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Role of MRI in Evaluation of Compression Fractures

Devidas B Dahiphale[1], Ejaj Isa Patel[2], P S Mishrikotkar[3], Vikas Shinde[4]

[1]Professor and HOD Department of Radiology MGM Medical College and Hospital, Aurangabad.
[2]Junior resident Department of Radiology MGM Medical College and Hospital, Aurangabad.
[3]Professor, Department of Radiology MGM Medical College and Hospital, Aurangabad.
[4]Assistant Professor, Department of Radiology MGM Medical College and Hospital, Aurangabad.

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ABSTRACT

Background: Vertebral compression fractures have a variety of etiologies including trauma, osteoporosis or neoplasm. Osteoporotic compression fractures have prevalence of approximately 25% among postmenopausal women and occurs less frequently in similar aged men. Trauma is most common cause in those younger than 50 years of age. The aim of this study is to evaluate compression fracture in cases of spinal trauma. **Aims and objectives:** To evaluate compression fractures by magnetic resonance imaging in cases of spinal trauma. To document the spectrum of MRI findings in patients of compression fracture in cases of spinal trauma. To detect additional information about the nature and extent of tissue damage in patients with compression fractures. To study the incidence of injury and MRI morphology of ligaments, spinal cord, intervertebral discs, vertebra and extraspinal soft tissues in patients with compression fractures in cases of spinal trauma. **Methods:** This study was carried out at Department of Radiology, MGM Medical College and hospital Aurangabad. The study was conducted on 53 patients refereed to department of radiology between May 2018 to September 2019.All scans are done using PHILIPS MULTIVA1.5 tesla MRI system technique with Standard spine coil. **Discussion:** In our study, 53 patients underwent MRI for evaluation of traumatic compression fractures with majority being males. MRI was helpful in detecting bone marrow edema and was seen in 11 cases. Fractures with vertebral compression generated marrow edema. Most common type of spinal cord injury in our study was cord edema followed by compression. MR imaging is only imaging modality to assess spinal cord injury, to diagnose location and the severity of lesion and to detect cause of spinal cord compression. **Conclusions:** MRI plays a major role in the diagnosis of SCIs, directing early and prompt management and predicting prognosis of neurological recovery. MR imaging should be considered as primary imaging modality in assessing ligamentous injury. MRI should be recommended in all patients with suspected spinal compression fracture both as a diagnostic and prognostic indicator.

Keywords: Magnetic Resonance Imaging, Compression Fractures, Spinal trauma, Ligament injuries.

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INTRODUCTION

Vertebral compression fractures have a variety of etiologies including trauma, osteoporosis or neoplasm. Osteoporotic compression fractures have prevalence of approximately 25% among postmenopausal women and occurs less frequently in similar aged men.[1] Trauma is most common cause in those younger than 50 years of age. Cancers such as breast, prostate, thyroid and lung tend to metastasize to bone which lead to malignant vertebral compression fractures.[2] Primary tumours of bone and lymphoproliferative disease such as lymphoma and multiple myeloma can be the cause of malignant vertebral compression fractures.MRI traditionally has been the technique of choice because of characteristic morphologic features, enhancement patterns and signal intensities are well described.[3] When a patient with spinal trauma is referred for imaging, exact mechanism of trauma is unknown in many cases. Therefore most radiologist use a pragmatic approach to classify and describe vertebral fractures based on vertebral morphology.4This classification system takes into account the loss of height of vertebra body and location of fractures. Osteoporotic fractures can be classified into three major types, depending on location of the fracture lines.[4]

- Wedge fracture-involving anterior (or less commonly posterior) edge of vertebral body.
- Concave or biconcave fractures, involving the central part of vertebra
- Crush fracture, involving a combination of anterior, posterior and central elements.

Within each group, the deformity can be graded semi quantitatively according to the loss of vertebral body height:[5]

- Grade I: vertebral body height is >75% of normal value

Name & Address of Corresponding Author
Dr Ejaj Isa Patel
Junior Resident
Department of Radiology
MGM Medical College and Hospital,
Aurangabad

- Grade II: vertebral body height is between 50 and 75% of normal value
- Grade III: vertebral body height is < 50% of normal value

Even more important is to assess the deformity of the spinal canal and neural foramina. In spine fractures, the spinal canal is often narrowed from translation and intrusion of vertebral body fragments.[6]

Mechanism of injury:

With reference to Denis' three column theory of spinal stability,[7] spinal fractures are classified based on pattern of injury and forces involved.[8]

Flexion-compression mechanism (Wedge or compression fracture):

Anterior wedge compression fracture is caused by combination of flexion and compression forces. Anterior column is compressed with variable involvement of middle and posterior column. Three subtypes are defined:[9,10]

1. Stable fracture-only anterior column is implicated resulting in anterior wedging of vertebral body with < 50% loss of anterior vertebral body height.
2. Potentially unstable fracture-anterior column involvement and posterior column ligamentous failure is seen with anterior wedging of vertebral body and increased interspinous distance. There is >50 % loss of vertebral body height.
3. Unstable fracture-failure of all three columns is seen. Imaging studies shows anterior wedging of vertebral body and disruption of posterior vertebral body. Disrupted bone fragment in spinal canal may compress spinal cord or nerve roots.

Axial-compression mechanism (Burst fracture):

Axial –compression forces causes burst fracture or crush fracture. This type of injury is associated with high energy trauma like fall from height, motor vehicle accident and sports related trauma. Burst fractures are most commonly found at thoraco-lumbar junction and between levels T5 and T8.[11]

Burst fracture is characterized by loss of height of vertebral body. The fracture involves anterior and middle columns; the state of posterior column determines whether fracture is stable or unstable. Displacement of posterior elements or dislocation/subluxation of vertebral body or facet is found in unstable fracture. Displacement of bony fragment into spinal canal may cause spinal cord or nerve roots compression or vascular injury.[12]

Flexion-distraction mechanism (Chance fractures):

Chance (or seatbelt) fracture occurs due to a combination of flexion and distraction forces. This fracture is a type of thoracolumbar injury involving posterior column and injury to ligamentous components. These fractures are often associated with intraabdominal injuries.[13] The pathophysiology of Chance fracture depends on axis flexion. Several subtypes of Chance fractures exists. Most common type of fracture is horizontal fracture, in which the axis of flexion is anterior to anterior longitudinal ligament (ALL) with resultant horizontal fracture of bony elements along with supraspinous ligament disruption. Imaging studies shows increase in interspinous distance and may shows horizontal fracture lines through pedicles, transverse processes and pars interarticularis.[13]

In cases of more severe flexion-distraction forces, axis of flexion lies behind ALL. These types of Chance fractures are accompanied by burst type of vertebral fractures with buckling or retropulsion of posterior cortex. This is unstable type of injury. Neurological sequels are related to degree of compression of neural elements.

Rotational fracture-dislocation mechanism:

There is combination of lateral flexion and rotation with or without component of posterior-anteriorly directed force .The resultant injury pattern is failure of both posterior and middle columns with varying degrees of anterior column insult. Rotational force is responsible for disruption of posterior elements and facet joints. Vertebral compression fractures most commonly occur in the mid-thoracic or thoracolumbar transition zone of the spine. Though exceedingly rare, occasionally retropulsion of fracture fragments may result in compression of the spinal cord or cauda equina and result in weakness and loss of sensation of the lower extremities or even bowel or bladder incontinence. Depending on the severity and rapidity of deficit onset, this may constitute a surgical emergency.[14]

MATERIALS & METHODS

This study was carried out at Department of Radiology, MGM Medical College and hospital Aurangabad. The study was conducted on 53 patients referred to department of radiology between May 2018 to September 2019. All scans are done using PHILIPS MULTIVA1.[5] tesla MRI system technique with Standard spine coil.

Inclusion criteria:

- Patient clinically symptomatic and with history of spinal trauma
- Patients above age of 18 years

Exclusion Criteria:

- Patients with history of metallic implant, foreign body, pacemaker, aneurysm clip, recently implanted prosthetic valve.
- Patients too unstable to undergo MRI scan who are on ventilator support.
- Patients with history of claustrophobia.

Spine is evaluated by axial, sagittal and coronal views. Dedicated study of clinically area was performed along with screening of whole spine.

Recommended sequences are:-

- T1-sagittal.
- T2-sagittal
- Sagittal – STIR.
- T1-axial
- T2-axial
- Sagittal MERGE,
- Coronal –STIR.

RESULTS

Assessment of spine injuries was done under following categories: distribution of patients according to age and sex, cause of injuries, disc injuries, ligament injuries, cord injuries, listhesis injuries, osseous injuries and soft tissue injuries.

Total numbers of patients studied were 53 and were divided into 3 age groups. They are 1]18-40 2] 41-60 3] 31-60 years. In our study the smallest age was 18 years and highest age was 80 years. Maximum number of patients were found in the age group 18 to 40 years constituting 19 patients (35.84%) followed by the age group 41 to 60 years constituting 18 patients (33.96 %).(Table 1)

Table 1: Distribution of patients according to age

Age group in years	No. of patients	Percentage
18-40 years	19	35.84%
41-60 years	18	33.96%
61-80 years	16	30.18%
Total	53	100

Table 2: Distribution of patients according to sex

Gender	No. of patients	Percentage
Male	33	62.26%
Female	20	37.74

Out of the total 53 patients evaluated for compression fractures, 33 (62.26%) patients were males and 20 (37.74%) patients were females. In our study males are found more prone for acute compression fractures.
(Table 2)

Out of the total 53 patients evaluated for traumatic compression fractures, most common cause of injury was road traffic accidents followed by fall from height and slip injuries. [Table 3]

Table 3: Distribution of patients according to cause of injuries

Type of injury	No of Patients	Percentage
Fall from height	20	37.74 %
Road traffic accidents	24	45.28 %
Slip injuries	9	16.98 %

Table 4: Distribution of patients according to disc injuries

Disc injuries	No of Patients	Percentage
Absent	35	66.03 %
Present	18	33.97 %

In our study, we found that 35 patients (66.03 %) not suffered from intervertebral disc injuries and 18 patients (33.97 %) suffered from intervertebral disc injuries (most commonly found is posttraumatic disc herniation) (Table 4)

Table 5: Distribution of patients according to region of spine involved in patients with intervertebral disc injuries

Region of spine involved	No. of patients (n=18)	Percentage
Cervical	5	27.77 %
Dorsal	0	0
Lumbar	10	55.56 %
Lumbosacral	3	16.67%

Most of the intervertebral disc injuries are found in lumbar region followed by cervical and lumbo-sacral region. Intervertebral disc injury is not found in dorsal region. (Table 5)

Table 6: Distribution of patients according to ligament injuries

Ligament injury	No of Patient	Percentage
Absent	51	96.24 %
Isolated ALL	1	1.88%
Isolated PLL	0	0
Both ALL & PLL	0	0
Both PLL and ligamentum flavum	1	1.88 %
Interspinous and supraspinous ligaments	0	0

In our study we found that, most of the patients are not suffering from ligaments injuries .We found 2 patients with ligament injuries ,one patients with disruption of ALL and 1 patient with disruption of PLL and ligamentum flavum [Table 6]

Table 7: Distribution of patients according to cord injuries

Cord injury	No of Patient	Region of spinal cord involved		
		Cervical	Dorsal	Conus medullaris
Compression	11(20.75%)	4	3	4
Edema/ contusion	13(24.53%)	7	4	2
Cord hemorrhage	0	0	0	0
Epidural hematoma	1 (1.88%)	0	1	0

In our study we found that most common cord injury is cord edema followed by cord compression. Only 1 patient with epidural hematoma is found. Patients with cord hemorrhage are not found in our study. (Table 7)

Table 8: Distribution of patients according to Listhesis injuries

Listhesis injury	No of Patients
Normal	47 (88.68%)
Anterolisthesis	3 (5.66%)
Retrolisthesis	1 (1.88%)
Subluxation /dislocation	2 (3.78%)

In our study we found 47 patients with no listhesis injury. We found 3 patients with anterolisthesis, 1 patient with retrolisthesis and 2 patients with traumatic subluxation.(Table 8)

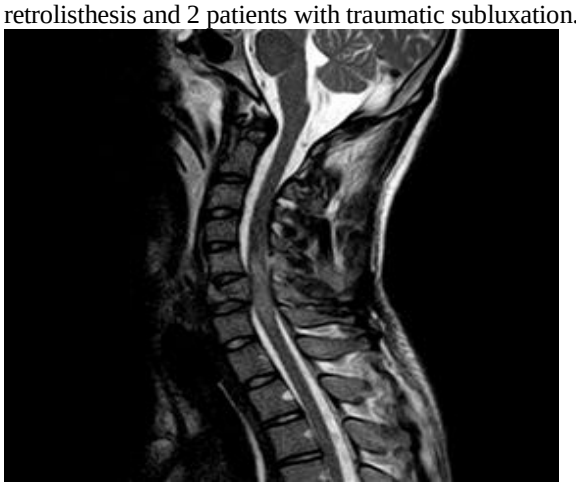

Figure 1: Sagittal T2W image showing hyperintense signal intensity from lower border of C5 to upper border of C7 vertebral level suggestive of cord edema.

Figure 2: Sagittal T2W image showing anterolisthesis of L5 over S1 and anterior wedge compression fracture of L4 vertebral body.

Table 9: Distribution of patients according to region of spine involved in patients of compression fracture

Region of spine involved	No. of patients	Percentage
Cervical	2	3.77 %
Upper dorsal (D1-D4)	3	5.66%
Mid-dorsal (D7-D8)	9	16.98%
Lower dorsal(D9-D12)	19	35.84%
Dorso-lumbar	1	1.88%
Lumbar	28	52.83%

In our study group, out of the 53 patients, maximum patients had compression fractures in the dorsal spine followed by lumbar spine. Cervical spine were least commonly affected. (Table 9)

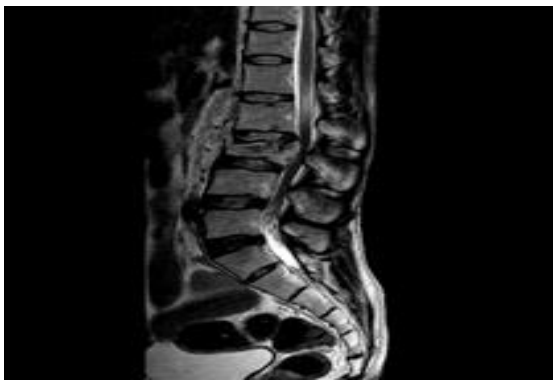

Figure 3: Sagittal T2W image showing anterior wedging of L3 vertebral body.

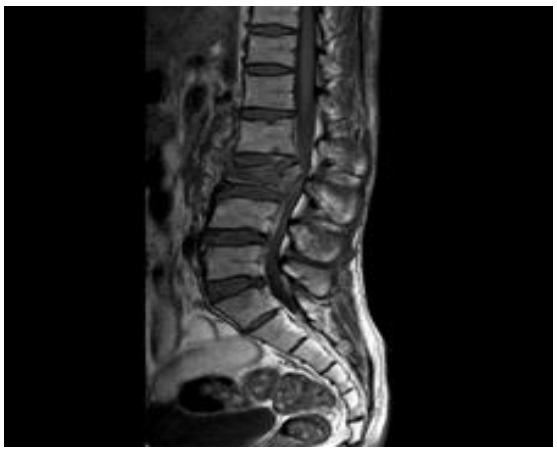

Figure 4: Sagittal T1W image showing anterior wedging of vertebral body and appears hypointense on T1W images.

Figure 5: L3 vertebral body appearing hyperintense on coronal STIR images.

These images are suggestive of acute compression fracture of L3 vertebral body.

Table 10: Distribution of patients according osseous injuries

Osseous injuries	Number of Patients	Percentage
Burst fractures	4	7.5 %
Marrow edema	11	20.75 %
Posterior element fractures	3	5.66 %

In our study, we found 4 patients with burst fracture, 11 patients with marrow edema and 3 patients with posterior element fractures. (Table 10)

Table 11: Distribution of patients according to soft tissue injuries

Soft tissue injury	Number of patients
Normal	49 (92.45%)
Hematoma	1 (1.88%)
Muscle contusion /edema	3 (5.66%)

In our study, most of patients are not suffering from soft tissue injuries. We found 1 patient with hematoma and 3 patients with muscle edema or contusion. (Table 11).

DISCUSSION

In our study, 53 patients underwent MRI for evaluation of compression fractures in patients with spinal trauma.

Maximum numbers of patients were found in the age group 18 to 40 years constituting 19 patients (35.84%) followed by the age group 41 to 60 years constituting 18 patients (33.96%).

As per Nalina et al,[15] the commonly affected age group is 18 – 50 years and as per Donald et al,[16] Timothy et al,[17] and Flanders et al,[18] the most commonly affected age group is 16-30 years. These observations by the above authors regarding the affected age group are close to our study.

In our study most of patients are males. Females with compression fractures are elderly with some of them suffering from slip injuries. The gender distribution in our study was consistent with Kerslake19 et al and close to Roop Singh et al.[20] Most common cause of spinal injury was road traffic accident in this study. Most of the literature provide motor vehicle accidents to be the most common cause of spinal injury.[21,22]

In our study, we found 33.97 % patients with intervertebral disc injuries (most commonly post traumatic disc herniation). The incidence of disc injuries in our study is consistent with study done by Katzberg et al.[23] Most common type of spinal cord injury in our study was cord edema followed by compression. This is consistent with studies by Khandelwal et al,[24] Kulkarni et al,[25] and Mc Ardle et al,[26] who also found cord oedema to be the most common cord injury pattern.

MR imaging is only imaging modality to assess spinal cord injury, to diagnose location and the severity of lesion and to detect cause of spinal cord compression. Most of the patients in our study are not suffering from ligament injuries. MRI was helpful in detecting bone marrow edema and was seen in 11 cases. Fractures with vertebral compression generated marrow edema which was statistically significant whereas distraction fractures and other types of fractures did not reliably generate marrow edema. This is in keeping with the study done by Mark A. Brinckman et al. which says statistically significant differences in marrow edema were observed between vertebral body compression fractures compared to distracted fractures or those fractures that did not distract or compress.[27]

In our study, most of the patients are not suffered from any listhesis injuries. Out of 53 patients, only 3 patients with anterolisthesis and 1 patient with retrolisthesis is found. In our study, soft tissue injuries are not found in most of patients. We found 1 patients with hematoma, 3patients with muscle edema /contusion.

CONCLUSION

Thus we conclude that, spinal compression fractures are more common in males as compared to females and more common in the age group 18 years to 40 years age group. All types of injuries like road traffic accidents, fall from height more common in males except slip injuries which were more common in females. Bone marrow edema was the most common type of osseous injury found in our study. MRI is the only investigation which can detect marrow oedema. Most common type of spinal cord injury in our study was cord edema followed by compression. MR imaging is only imaging modality to assess spinal cord injury, to diagnose location and the severity of lesion and to detect cause of spinal cord compression.

In a polytrauma patient MRI helps in diagnosis of multilevel injuries and may reveal clinically unsuspected injuries compressing the cord. We concluded that MRI plays a major role in the

diagnosis of SCIs, directing early and prompt management and predicting prognosis of neurological recovery. MR imaging should be considered as primary imaging modality in assessing ligamentous injury. MRI should be recommended in all patients with suspected spinal compression fracture both as a diagnostic and prognostic indicator.

REFERENCES

1. Melton LJ 3rd. Epidemiology of spinal osteoporosis. Spine (Phila Pa 1976) 1997;22:2S–11S CrossRef Medline
2. Coleman RE. Skeletal complications of malignancy. Cancer 1997;80: 1588–94 Medline
3. Porter BA, Shields AF, Olson DO. Magnetic resonance imaging of bone marrow disorders. Radiol Clin North Am 1986;24:269–89 Medline
4. Lenchik L, Rogers LF, Delmas PD, Genant HK (2004) Diagnosis of vertebral osteoporotic fractures: importance of recognition and description by radiologists. AJR Am J Roentgenol 183:949–958
5. Genant HK, Wu CY, van Kuijk C, Nevitt MC (1993) Vertebral fracture assessment using a semiquantitative technique. J Bone Miner Res 8:1137–1148
6. Tsou PM, Wang J, Khoo L, Shamie AN, Holly L (2006) A thoracic and lumbar spine injury severity classification based on neurologic function grade, spinal canal deformity, and spinal biomechanical stability. Spine J 6:636–647
7. Denis F (1983) The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. Spine 8:817–831
8. Vollmer DG, Gegg C (1997) Classification and acute management of thoracolumbar fractures. Neurosurg Clin N Am 8:499–507
9. Ferguson RL, Allen BL Jr (1984) A mechanistic classification of thoracolumbar spine fractures. Clin Orthop Relat Res 189:77–88
10. Singh K, Vaccaro AR, Eichenbaum MD, Fitzhenry LN (2004) The surgical management of thoracolumbar injuries. J Spinal Cord Med 27:95–101
11. Bensch FV, Koivikko MP, Kiuru MJ, Koskinen SK (2006) The incidence and distribution of burst fractures. Emerg Radiol12:124–129
12. McAfee PC, Yuan HA, Fredrickson BE, Lubicky JP (1983) The value of computed tomography in thoracolumbar fractures. An analysis of one hundred consecutive cases and a new classification. J Bone Joint Surg Am 65:461–473
13. Bernstein MP, Mirvis SE, Shanmuganathan K (2006) Chance type fractures of the thoracolumbar spine: imaging analysis in 53 patients. AJR Am J Roentgenol 187:859–868
14. Kavanagh M, Walker J. Assessing and managing patients with cauda equina syndrome. Br J Nurs. 2013;22(3):134–137.
15. Nalina Gupta, John Solomon M, Kavitha Raja. Demographic Characteristics of Individuals with Paraplegia in India- A survey. Vol. 2, No. 3 (2008-07 - 2008-09)
16. Donald Schreiber, MD, CM; Chief Editor: Rick Kulkarni, MD. Spinal Cord Injuries. [Medline]
17. George Timothy Reiter, MD; Chief Editor: Allen R Wyler, MD. Vertebral Fracture. [Medline]
18. Flanders AE, Schaefer DM, Doan HT, et al. Acute cervical spine trauma: correlation of MRI imaging findings with degree of neurologic deficit. Radiology. 1990;177(1):25-33.
19. Kerslake. R. W. , T. Jaspan, and B. S. Worthington. Magnetic resonance imaging of spinal trauma. British journal of radiology.1991:64.386-402.
20. Traumatic spinal cord injuries in haryana : an epidemiological study .Roop Singh, Sansar Chand Sharma, Rajeev Mittal, Ashwini Sharma Deptt, of Orthopaedics, Paraplegia and Rehabilitation,Pt. B.D. Sharma PGIMS, Rohtak.
21. Blackmore CC, Ramsey SD, Mann FA, Deyo RA. Cervical spine screening with CT in trauma patients: a cost-effectiveness analysis. Radiology 1999;212:117-25.
22. Ross JS, Brant-Zawadzi M, Moore KR, Crim J, Chen MZ, Katzman GL. Diagnostic imaging spine. In: Trauma, vol. 2. Itapetininga: Amirsys; 2007. p. II1–II138.
23. Richard. W. Katzberg , MD, Philip F Benedetti, MD Christiana M Drake, Phd. Marija Ivanovic, Phd. Carol S Beatty MD. William R Nemzek, MD. Francesca K Ontell MD, Dorene M Bishop , BS, Virginia C Poirer MD , Brain W Chong MD. Acute cervical spine injuries: Prospective MR imaging Assessment at a level 1 trauma care center.
24. S Khandelwal, GL Sharma, UD Saxena, P Sakhi, S Gopal, P Saxena. Prospective evaluation of cervical spine injuries by MRI and assessing role of MR findings in predicting prognosis. IJRI:Year : 2004,Volume: 14,Issue:1,Page:71-80.
25. Madan V. Kulkarni, M.D.' Fonda ,J.Bondurant, M.D.Stephen L. Rose, M .D.'Ponnada A. Narayana, Ph.D. 1.5 tesla magnetic resonance imaging of acute spinal trauma. Volume 8, Number 6 November, 1988)
26. Kulkarni MV, MC Ardle CB, Kopanicky D et al . Acute spinal cord injury: MR imaging at 1.51. Radiology 1987; 164: 837-843.
27. Brinckman, M., Chau, C., & Ross, J. (2015). Marrow edema variability in acute spine fractures. The Spine Journal, 15(3), 454-460.

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