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RESEARCH ARTICLE

ACCURACY OF MAGNETIC RESONANCE IMAGING IN DIFFERENTIATING BENIGN AND MALIGNANT CAUSES OF VERTEBRAL COLLAPSE

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ABSTRACT

Vertebral collapse is the breakdown of a vertebra resulting in a decreased height of its body. The collapse may occur to a variable extent. Vertebral collapse is associated with an increased width of the body with possible bulging of the posterior wall towards the spinal canal and consequent spinal cord or nerve root compression in severe cases. While the diagnosis of vertebral collapse is easily accomplished with plain X-ray films, etiology & in particular differentiation between benign osteoporotic vertebral collapses from tumoral replacement is difficult.

Objectives: Evaluate the accuracy of various magnetic resonance imaging (MRI) features in differentiating malignant from benign vertebral collapses. Analyse the sensitivity & specificity of MR imaging in differentiating causes of vertebral collapse.

Methods: The study is basically a prospective observational study conducted from December 2014 to June 2016. The group comprised of patients who attended Department of Radiodiagnosis & orthopaedics with complaint of back pain, lower limb weakness & generalized body ache. A detailed clinical history was obtained from all patients. Detailed examination and findings were recorded.

Results: Accuracy of pedicle involvement (96%), convex posterior border(90%),homogenenous replaced marrow (74%) and paravertebral spinal mass (86%) was found to be high in cases of malignant vertebral collapse, which helps in accurately differentiating it from benign vertebral collapse.

Conclusion: 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 etiology Thus, it was concluded in our study that the MRI helps 1.differentiating between benign and malignant etiology 2.deciding in surgical and nonsurgical treatment options which are available to achieve the goals of preservation of neurologic function and restoration of spinal stability.

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INTRODUCTION

Vertebral collapse is the breakdown of a vertebra resulting in a decreased height of its body. The collapse may occur to a variable extent. Vertebral collapse is associated with an increased width of the body with possible bulging of the posterior wall towards the spinal canal and consequent spinal cord or nerve root compression in severe cases (Laredo *et al.,* 1995). In spontaneous collapse, condition such as a primary osseous disease or secondary replacement by tumours is responsible for weakening of the vertebral osseous structure (Vaccaro *et al.,* 1999). While the diagnosis of vertebral collapse is easily accomplished with plain X-ray films, etiology & in particular differentiation between benign osteoporotic vertebral collapses from tumoral replacement is difficult. Evidence of osteoporosis may be documented on plain films as multiple vertebral deformities leading to a biconcave appearance of its intervertebral discs and osseous demineralization (Old and Calvert, 2004). CT may show specific evidences of tumoral replacement such as osseous lysis in the cortical areas and excessive soft tissue along the vertebral walls (Zhou *et al.,* 2002). In the absence of such signs the diagnosis is harder but still cannot be excluded. In the setting of chronic vertebral collapse, MRI can easily differentiate between the two conditions on the basis of signal intensities. An osteoporotic collapsed vertebral body demonstrates similar signal intensity to normal vertebrae, whereas replaced vertebral body appears to be of lower signal intensity on short TR images (Pongpornsup *et al.,* 2009). In more acute cases, the distinction between the two causes is more difficult because both display a low signal due to marrow oedema in non-neoplastic causes and to tumour itself in neoplasms (Falcone, 2002). Differentiation between benign and malignant vertebral compression fractures may not always be possible. Considering upto one-third of vertebral collapse in patients with a known primary malignancy are benign, the

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diagnosis becomes even more difficult when there is history of malignancy (Vaccaro *et al.,* 1995). As the primary cancer patients may be immunocompromised, the possibility of infectious vertebral collapse should also be considered. The acute phase of a vertebral collapse is of considerable clinical interest but the role of MR imaging in acute vertebral collapse has not been fully described (Castillo *et al.,* 2000). Fast spin-echo pulse sequences are frequently used recently, but previous reports were made by using conventional spin-echo pulse sequences. Magnetic resonance (MR) imaging is a well-known useful method in evaluating disease of bone and bone marrow. Several MR imaging findings have been published as useful measures for differentiating benign and malignant compression fracture (Vaccaro *et al.,* 1999; Old and Calvert, 2004; Pongpornsup *et al.,* 2009; Falcone, 2002; Fu *et al.,* 2004; Hsu *et al.,* 2008; An *et al.,* 1995; Baker *et al.,* 1990; Baur *et al.,* 2002; Jung *et al.,* 2003; Moulopoulos *et al.,* 1996; Cuenod *et al.,* 1996; Tehranzadeh and Tao, 2004; Lolge *et al.,* 2013). Therefore, the present study was performed with an aim to evaluate the diagnostic accuracy, sensitivity & specificity of various MR imaging based criteria in differentiating benign & malignant etiologies of vertebral collapse. Further, a review and comparison of the previously published spectrum of cases of vertebral collapse and their MRI features was also done in the present study.

Objectives

- Evaluate the accuracy of various magnetic resonance imaging (MRI) features in differentiating malignant from benign vertebral collapses.
- Analyse the sensitivity & specificity of MR imaging in differentiating causes of vertebral collapse.

MATERIALS AND METHODS

The present study was conducted in the "Department Of Radiodiagnosis, Shri B M Patil Medical College Hospital & 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 & orthopaedics with complaint of back pain, lower limb weakness & generalized 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 Orthopedics, were included in this study.

Exclusion criteria

- Patients with benign or malignant spinal involvement without associated collapse were excluded.
- 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.
- Non ionic contrast medium, if and when required.

OBSERVATIONS AND RESULTS

Of the total 50 cases clinically presenting with vertebral collapse, 12 were confirmed with biopsy and the remaining 38 cases were confirmed either by further imaging studies (such as plain film, bone scan, CT or MRI) or a clinical follow-up. A thorough evaluation of all patients was performed, which included evaluation of past medical history with special attention to any malignant disease, laboratory tests, clinical examination, and plain radiographs of the thoracic and lumbar spine. The appearance of each MRI characteristic on images was determined and recorded. Statistical analysis was performed and results were compared. 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% (33/50cases) males and 34% (17/50cases) 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.

Involvement of pedicles and posterior elements is the diagnostic sign for malignant vertebral collapse on MRI & was seen in almost all the cases with malignant etiology in our study. Pedicle or posterior element was seen in 11 cases of malignant vertebral collapse, while 1 case of benign collapse cases also had pedicle involvement. Thus, involvement of pedicle and posterior element was found to be statistically significant ($P<0.001$) for malignant collapse (Table 1). In homogenous bone marrow signal was seen in 15cases with rest showing homogenous signal intensity. In homogenous signal intensity was noted in 7 cases of malignant and in 8 cases of benign vertebral collapse. Presence of inhomogenous signal intensity was found to be statistically significant for malignant collapse ($P<0.05$). In our study, 11 (22%) out of 50 cases showed associated epidural or paravertebral mass with vertebral collapse. Out of 12 malignant collapse cases, 8 cases (66.6%) presented with epidural or paravertebral mass. Out of 38 benign collapse cases, 3 cases (7.8%) also presented with epidural or paravertebral mass. The appearance of paravertebral or epidural soft tissue mass was irregular and nodular. Presence of paravertebral or epidural soft tissue mass was statistically significant ($P<0.001$) for malignant collapse.

Table 1. Distribution of lesions according to involvement of pedicle and posterior elements

Involement of Pedicle or Posterior element	Final Diagnosis					
	Benign		Malignant		Total	
	No.	%	No.	%	No.	%
Absent	37	97.37	1	8.33	38	76.00
Present	1	2.63	11	91.67	12	24.00
Total	38	100.00	12	100.00	50	100.00

Table 2. Distribution of lesions according to convex posterior vertebral border

Convex Posterior Vertebral Border	Final Diagnosis					
	Benign		Malignant		Total	
	No.	%	No.	%	No.	%
Absent	35	92.11	2	16.67	37	74.00
Present	3	7.89	10	83.33	13	26.00
Total	38	100.00	12	100.00	50	100.00

Table 3. Distribution of lesions according to replaced bone marrow signal intensity

Replaced Marrow Signal	Final Diagnosis					
	Benign		Malignant		Total	
	No.	%	No.	%	No.	%
Homogenous	30	78.95	5	41.67	35	70.00
Inhomogenous	8	21.05	7	58.33	15	30.00
Total	38	100.00	12	100.00	50	100.00

Table 4. Distribution of lesions according to epidural or paravertebral soft tissue mass

Epidural or Paravertbral Mass	Final Diagnosis					
	Benign		Malignant		Total	
	No.	%	No.	%	No.	%
Absent	35	92.11	4	33.33	39	78.00
Present	3	7.89	8	66.67	11	22.00
Total	38	100.00	12	100.00	50	100.00

Table 5. Statistical analysis of mri findings between metastatic and non-metastatic vertebral collapse

MRI Findings	Sensitivity	Specificity	PPV	NPV	DA
Convex Posterior Vertebral Border	83.33	92.10	76.92	94.59	90.00
Involement of Pedicle	91.67	97.36	91.67	97.36	96.00
Inhomogenous Replaced Marrow Signal	58.33	78.94	46.67	85.71	74.00
Epidural or Paravertbral Mass Present	66.67	92.10	72.72	89.74	86.00

DISCUSSION

Vertebral collapse is one of the most common clinical problems encountered in the elderly (Castillo *et al.,* 2000). Vertebral collapse has always been a diagnostic dilemma for radiologists, to arrive at a definitive diagnosis based on the imaging data alone. Determining the etiology 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 (Vaccaro *et al.,* 1999). MRI is a well validated technique in evaluating disease of bone and bone marrow. Hence the present study evaluate the role of MRI in cases of vertebral collapse equivocal in accurately differentiating a malignant compression fracture from a benign process in the presented population. Attempts to differentiate between benign and malignant vertebral collapse present a major problem in elderly patients where the two entities may occur simultaneously. The limitations of other imaging modalities like radiographs, bone isotope scanning, myelography and computed tomography in the diagnosis of benign and malignant vertebral disease have been well documented (Castillo *et al.,* 2000; Fu *et al.,* 2004). Pongpornsup *et al.,* 2009 had reported that MR imaging features suggestive of malignant vertebral compression fracture were convex posterior border of the vertebral body, involvement of pedicle or posterior element, epidural or paraspinal mass and destruction of bony cortex. Among these, involvement of pedicle or posterior element was the most reliable finding for malignant collapse with sensitivity and specificity of 91.4% and 82.6% respectively. In our study, pedicle involvement was the most consistent finding with a high sensitivity and specificity of 91.6% and 97.3% respectively.(Table I) It was followed by convex posterior border as the most reliable individual finding with sensitivity of 83.3% and specificity of 92.1%(TABLE II). Among 38 cases with non-metastatic vertebral collapse, pedicle involvement was seen in a single case .Thus, statistically presenting with a high NPV i.e. 97.3% and PPV of 91.6%. These finding are consistent with previous studies which also had high sensitivity of 95% (Yusof *et al.,* 2009), high diagnostic accuracy of 84% and significant p value < 0.05 (Vaccaro *et al.,* 1999; Old and Calvert, 2004; Pongpornsup *et al.,* 2009; Falcone, 2002; Fu *et al.,* 2004; Hsu *et al.,* 2008; An *et al.,* 1995; Baker *et al.,* 1990; Baur *et al.,* 2002; Jung *et al.,* 2003; Moulopoulos *et al.,* 1996; Cuenod *et al.,* 1996) finding is possible because in most cases of malignant compression

Table 6. Involvement of pedicle or posterior element

Author	Sensitivity	Specificity
Abdel-Wanis et al	95	70
Pongpornsup et al	91.4	82.6
Present study	91.6	97.3

Table 7. Pedicle Involvement

	Malignant	Osteoporotic	Infective
Jung et al	85%	51%	-
Fu TS et al	93.8%	12%	-
Abdel-Wanis et al	95%	15%	46%
Present study	91.6%	0%	9%

Table 8. Convex posterior border (Percentage)

Author	Malignant	Osteoporotic
Abdel-Wanis et al	71%	3%
Jung et al	74%	20%
Cuenod CA et al	70%	6.3%
Present study	83.3%	0%

fractures, tumoral cell has already spread to the pedicles and neural arch before it collapses, whereas the reactive bone marrow changes usually spare the pedicles in osteoporotic compression fractures (Pongpornsup *et al.,* 2009; An *et al.,* 1995). Simlarly, in a recent study by Yusof *et al.,* in 2009, the posterior spinal involvement especially the pedicle was noted in 64.5% of patients with tuberculosis. They concluded that pedicle involvement is part of the disease process and usually associated with relatively severe vertebral body and disc destruction, wide prevertebral abscess, and severe kyphosis. Pedicle involvement can be detected early from MRI and need to be documented as it may influence the treatment strategy (Castillo *et al.,* 2000; Baker *et al.,* 1994; Jung *et al.,* 2003).

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