# Imaging in Thoracic Disc Prolapse: A Study of 25 Patients and Review of Literature

Devanand Degulmadi[1], Bharat R Dave[1], Ajay Krishnan[1], Shivanand Mayi[1], Ravi Ranjan Rai[1]

## Abstract

**Purpose:** Unlike cervical and lumbar disc, thoracic disc prolapse (TDP) has limited literature. Many studies have focused on surgical technique of TDP. The aim of this study is to highlight the radiological features of TDP that would help surgeons in understanding the peculiar features of such uncommon entity and also planning the surgery.

**Materials and Methods:** All the patients surgically treated for TDP between May 2010 and June 2018 were included in the study. A retrospective collection of all the radiographs, CT and MR images were done.

**Results:** A total of 25 subjects, two patients had double level disc prolapse; hence, a total of 27 discs were analyzed. On radiographs, end-plate was concave (n = 9), straight (n = 12), cupid bow shaped (n = 6), calcification in disc space (n = 5), and calcification within the canal (n = 14). EP junction failures were type IA (n = 10), type IB (n = 6), type ID (n = 2), and type II (n = 9). On MRI, central disc prolapse (n = 10), right paracentral (n = 12), and left paracentral (n = 5). According to Pfirmann grading, three discs were Grade 2; five discs as Grade 3; 14 as Grade 4; and five as Grade 5. Fourteen discs had >40% canal occupancy. Schmorl nodes were noted (n = 17).

**Conclusion:** Lower thoracic spine has a higher incidence of TDP. Calcification is commonly seen in cases of TDP, either in the disc space or within the canal. Most of the cases present with >40% of canal occupancy. End plate defect, a variant of schmorl node, may be a possible contributor to disc prolapse.

**Keywords:** Thoracic disc prolapse; Radiology; Calcification.

## Introduction

Thoracic disc prolapse (TDP) is relatively uncommon with an incidence of approximately one case per million of habitants per year [1, 2]. TDP most commonly occurs in the lower thoracic spine with clinical features ranging from radiculopathy to significant myelopathy [1]. Unlike cervical and lumbar disc, TDP has very limited literature. There are few unique characteristics that make the cord vulnerable to dysfunction such as anatomic area of poor blood supply, narrow canal, limited mobility, and frequent calcification of disc at this level [3]. Much of the literature has focused on the surgical technique of managing TDP. However, radiological features of such uncommon entity have not been discussed so far in detail. The aim of this retrospective study is to highlight radiological features of TDP that would help surgeons in understanding the peculiar features of such uncommon entity and also planning the surgery. We analyzed the radiological imaging of thoracic disc and highlighted features distinctive to TDP.

[1]Stavya Spine Hospital and Research Institute, Near Nagari Eye Hospital, Mithakhali, Ellisbrige, Ahmedabad, Gujarat, India .

**Address of correspondence :**
Dr. Devanand Degulmadi,
Stavya Spine Hospital and Research Institute, Mithakali, Ellisbrige, Ahmedabad, Gujarat, India.
**E-mail:** drdanand@yahoo.co.in

## Materials and Methods

All the patients surgically treated for TDP between May 2010 and June 2018 were included in the study. A retrospective collection of all the radiographs, computed tomography (CT) and magnetic resonance images (MRI) were done. All the cases with complete records of imaging of thoracic spine were included in the study. Demographic details such as age and gender were noted.

### Assessment of radiographs

End-plates (superior/inferior or both) were analyzed for the presence of normal concave end plate, straight end plate, cupid bow contour (localized concavity in the end plate), or any fracture [4] (Fig. 1). Presence of schmorl node was defined as the focal indentation of the end plate [4]. The presence of claw or traction osteophytes was recorded. The presence of calcification either in the disc space or in the spinal canal was noted as on anteroposterior and lateral images (Fig. 2).

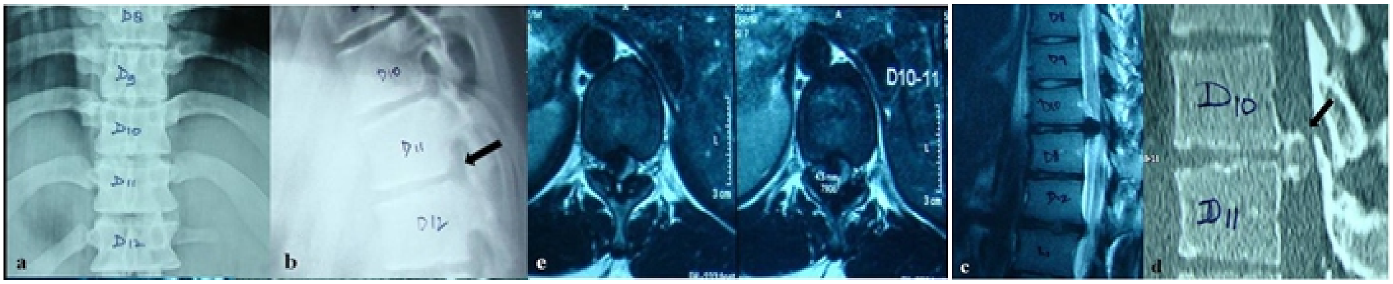

**Figure 1:** (a) Illustrative case showing calcification within the canal, claw osteophytes (arrow). (b) CT showing Type Ib EP injury, intra discal as well as calcification in spinal canal. (c) Hypointense mass on right paracentral area displacing the cord. (d) Irregular calcified mass (ossification) seen in axial CT images. (e) T2 sagittal images showing disc prolapse.

## Assessment of CT images

The presence of calcification, type of calcification, and margins of calcified/ossified disc were noted.

## Assessment of MR images

MR images were assessed for the level of disc prolapse, type and extent (migration) of disc prolapse, stage of disc degeneration (Pfirmann grading), status of ligamentum flavum, end-plate changes, presence/absence of schmorl nodes, modic changes, status of posterior longitudinal ligament (PLL), % of canal compromise, and cord signal intensity changes. Whole spine screening images were numbered from C2 onward caudally and level of disc prolapse was noted. Type of disc prolapse was recorded as central or paracentral. Protrusion, extrusion, or sequestration were noted along with migration of disc either proximal or distal in relation to the parent disc. Stages of disc degeneration were classified according to Pfirmann grading into five grades [5]. End-plate (EP) junction failures were classified as per classification by Rajasekharan et al. into types 1 and 2 [6]. Any occult evidence of irregularity of EP or vertebral corner defects (type IA), thin rim avulsions of the EP (type IB), large bony avulsions (type IC), and EP avulsions at both the upper and lower levels (type ID), and intact EP (type 2). Ligamentum flavum hypertrophy was noted on T2 axial images.

**Figure 2:** MR images showing different patterns of disc prolapse. (a) Extruded disc prolapse with inferior migration. (b) Disc prolapse with irregularity in both inferior and superior end plates. (c) Calcified disc prolapse with defect in posterior margin of the inferior end plate. (d) Disc protrusion with intact PLL. (e) Soft disc prolapse with superior migration. (f) Calcified disc protrusion occupying more than 40% of the canal.

End-plate erosions were defined as irregularities and low-signal intensity changes on MRI. Schmorl nodes were defined as the vertical herniation of nucleus pulposus through the cartilaginous and bony end-plate into the body of the adjacent vertebra and their presence was noted on sagittal T2 (high signal) and T1 (low signal) MR images [5]. Modic changes were noted based on criteria as defined – Type 1 – low signal

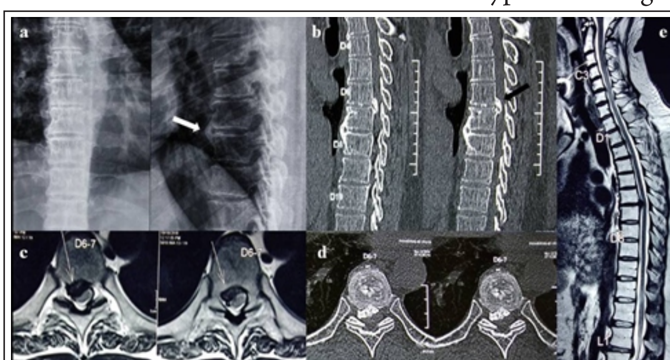

**Figure 3:** (a) Illustrative case showing irregular end plates on radiographs. (b) Calcification in spinal canal. (c) Disc protrusion on MRI. (d) Type Ia EP, Calcified disc with smooth margins on CT. (e) Right paracentral disc prolapse occupying more than 40% of canal space on axial images.

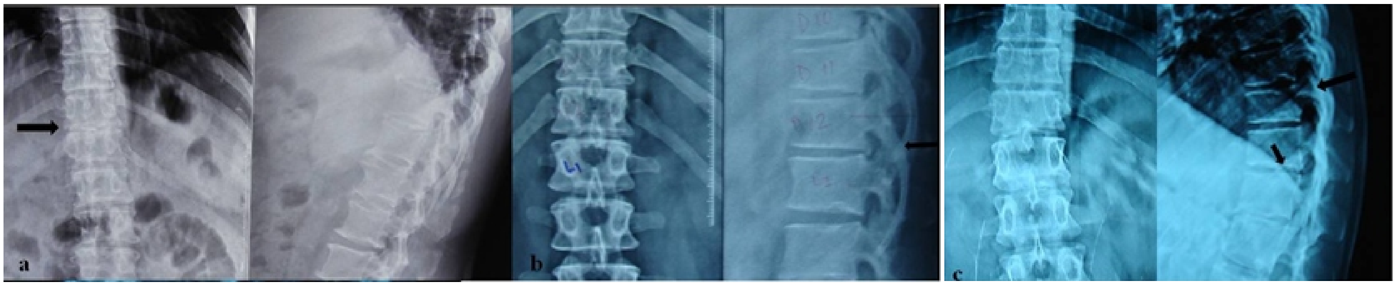

**Figure 4:** Radiographs showing different types of end-plate changes classified according to Pfirmann. (a) Calcification within the disc space on AP view, concave end plates with intra discal calcification on lateral view. (b) Straight end plates with calcification in spinal canal (lateral view). (c) Cupid bow contour of end plates (bold arrow) and end-plate showing a fracture (thin arrow).

(T1), high signal (T2); Type 2 high signal (T1), low signal (T2); and Type 3 low signal (T1), low signal (T2) [7]. PLL was noted to be either intact or breached on T2 sagittal images. Canal compromise was measured as <40 or > 40% on T2 sagittal section at most compromised location. Intra-medullary high cord signal intensity changes (indicating myelomalacia – hyperintense on T2, hypointense on T1) were noted on sagittal images. Cord changes were looked into either at the level of disc prolapse or immediately above and/or below in cases of major cord compression.

## Results

A total of 25 subjects were included in the study. Two patients had double level disc prolapse; hence, a total of 27 discs were analyzed. There were 22 males (88%) and three females (12%). The average age was 44 years (range 22–66 years). T5-6 (n = 1), T8-9 (n = 2), T9-10 (n = 1), T10-11 (n = 4), T11-12 (n = 11), and T12-L1 (n = 8) were the levels involved. On radiographs, end-plate was concave (n = 9), straight (n = 12), and cupid bow shaped (n = 6). Calcification in disc space was seen in five and calcification within the canal was noted in 14 discs. Claw osteophytes (n = 8) and traction osteophytes (n = 2) were noted. EP junction failures were type IA (n = 10), type IB (n = 6), type ID (n = 2), and type II (n = 9). CT showed calcification in disc space (n = 5) and disc space (n = 14).

On MRI, central disc prolapse was noted (n = 10), right paracentral (n = 12), and left para-central (n = 5). Protrusion (n = 9), extrusion (n = 16), and sequestration (n = 2) were seen. According to Pfirmann grading, three discs were classified as Grade 2; five discs as Grade 3; 14 as Grade 4; and five as Grade 5. Disc was noted to be calcified (n = 24). Ten discs were migrated superiorly, three inferiorly, and 14 were central. Fourteen discs had > 40% canal occupancy. Schmorl nodes were noted (n = 17). Modic changes were uncommon except for type 2, noted in five cases. Ligamentum flavum

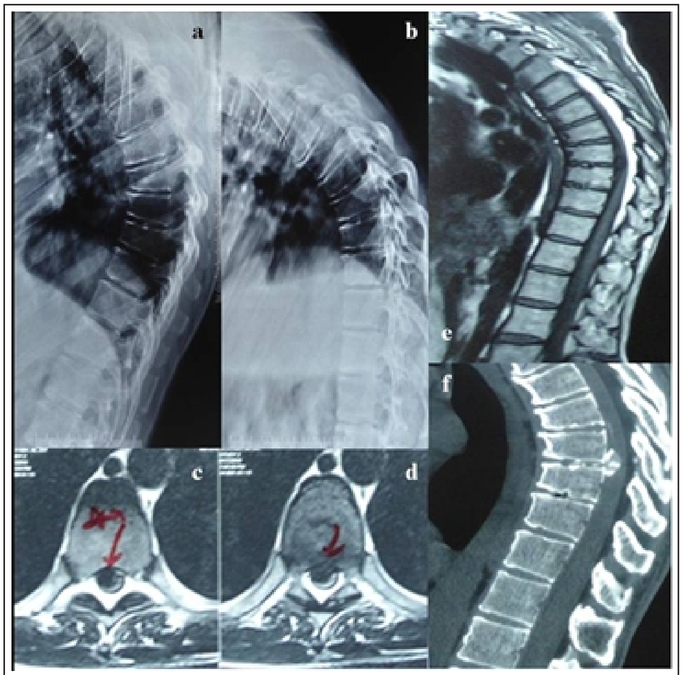

**Figure 5:** (a and b) Case of Scheuermann's kyphosis, flexion, and extension radiographs. (c and d) Axial T2 MR images showing disc prolapse on right side without displacement of the cord. (e and f) Depicting Type Ia EP, calcified disc on sagittal T2 images and CT images.

**Table 1: Demographic data and results**

| | |
|---|---|
| Total no. of patients | 25 (22-males,3 females) |
| Average age | 44 (22–66 years) |
| End-plate configuration | Concave (*n* =9) |
| | Straight (*n* =12) |
| | Cupid bow shaped (*n* =6) |
| End-plate junction failures | IA (*n* =10) |
| | IB (*n* =6) |
| | ID (*n* =2) |
| | II (*n* =9) |
| Disc prolapse | Central (*n* =10) |
| | Right paracentral (*n* =12) |
| | Left paracentral (*n* =5) |
| Disc migration | Superior (*n* =10) |
| | Inferior (*n* =3) |
| | central (*n* =14) |

hypertrophy is noted (n = 3) at the level of disc prolapse. PLL was intact in 15 cases. Cord signal intensity changes were noted (n = 5) discal levels with >40% occupancy.

## Discussion

Ever since MC Callister has published his findings of thoracic disc imaging in 1976, no other studies have described TDP imaging in detail [8]. The first reports of TDP management were published by Key in 1838 and by Middleton and Teacher in 1911 c [9, 10]. Historically, only 0.15–4% of all symptomatic disc herniation is in thoracic spine [1, 2]. Its low incidence is likely caused by the motion restriction of the thoracic anatomy due to the chest wall, smaller intervertebral discs, and dentate ligaments [11, 12]. More commonly the lower thoracic discs are involved and 75% of all the TDP are reported to occur below T8 more likely due to increased movements with greater forces exerted [13]. Caron et al. (1971) found that 67.3% of protrusions involve the lower thoracic spine [14]. Dreyfus et al. (1972) found a similar distribution of about two-third of protrusions in lower thoracic spine [15]. Twenty-three out of 27 thoracic discs had prolapse at the lower thoracic level (below T10) in our study. Twenty patients were <50 years of age in our study but a higher incidence has been described in age groups between 40 and 70 years in the literature. Unlike the previous studies that have reported the incidence of TDP to be markedly predominant in females, our series had majority of males (88%) [16, 17].

Plain radiographs show disc space narrowing, osteophytic spurs, disc space calcification, and even calcified disc material in the canal. However, TDP has been reported to occur in the absence of disc height narrowing and osteophytic spurs [8]. Degenerative process has been the major cause identified for TDP apart from trauma. Many authors have suggested an association between Scheuermann's disease and TDP [18, 19]. Sorenson had single criteria of wedging more than 5 degrees in three consecutive vertebras as diagnostic criteria for SD [20]. It has been modified by Heithoff and further by Ning Liu on MR images for the presence of Schmorl nodes, irregular vertebral end plates, posterior bony avulsion of the vertebra, and wedge shaped vertebra [19, 21]. Schmorl and Junghans hypothesized that herniation of disc material into vertebral body end-plates occurred as a result of inherent weakening of cartilaginous end-plate with resultant damage to end-plate causing growth disturbances and kyphosis. Videman et al. noted that moderate and severe osteophytes were most common at T11-12 level and upper end-plate irregularities were most common at levels T8-12 [22].

Nineteen out of 27 discs in our case series had end-plate irregularities. The presence of straight end-plate has been commonly observed in our study. Inferior end-plate of superior vertebrae showed defect in most of the cases. Posterior bony avulsion that morphologically corresponds to anterior schmorl node was considered as an avulsion of the posterior ring apophysis due to the lack of fusion between the separated bony mass and the vertebral body [21]. Ten discs showed proximal migration of the disc that can be explained in part by the inferior end-plate defect of the proximal vertebra.

Calcification of the disc is known to occur more frequently in thoracic spine with varying rates between 26 and 90% and the condition is generally asymptomatic unless herniation of disc occurs [23, 24]. Two patterns of disc calcification have been described in the literature; fine linear type, probably arising from annulus fibrosis and a denser central calcification involving the nucleus pulposus [8]. Many studies have reported that if the diagnosis of TDP is considered, it should lead immediately to plain radiographs, in which disc calcification is of great diagnostic value. In the presence of a calcified lesion in spinal canal, the differential diagnosis must include meningioma and osteochondroma, as well as protruded thoracic disc. Calcification in disc space (denser central calcification) was seen (n = 5) and calcification within the canal was noted (n = 14) discs on radiographs as well as CT images. Calcified disc in thoracic spine has been reported to be seen as lack of signal on T1 and T2 images by Paolini et al.; however, Due et al. in his study reported that calcified discs are seen with a hyper intense central core surrounding hypointense area [25]. We noticed calcification as lack of signal on both T1 and T2 images in all our cases. Determination of TDP characteristics is important for the surgeon in planning of the surgical approach. Imaging of a calcified disc shows a clear edge as opposed to unclear edge in ossified intervertebral disc herniation on CT. Clear edges were seen in cases with calcification in our study. The calcified disc extrusion may result in damage to the ventral dura mater that may manifest as erosion, thinning, and tearing of the ventral dura [24].

There are few unique characteristics that make the cord vulnerable to dysfunction such as anatomic area of poor blood supply, narrow canal, limited mobility, and frequent calcification of disc at this level [3]. Unlike lumbar spine that had modic changes ranging from 19 to 59%, thoracic spine modic changes are not reported in the literature [7, 26]. In our study, modic changes were uncommon except for type 2, noted in five cases. The natural history of TDP suggests that it may remain asymptomatic for a long time, during which it may enlarge but it rarely presents as acute myelopathy [27]. Hott et al. defined giant herniated thoracic discs as those "occupying more than 40% of the spinal canal based on pre-operative CT myelography, MRI, or both" [24]. Delay in presentation secondary to paucity of clinical symptoms in such cases is a well-known entity. Fourteen out of 27 discs (52%) had disc prolapse that was occupying more than 40% of the spinal canal. Cord signal intensity changes (hyperintense on T2) were noted (n = 5) disc levels with >40% occupancy. In summary, this study identified distinct MR characteristic features of TDP that further throw light on the probable pathogenesis and causation.

## Conclusions

To the best of our knowledge, this is the first study to describe in detail the various radiological findings in TDP. Lower thoracic spine has a higher incidence of TDP. Calcification is commonly seen in cases of TDP, either in the disc space or within the canal. Most of the cases present with >40% of canal occupancy. End plate defect, a variant of schmorl node, may be a possible contributor to disc prolapse.

## References


1. Arce CA, Dohrmann GJ. Herniated thoracic disks. Neurol Clin 1985;3:383-92.
2. Ridenour TR, Haddad SF, Hitchon PW, Piper J, Traynelis VC, VanGilder JC. Herniated thoracic disks: Treatment and outcome. J Spinal Disord 1993;6:218-24.
3. Patterson RH Jr., Arbit E. A surgical approach through the pedicle to protruded thoracic discs. J Neurosurg 1978;48:768-72.
4. Pfirrmann CW, Resnick D. Schmorl nodes of the thoracic and lumbar spine: Radiographic-pathologic study of prevalence, characterization, and correlation with degenerative changes of 1, 650 spinal levels in 100 cadavers. Radiology 2001;219:368-74.
5. Pfirrmann CW, Metzdorf A, Zanetti M, Hodler J, Boos N. Magnetic resonance classification of lumbar intervertebral disc degeneration. Spine (Phila Pa 1976) 2001;26:1873-8.
6. Rajasekaran S, Nipun B, Vijay T, Rishi MK, Shetty AP. ISSLS prize winner: The anatomy of failure in lumbar disc herniation: An in vivo, multimodal, prospective study of 181 subjects. Spine (Phila Pa 1976) 2013;38:1491-500.
7. Modic MT, Steinberg PM, Ross JS, Masaryk TJ, Carter JR. Degenerative disk disease: Assessment of changes in vertebral body marrow with MR imaging. Radiology 1988;166:193-9.
8. Mcallister VL, Sage MR. The radiology of thoracic disc protrusion. Clin Radiol 1976;27:291-9.
9. Key CA. On paraplegia: Depending upon disease of the ligaments of the spine. Guys Hosp Rep 1838;3:17-34.
10. Middleton GS, Teacher JH. Injury of the spinal cord due to rupture of an intervertebral disc during muscular effort. Glasgow Med J 1911;76:1-6.
11. Stetkarova I, Chrobok J, Ehler E, Kofler M. Segmental abdominal wall paresis caused by lateral low thoracic disc herniation. Spine (Phila Pa 1976) 2007;32:E635-9.
12. Khoo LT, Smith ZA, Asgarzadie F, Barlas Y, Armin SS, Tashjian V, et al. Minimally invasive extracavitary approach for thoracic discectomy and interbody fusion: 1-year clinical and radiographic outcomes in 13 patients compared with a cohort of traditional anterior transthoracic approaches. J Neurosurg Spine 2011;14:250-60.
13. Gille O, Soderlund C, Razafimahandri HJ, Mangione P, Vital JM. Analysis of hard thoracic herniated discs: Review of 18 cases operated by thoracoscopy. Eur Spine J 2006;15:537-42.
14. Caron JP, Djindjtan R, Julian H, Lebrigand R, Comoy J. Les hernies discales dorsales. Ann Med Interne 1971;6-7:657-88.
15. Dreyfus P, Six B, Dorfmann I, Desezi H. La hernie discale dorsale. Sem Hop Paris 1972;l48:3045-52.
16. Stillerman CB, Chen TC, Day JD, Couldwell WT, Weiss MH. The transfacet pedicle-sparing approach for thoracic disc removal: Cadaveric morphometric analysis and preliminary clinical experience. J Neurosurg 1995;83:971-6.
17. Brown CW, Deffer PA Jr., Akmakjian J, Donaldson DH, Brugman JL. The natural history of thoracic disc herniation. Spine (Phila Pa 1976) 1992;17:S97-102.
18. Lowe TG. Current concepts review: Scheuermann disease. J Bone Joint Surg Am 1990;72:940-5.
19. Heithoff KB, Gundry CR, Burton CV, Winter RB. Juvenile discogenic disease. Spine (Phila Pa 1976) 1994;19:335-40.
20. Sorensen KH. Scheuermann's Juvenile Kyphosis: Clinical Appearances, Radiography, Aetiology, and Prognosis. Copenhagen, Denmark: Ejnar Munksgaard Forlag; 1964.
21. Liu N, Chen Z, Qi Q, Shi Z. The relationship of symptomatic thoracolumbar disc herniation and scheuermann's disease. Eur Spine J 2014;23:1059-66.
22. Videman T, Battie MC, Gill K, Manninen H, Gibbons LE, Fisher LD. Magnetic resonance imaging findings and their relationships in the thoracic and lumbar spine. Insights into the etiopathogenesis of spinal degeneration. Spine (Phila Pa 1976) 1976;20:928-35.
23. Barbanera A, Serchi E, Fiorenza V, Nina P, Andreoli A. Giant calcified thoracic herniated disc: Considerations aiming a proper surgical strategy. J Neurosurg Sci 2009;53:19-25.
24. Hott JS, Feiz-Erfan I, Kenny K, Dickman CA. Surgical management of giant herniated thoracic discs: Analysis of 20 cases. J Neurosurg Spine 2005;3:191-7.
25. Paolini S, Tola S, Missori P, Esposito V, Cantore G. Endoscope-assisted resection of calcified thoracic disc herniations. Eur Spine J 2016;25:200-6.
26. Braithwaite I, White J, Saifuddin A, Renton P, Taylor BA. Vertebral end-plate (Modic) changes on lumbar spine MRI: Correlation with pain reproduction at lumbar discography. Eur Spine J 1998;7:363-8.
27. Wood KB, Blair JM, Aepple DM, Schendel MJ, Garvey TA, Gundry CR, et al. The natural history of asymptomatic thoracic disc herniations. Spine (Phila Pa 1976) 1997;22:525-9.


Conflict of Interest: NIL
Source of Support: NIL

How to Cite this Article

Degulmadi D, Dave BR, Krishnan A, Mayi S, Rai RR | Imaging in Thoracic Disc Prolapse: A Study of 25 Patients and Review of Literature | Back Bone: The Spine Journal | October 2020-March 2021; 1(1): 23-27.