showed that there was a male predominance with 66% and 34% being females. The age of presentation in maximum number of patients were in the age group of 31-40 (22%), followed by 51-60 years (20%) and 61-70 years (20%). Vertebral collapse was most commonly seen in lumbar spine in 43.4% cases followed by dorsal spine in 39.1% cases. Out of 50 cases, solitary vertebral collapse was seen in a total of 10 cases (20%) presenting with traumatic aetiology in 6 cases (12%) and 2 cases each (4%) due to metastasis and osteoporosis. 40 cases (80%) presented with multiple vertebral collapses, majority of them osteoporotic in nature. In present study, MRI diagnosed 100% malignant collapse cases.

CONCLUSION

It was concluded in our study that the MRI helps to evaluate various Magnetic Resonance Imaging (MRI) features in differentiating malignant from benign vertebral collapses, which aid to achieve the goals of preservation of neurologic function and restoration of spinal stability.

KEYWORDS

Vertebral Collapse, Cord Compression, Infective Collapse, Osteoporotic Collapse.

HOW TO CITE THIS ARTICLE: Patil SD, Vaishnav PA, Nimbal VS, et al. Evaluation of vertebral collapse based on anatomic site and magnetic resonance imaging. J. Evid. Based Med. Healthc. 2017; 4(68), 4087-4092. DOI: 10.18410/jebmh/2017/814

BACKGROUND

Vertebral collapse is decrease in height of vertebral body. It may occur due to variable extent. It is associated with posterior wall bulging with increase in width of the body towards spinal canal. Subsequently, in severe cases leading to cord and nerve root compression.[1]

Usually, patient presents with low back pain, ache in neck region according to nerve root distribution with respect to site of compression. Here, the pain is burning or shooting type including with changes in strength and sensation over the affected area.

Radiographic features of plain films, which is largely nonspecific investigation, which shows metastatic deposits or vertebral compression, but cannot be used to assess the spinal cord or identify the cause can sometimes be used in preoperative planning.

Financial or Other, Competing Interest: None.
Submission 22-07-2017, Peer Review 28-07-2017,
Acceptance 15-08-2017, Published 24-08-2017.
Corresponding Author:
Dr. Parth Avinash Vaishnav,
A-304, Girnar Darshan, Shastri Nagar,
Vasai Road West, Thane- 401202, Maharashtra.
E-mail: vaishnavparth007@gmail.com
DOI: 10.18410/jebmh/2017/814

MRI is the gold standard in imaging for suspected spinal cord compression. It is performed immediately in those with suspected malignancy or infection urgently in those with neurological signs. MRI allows best imaging of the spinal canal and its content.[2]

As present study is conducted to determine benign and malignant cases among vertebral collapse with cord compression and to determine aetiology among them.

Objectives

1. Evaluate various Magnetic Resonance Imaging (MRI) features as per anatomical site of origin.
2. Diagnosis of vertebral collapse according to magnetic resonance imaging.

MATERIALS AND METHODS

The present study was conducted in the "Department of Radiodiagnosis, Shri B. M. Patil Medical College Hospital and Research Centre, Bijapur." The study is basically a prospective observational study conducted from December 2014 to June 2016.

The subjects were those who attended Department of Radiodiagnosis and orthopaedics with complaint of back pain, lower limb weakness and generalised body ache.

A detailed clinical history was obtained from all patients. Detailed examination and findings were recorded.

Imaging was done with 1.5 Tesla magnetic resonance imaging equipment Philips Achieva.

Inclusion Criteria

Patients of all age groups, both sexes, referred for MRI, having vertebral collapse (whether solitary or multiple), from the Department of Radiodiagnosis and Department of Orthopaedics were included in this study.

Exclusion Criteria

1. Patients with benign or malignant spinal involvement without associated collapse were excluded.
2. Patients who underwent previous spinal surgeries.

The normal bone marrow signal intensity of vertebral body on T1 and T2 weighted images were evaluated in detail. Signal intensity in the marrow of abnormal vertebral bodies was considered hypointense, isointense, hyperintense or mixed in comparison with the signal intensity of normal vertebrae in the same patient on T1- and T2-weighted images. The replacement of bone marrow is homogenous or heterogenous was also evaluated in detail. In addition, the following findings were particularly examined; convex posterior border of vertebral body, abnormal signal intensity of the pedicle or posterior element and paravertebral collection.

Our study was approved by institutional thesis board, which maintained that a formal consent should be acquired from the patient undergoing examination or from his/her relatives.

Equipment

- 1.5 Tesla Magnetic Resonance Imaging Equipment Philips Achieva.
- Body surface coil.
- Nonionic contrast medium, if and when required.

RESULTS

Age and Sex Distribution

Age	Male	Female	Total	
	No.	No.	No.	%
1-10	2	0	2	4
11-20	1	0	1	2
21-30	5	4	9	18
31-40	7	4	11	22
41-50	4	2	6	12
51-60	7	3	10	20
61-70	7	3	10	20
71-80	0	1	1	2
Total	**33**	**17**	**50**	**100**

Table 1. Age and Sex Distribution (N=50)

The whole of the study group was divided in 8 age groups with age of patients ranging from 3 years to 80 years. There was a male predominance with 66% (33/50 cases) males and 34% (17/50 cases) being females. The male:female ratio was almost 2:1. The mean age of presentation was 45.06 years. Maximum number of patients were in the age group of 31-40 (22%), followed by 51-60 years (20%) and 61-70 years (20%). Majority of male patients were in the age group of 31 to 40 and 51 to 70 years and majority of female patients were in the age group of 21 to 40 years.

The distribution of vertebral collapse lesions as per anatomic site of origin is shown in Table 2.

Anatomic Site of Origin			
Sl. No.	**Anatomic Site**	**No. of Cases**	**Percentage**
1.	Cervical spine	8	11.5%
2.	Dorsal spine	27	39.1%
3.	Lumbar spine	30	43.4%
4.	Sacral spine	4	5.7%
	Total	**69**	**100%**

Table 2. Distribution of Lesions as Per Anatomic Site of Origin

Vertebral collapse was most commonly seen in lumbar spine in 43.4% cases followed by dorsal spine in 39.1% cases. In many cases, simultaneous involvement of dorsal and lumbar spine was noted. Other commonly involved primary anatomic site of involvement was cervical spine seen in 8 cases (11.5%) and sacral spine in 4 cases (5.7%).

Table 3 describes the distribution of cases according to number of vertebrae involved and their related aetiology.

Final Diagnosis	Number of Vertebrae Involved					
	Multiple		Solitary		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Infective collapse	11	100	0	0	11	100
Malignant collapse	10	83.33	2	16.67	12	100
Osteoporotic collapse	13	86.67	2	13.33	15	100
Traumatic collapse	6	50	6	50	12	100
Total	**40**	**80**	**10**	**20**	**50**	**100**

Table 3a. Distribution of Lesions According to Number of Vertebrae Involved

Out of 50 cases, solitary vertebral collapse was seen in a total of 10 cases (20%) presenting with traumatic aetiology in 6 cases (12%) and 2 cases each (4%) due to metastasis and osteoporosis. 40 cases (80%) presented with multiple vertebral collapses; 13 (32.5%) of them were osteoporotic in nature, 11 (27.5%) were due to infective causes, 10 (25%) were malignant and 6 (15%) were traumatic in nature. All infective cases had multiple vertebrae involvement. Multiple vertebrae involvement is not statistically significant for malignant collapse (P>0.05).

Number of Vertebrae Involved		Final Diagnosis					
		Benign		Malignant		Total	
		Number	Percentage	Number	Percentage	Number	Percentage
Multiple	Continuous vertebral involvement	12	31.5	2	16.67	14	28
	Skip vertebral involvement	18	47.35	8	66.66	26	52
Solitary		8	21.05	2	16.67	10	20
Total		**38**	**100**	**12**	**100**	**50**	**100**

Table 3b

MRI Diagnosis	Final Diagnosis					
	Benign		Malignant		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Inconclusive	1	2.63	0	0	1	2
Infective collapse	10	26.32	0	0	10	20
Malignant collapse	0	0	12	100	12	24
Osteoporotic collapse	15	39.47	0	0	15	30
Traumatic collapse	12	31.58	0	0	12	24
Total	**38**	**100**	**12**	**100**	**50**	**100**

Table 4a. Distribution of Cases According to MRI Diagnosis

Out of all cases, only 1 case (2.63%) was diagnosed as inconclusive, which was later confirmed by biopsy as infective collapse. In present study, MRI diagnosed 100% malignant collapse cases (12 cases) correctly. Rest of benign cases were correctly diagnosed into osteoporotic (15 cases), traumatic (12 cases) and infective collapse.

Type of Infection	Number of Cases	Percentage
Pyogenic	3	30
Tuberculosis	6	60
Fungal	0	0
Brucellar	1	10
Total Cases	**10**	**100**

Table 4b. Among the Infective Causes of Vertebral Collapse Following was its Found Distribution

Primary Site	Number of Cases	Percentage
Lung	5	41.66
Prostate	2	16.67
Colorectal	2	16.67
Renal	1	8.33
Breast	1	8.33
Cervix	1	8.33
Total	**12**	**100**

Table 5. Distribution of Metastatic Vertebral Collapse on the Basis of Primary Site of Origin

Malignant vertebral collapse was seen in a total of 12 cases, all of which were metastatic in nature. The most common site of primary involvement was lung outnumbering. All the other primary sites comprising of 5 patients (41.6%). It was followed by 2 cases each of prostate and colorectal carcinoma (16.67%) and 1 (8.33%) case each of renal cell carcinoma, breast carcinoma and cervical carcinoma.

Pre and Paravertebral Soft Tissue Collection	Final Diagnosis					
	Benign		Malignant		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Present	13	34.21	0	0	13	26
Absent	25	65.79	12	100	37	74
Total	38	100	12	100	50	100

Table 6. Distribution of Lesions According to Pre and Paravertebral Soft Tissue Collection

Pre and paravertebral soft tissue collection was smooth and rim like and noted in 13 (34%) cases of benign vertebral collapse. Out of which, 10 cases (26.3%) were of infective aetiology and 3 cases (7.89%) were of traumatic aetiology. Malignant cases did not show any paravertebral collection. Presence of paravertebral collection was found to be statistically insignificant (P>0.05) for malignant cases.

Cause	No. of Cases of Cord Compression
Malignant collapse	8
Infective collapse	5
Traumatic collapse	2
Osteoporotic collapse	0
Total	**15**

Table 7. Vertebral Collapse Associated with Cord Compression

Cord compression was seen in less than 1/3rd of the total cases of vertebral collapse. Amongst the positive cases, it was most commonly seen in 8 (66.6%) out of 12 cases of malignancy followed by infection as the second most common cause comprising of 5 cases (45.4%) and 2 cases (16.6%) of trauma. None of osteoporotic collapse cases had cord compression.

Figure 1. T1 and T2 Sagittal Images of Spine Showing Central Wedge-Shaped Collapse of L2and L3 Vertebral Bodies Suggestive of Osteoporotic Collapse

Figure 2. D9, D10 and D11 Vertebral Bodies Appear Hyperintense on T2W/STIR and Hypointense on T1W Sequences) with D9 Vertebral Body Showing Evidence of Partial Inferior Collapse and Partial Superior Collapse of D10 Vertebral Body with Pre/Para Vertebral Collection is Noted at D8 to D11 Vertebra Level

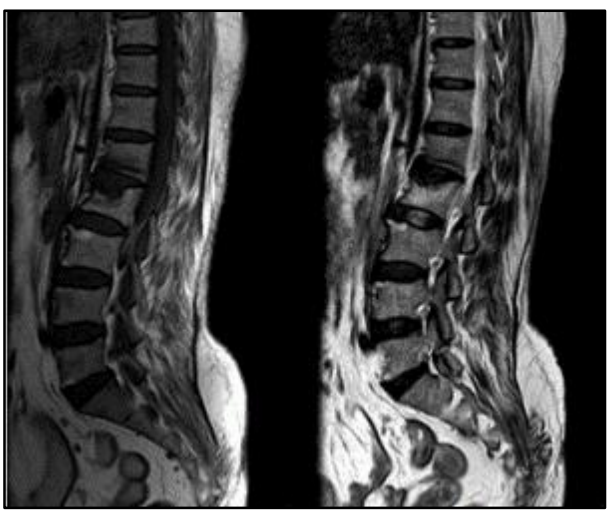

Figure 3. Anterior Wedge Compression Fracture of L1 Vertebral Body Showing Decreased Anterior Height of L1 Vertebral Body

Figure 4. In a K/C/O Carcinoma Prostate, Fracture is Noted L3 Vertebral Body Shows Reduced Height with Biconcave Wedging and Posterior Bulging Causing Severe Narrowing of Spinal Canal Appearing Hyperintense on T2W/STIR and Hypointense on T1W Sequences. Few Small T1/T2 Hypointense Lesions are seen in other Lumbar Vertebral Bodies Suggesting Metastasis

Figure 5. Osteoporotic Collapse-Sagittal T2 Weighted Image Shows Complete Collapse of T6 Vertebrae with Partial Collapse of T5 Vertebrae, T6 Vertebral Body and Superior Articular Margin of T5 Appears Hypointense on T2 and STIR due to Sclerosis

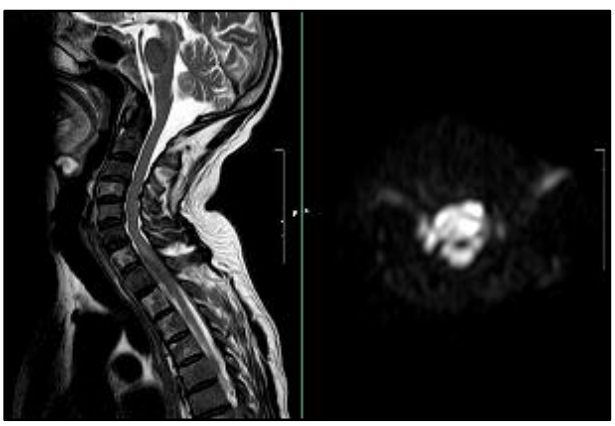

Figure 6. T2WI and Corresponding DWI Image at the Level of C7 Level Vertebral Body Showing Multiple Metastasis and the Corresponding Areas Showing Restriction on DWI Images

DISCUSSION

Vertebral collapse is one of the most common clinical problems encountered in the elderly.[1] Vertebral collapse has always been a diagnostic dilemma for radiologists to arrive at a definitive diagnosis based on the imaging data alone. Determining the aetiology of vertebral collapse has always been a challenging aspect in cases of vertebral collapse with no significant history of trauma or infection, especially in the older population.[2] MRI is a well-validated technique in evaluating disease of bone and bone marrow. Several MR imaging findings have been published as useful measures for differentiating among various aetiologies of vertebral collapse.

Lolge et al[3] emphasised tuberculosis as an important entity in the differential diagnosis of pathologies involving a single vertebral body besides neoplasm. Although, no case of tubercular solitary vertebral collapse was encountered in our study. Among 10 cases with solitary vertebral collapse, posttraumatic aetiology was most frequent with 6 cases, along with 2 cases each of osteoporotic and malignant collapse presenting with solitary vertebral involvement.

Jung HS[4] et al discriminated metastatic and acute osteoporotic compression fractures on the basis of MR imaging findings and computed the differences by using Chi-square test. They deduced that the following imaging findings are suggestive of acute osteoporotic compression fractures- a low signal intensity band on T1 and T2 weighted images, spared normal bone marrow signal intensity of the vertebral body, retropulsion of a posterior bone fragment and multiple compression fractures. In our study, normal bone marrow signal intensity was seen in most of the cases, i.e. 13 cases out of 15 osteoporotic collapse cases; however, linear intravertebral hyperintense signal on sagittal STIR sequences was seen only in 6 cases of 15 osteoporotic collapse. Table 6 compares restored bone marrow signal intensity in other studies.

	Osteoporotic	**Malignant**
Abdel-Wanis et al[4]	79%	7%
Present study	86%	41%

Table 8. Restored Normal Marrow Signal Intensity

Metastatic disease and osteoporosis may have diffuse involvement and present with multiple lesions of the spine.[5,6,7,8] In our study, both malignant and osteoporotic compression fractures showed their propensity towards thoracolumbar vertebrae. Although, this characteristic did not appear to be useful in differentiating benign and malignant fractures in our study as both involved thoracolumbar region and the signal pattern of the involved vertebrae was different in these two fractures. In the benign cases, the signal intensity was different in the varied involved levels in each patient. On the other hand, the signal intensity was the same in the involved vertebral lesions in the most of the malignant cases.[5] It is possible that patients with osteoporosis may have had vertebral compression fractures due to trivial injuries affecting different levels at different times, thus explaining the different signal intensities of the involved vertebral fractures. Otherwise, metastasis and infiltration of the tumour cells would involve different levels of vertebrae and the associated reactive response would continue even at different stages. Table 7 compares multiple vertebral involvements of osteoporotic and malignant aetiologies in various other studies.

	Malignant	**Osteoporotic**
Jung et al[4]	33%	58%
Fu TS et al[9]	68.7%	52%
Present study	83.3%	86%

Table 9. Multiple Vertebral Involvement

Distribution of metastatic vertebral collapse on the basis of primary site of origin was also evaluated in our study. Lung cancer was the most common primary site followed by prostate cancer and colorectal cancer. Dorsal vertebrae were seen to be most commonly involved in patients with lung cancer, however, cervical and lumbar vertebral segments too were not unaffected. This explains that the haematogenous route is the primary route of metastasis than paravertebral venous system and lymphatics.[10,11,12] In our study, dorsal spine was involved in 27 cases, out of which 6 were due to metastatic involvement, however, this finding was inconclusive as rest other pathologies showed

similar propensity towards the involvement of dorsal vertebral segments.

Limitations of Our Study

The main limitation of our study was the expensive cost of MRI due to which it cannot be used as primary mode of investigation in many of undiagnosed cases.

MRI was less sensitive in picking up the small bony disruptions and vertebral fractures, which were better picked up on CT.

CONCLUSION

All these MRI based features help in differentiating causes of vertebral collapse into benign and malignant aetiology and correct diagnosis helps in deciding best management protocol for the patient. The formulation of a treatment plan for patients with injuries to spine also depends on the presence and extent of neurologic injury and deformity and an estimate concerning spinal stability. Both nonsurgical and surgical treatment options are available to achieve the goals of preservation of neurologic function and restoration of spinal stability.[5,13] MRI is well known useful method in evaluating diseases of bone and bone marrow and one of the reliable method to differentiate between benign and malignant aetiology. Thus, it was concluded in our study that the MRI helps evaluate various Magnetic Resonance Imaging (MRI) features in differentiating malignant from benign vertebral collapses, which aid to achieve the goals of preservation of neurologic function and restoration of spinal stability.

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