Original Article

Calcified Thoracic Disc – A descriptive classification with clinical and management implications

ABSTRACT

Introduction and Objective: Thoracic disc calcification is a radiological finding which may be incidental or diagnosed in patients presenting with myelopathy due to spinal cord compression. We performed a study to analyze the imaging patterns of calcified thoracic discs (CTDs).

Patients and Methods: A retrospective review of the spinal and radiology database of a tertiary referral orthopedic hospital was conducted for the incidence of CTDs between 2007 and 2020. Patients' demographics and radiological findings were recorded. The relationship between disc size, morphology, spinal cord compression, and management was assessed.

Results: Fifty-one cases of CTDs were identified. The mean size of CTD was 806.2 mm^3 (range: 144–2340). The most common level of disc calcification was T9–T10 (24%) in 12 patients. Thoracic disc calcifications in our series commonly involved disc "protrusion" in 67% (34 patients), followed by "mushroom" type in 31% (16 patients) and "extrusion" in 2% (1 patient). 37% (19 patients) had spinal cord compression with 12% (6 patients) undergoing surgical interventions. There was no statistically significant difference in the mean sizes of CTD between the groups with and without spinal cord compression ($P = 0.566$, independent sample *t*-test). Patients with "mushroom" type calcification were more likely to have surgical intervention ($P = 0.01$, Fisher's exact test).

Conclusion: Thoracic disc calcifications, while common, can still be underdiagnosed till late myelopathic deterioration. Care of the elderly physicians, spinal surgeons, and radiologists need to be aware of them to guide diagnosis and management. Our study demonstrates that disc morphology plays a vital role in myelopathic presentation and therefore determines the need for surgical intervention instead of the absolute size of disc calcification.

Keywords: Calcified, disc, thoracic

INTRODUCTION

The human intervertebral disc consists of two anatomical structures, the nucleus pulposus and the annulus fibrosus. The annulus fibrosus is a fibrocartilaginous structure enclosing the mucoid nucleus pulposes. The outer layer of the annulus fibrosus contains collagen fibers that join with the vertebral surfaces. Several changes appear in the intervertebral disc with advancing age, including hyalinization of the annulus and the replacement of the nucleus with fibrocartilaginous substances.[1]

Intervertebral disc calcification (IDC) was first described in 1838.[1] It is a common incidental finding on radiological imaging[2] with a prevalence of around 5% and 6% of the plain chest and abdominal radiographs, respectively.[3,4] The calcification of the intervertebral discs predominantly occurs at the cervical spine, followed by the thoracic and lumbar spine.[2] Radiograph examination of cadavers has reported a higher prevalence of IDC, ranging between 35% and 71%.[5]

Thoracic disc calcification may present with spinal myelopathy, radiculopathy, or back pain due to disc herniation.[2] Herniated

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thoracic discs occupying more than 40% of the spinal canal (based on magnetic resonance imaging [MRI], computed tomography [CT], or myelography) are termed as giant calcified thoracic discs (CTDs).[6]

There is scant literature reviewing patient demographics, radiological findings, and the management of patients with thoracic disc calcification. The study aims to investigate the relationship between the morphology and size of thoracic disc calcification with the evidence of spinal cord compression and surgical intervention. In addition, we have also discussed the common etiology of thoracic disc calcification.

PATIENTS AND METHODS

A retrospective review of the radiology and spinal database was conducted between 2007 and 2020 for presentations diagnosed with thoracic disc calcification at our tertiary referral orthopedic hospital. All spinal patients with acute and chronic symptoms were included in this study. Patients without any evidence of thoracic disc calcification on the radiograph, CT, or MRI imaging were excluded. Local institutional review board approval was obtained as a service evaluation. Written consent was not required for our study. Primary diagnosis was made with the aid of MRI and CT imaging. Patients presenting with symptoms and signs of acute spinal cord compression had urgent MRI scans of the whole spine as per hospital protocol. Those with evidence of thoracic disc calcification on MRI received CT scans for further evaluation and surgical planning. Data were collected on patient demographics, morphology and size of CTD, and clinical and interventional data. The dimensions of the calcification were calculated using the Picture Archiving and Communication System imaging software in three dimensions by the radiologist based on the CT scans. All images were reviewed by a musculoskeletal radiologist with 8 years of experience and a spinal surgeon. The schematic diagram demonstrating thoracic disc calcification with posterior herniation is shown in Figure 1.

RESULTS

During the study period, a total of 51 patients (female: male = 43:8) were identified with evidence of CTD on CT or MRI imaging. The patients' mean age was 61.7 years (range: 39–84 years). The most common level of thoracic disc calcification was T9–T10 in 24% of the cohort (12 patients), and the least common was T2–T3 consisting of 4% (2 patients). The number of patients for each level of thoracic disc calcification is summarized in Table 1.

CTD was further classified based on the anatomy and morphology of three subtypes which were determined after discussion with senior authors [Table 2]. The most common type of disc calcification was "protrusion" type found in 67% (34 patients) [Figure 2], followed by "mushroom" type in 31% (16 patients) [Figure 3] and "extrusion" in 2% (1 patient) [Figure 4]. Sixty-three percent (32 patients) showed no evidence of spinal cord compression on MRI scans.

The overall mean size of CTDs was 806.2 mm^3 (range: 144–2340 mm^3). The mean size of CTD causing cord compression was 876.8 mm^3 (144–1859), while the mean size of CTD without spinal cord compression was 763.3 mm^3 (160–2340). The mean size of CTD leading to surgical intervention was 1000.6 mm^3 (180–1859). Despite larger disc calcification in the patient cohort with spinal cord compression, there was no statistically significant difference in the mean sizes of CTD between the groups with and without spinal cord compression ($P = 0.566$, independent sample t-test). Similarly, there was no significant difference in the mean size of CTD when comparing groups undergoing surgical intervention ($P = 0.562$).

Eighty-eight percent (45 patients) with CTD did not undergo any surgical intervention. Out of 19 patients with radiological evidence of cord compression, only 32% (6 patients) had surgical intervention. In addition, 32% (5 patients) out of 16 patients who had "mushroom" type calcification underwent surgical intervention, while only 3% (1 patient) out of 34 patients who had "protrusion" type calcification underwent surgery. Hence, patients with "mushroom" type calcification were more likely to have a surgical intervention as compared to "protrusion" type calcification ($P = 0.01$, Fisher's exact test).

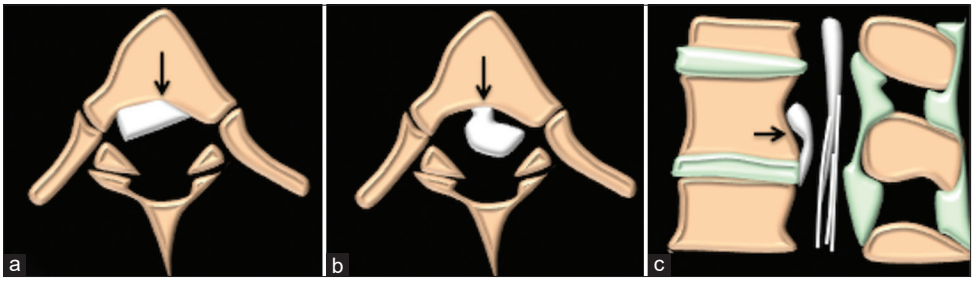

Figure 1: Schematic showing different types of thoracic disc (arrow), (a) protrusion, (b) mushroom type, (c) extrusion

Table 1: Calcified thoracic disc presentation according to spinal level

Vertebral level	*n* (%)
T9–10	12 (23.5)
T8–9	11 (21.6)
T7–8	7 (13.7)
T10–11	6 (11.8)
T11–12	5 (9.8)
T6–7	4 (7.8)
T5–6	4 (7.8)
T2–3	2 (3.9)

Table 2: Morphology of calcified thoracic disc

Disc morphology	*n* (%)
Protrusion	34 (67)
Mushroom	16 (31)
Extrusion	1 (2)

DISCUSSION

The prevalence of intervertebral disc calcification (IDC) is reported to be higher in the elderly population.[7] A study of 223 cadavers had shown IDC to be present in 80% of the subjects and is commonly associated in the elderly, particularly in the annulus fibrous and lower thoracic spine.[7] The findings suggest that IDC may be a common phenomenon due to the aging process, which does not require further investigation. However, IDC has also been associated with systemic conditions such as alkaptonuria, hemochromatosis, hyperparathyroidism, calcium pyrophosphate deposition, acromegaly, and amyloidosis.[1]

Our study reported female predominance (5.4:1) in the population presenting with CTD, similar to other studies.[8] This is speculated due to the altered calcium phosphate metabolism in the postmenopausal period.[9] Moreover, there was the highest frequency of thoracic disc calcification at the T9–10 level in our study, observed in 12 out of 51 patients. This finding was similar to the previously published literature, with more than three-quarters of thoracic calcification and herniation located below the T8 level, possibly due to the greater mobility of the spine and the increase in the weight exertion.[10] The presence of calcifications in the intervertebral disc is also often associated with the presence of hard herniated discs.[9]

Calcific discitis was found in 5 of 51 patients in our study. There is little information on the incidence of calcific discitis in the adult population and its etiology remains unknown.[11] However, painful discal calcification in children has been reported, associated with pyrexia, leukocytosis, and elevated inflammatory markers.[12] Previous reports of calcific discitis in adult patients have been published, with one case reporting migration of calcification to the intervertebral foramen and two cases with migration into the vertebral body.[13-15]

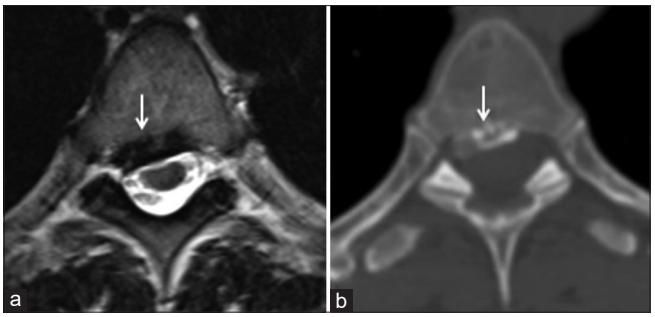

Figure 2: Axial T2 (a) and computed tomography (b) showing calcified thoracic disc protrusion (arrow)

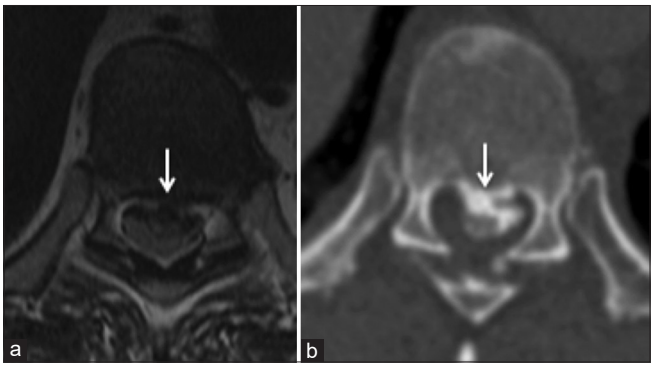

Figure 3: Axial T2 (a) and computed tomography (b) showing calcified thoracic disc – mushroom type (arrow)

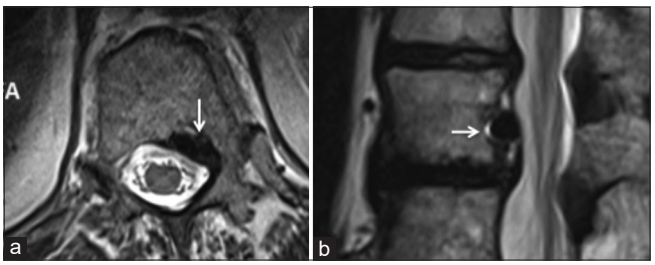

Figure 4: T2 axial (a) and sagittal (b) showing calcified sequestrated disc (arrow)

In our study, only 12% of the patients with evidence of thoracic disc calcification underwent surgical intervention. The relatively low percentage of patients having the surgery may be attributed to the incidental findings of the calcification in patients with chronic back pain, without the need for surgical intervention. In addition, the patients may present late to the hospital with chronic symptoms; hence, the benefits of conservative management outweighed the risks of surgery. Besides, our study showed no significant difference in CTD size in the patient cohort with spinal cord compression, compared to those without evidence of cord compression, despite the former demonstrating a larger overall CTD

mean size. This interesting finding may show that disc morphology may have a more significant impact on spinal cord compression than the absolute size of the calcification.

It is crucial to be aware of the morphology of the calcified discs in planning the surgical approach to treat myelopathy secondary to CTD. There are several surgical approaches to accessing the thoracic discs, including posterolateral, lateral, and anterior transthoracic approaches.[16] The decision of operative approaches depends on the disc location, morphology, and patient's tolerability. In general, posterolateral approaches are recommended for soft lateral herniations or multilevel compressions due to posterior longitudinal ligament ossification. This approach utilizes a posterior approach with a unilateral or bilateral arthrectomy to provide access to the disc space. The "Eggshell" technique was proposed by Yang *et al*. to reduce the risk of neurological damage when dissecting the hernia on the posterior side of the vertebral body.[17] Anterior surgical approach to CTD provides a direct view of the disc in central herniation and is generally used for giant, calcified, central herniation. The principles of this approach involve the resection of the rib head to access the anterior margin of the dural sheath, conical reaming on the posterior aspect of the disc and followed by reaming and removal of the fragmented bits of the disc herniation. However, this approach is known to have higher morbidity due to the need for thoracotomy. In view of this, thoracoscopy may reduce the complication associated with thoracotomy, but it is preferentially indicated in noncalcified and small lateral hernias. Hence, open-mini thoracotomy with a retropleural approach was reported to be a better approach to reduce complications associated with the transpleural approach, having the advantage of avoiding pulmonary-related consequences.[18]

In addition to degenerative changes, several other conditions may be associated with intervertebral disc calcification. IDC may be caused by ochronosis, a rare multisystem autosomal recessive metabolic disorder characterized by the accumulation of homogentisic acid (HGA) due to homogentisic oxidase deficiency.[19] Excess HGA binds to connective tissues affecting the cartilaginous structure of the shoulders, spine, pelvis, and knee joints.[20] Vertebral manifestations include severe osteoporosis with diffuse and multilevel disc calcification involving the annulus fibrosus and nucleus pulposus.[1] Besides, IDC may be caused by hemochromatosis, a condition characterized by systemic iron overload due to the reduction in the iron regulatory hormone hepcidin or hepcidin-ferroportin binding.[21] Literature by Bywaters *et al*. had reported the incidence of IDC in 7 of 47 patients with idiopathic hemochromatosis.[22] Radiological findings include the appearance of calcifications in the nucleus pulposus and the lateral margins of the vertebral bodies. Iron may also contribute indirectly to calcium pyrophosphate deposition due to pyrophosphatase inhibition, as reported in previous literature.[23]

Furthermore, familial chondrocalcinosis may cause the deposition of calcium pyrophosphate hydrate crystals (CPPD) in cartilaginous joints.[24] In these cases, dense calcification of the entire disc may be observed, resembling ochronosis.[25] Intervertebral disc calcification is primarily located in the cervical and lumbar regions instead of the thoracic region.[26] CPPD disease has also been reported to involve the spine in 24% of CPPD patients.[27] However, those with spinal CPPD had more extensive peripheral CC, with predominantly cervical and lumbar segments.

Moreover, hyperparathyroidism, an endocrine disorder characterized by the increased activity of the parathyroid glands causing increased excretion of the parathyroid hormone, may cause calcium pyrophosphate deposition in the intervertebral discs.[28] The calcification was seemed to be due to the subchondral bone injury at the site of mechanical pressure. Intravertebral disc calcification (IDC) has also been reported in acromegaly in several literature.[29,30] Calcification of the anterior aspect of the intervertebral discs, particularly in the cervical and thoracic regions, has been described along with the osteophytosis of the anterior aspect of the vertebral bodies.[31] These were common in the findings by Bluestone *et al*., where the vertebral bodies were initially flattened and subsequently became irregular and prolonged anterocaudally due to bony overgrowth.[31]

The present study has several limitations despite being the largest single-center study reporting the incidence of calcified thoracic intervertebral discs and the relationship of disc morphology, spinal cord compression, and surgical interventions. For example, the disc calcification was only observed in the MRI and CT images without performing any histopathological assessment of the tissues. Besides, from the methodological point of view, this study was also done retrospectively. Hence, there may be cases not included in the study due to the loss of patients' records. This was minimized by searching for patient details in the spinal and radiology database and clinical letters. The sizes of CTD were also measured by several radiologists during the study period. However, the discrepancies were minimized by having a final verification by an experienced musculoskeletal radiologist.

CONCLUSION

Thoracic disc calcification is an uncommon radiological finding attributed to many systemic and local etiology

and degenerative changes. Care of the elderly physicians, spinal surgeons, and radiologists should be aware of the disc anatomy involved, the differential diagnosis for the calcification, and the lesion's pathophysiology. The morphology of the calcified disc appeared to have a higher impact on spinal cord compression rather than the absolute size of the calcification in this study. The spinal team should consider CT imaging for assessment of disc calcification before surgical intervention.

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Conflicts of interest

There are no conflicts of interest.

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