ORIGINAL ARTICLE

Morphometric and Histological Analysis of 'Spondylosis Deformans' of Thoracic Region in South-Indian Cadaveric Spines

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Abstract:

Background: Osteophyte is a bony outgrowth in the vertebral column. Its high prevalence and clinical importance prompted us to conduct this study of thoracic osteophytes. *Aim and Objectives*: Morphometric and histological study of thoracic osteophytes in the cadaveric vertebral column to understand their development, frequency of occurrence and distribution. *Material and Methods:* Frequency of occurrence of osteophytes was studied in 50 cadavers of Indian origin over a period of five years. The thoracic part of the vertebral columns were dissected and examined. The vertebral levels of osteophytes, their exact distribution, and morphometric measurements were recorded. A small piece of the osteophyte was removed, processed and stained with Haemetoxylin & Eosin [H & E] stains for histopathological examination. *Results:* Osteophytes were present in 7 specimens (14%). They were predominantly found on the right side of the lower thoracic vertebral bodies. H & E stained sections of the osteophytes showed features resembling a cancellous bone which strongly indicate that the osteophytes are in development stage, and they develop by the process of endochondral ossification. *Conclusion:* We found a high incidence of thoracic osteophytes in our study, which mandates further studies in this regard.

Keywords: Osteophytes, Bone Spurs, Thoracic Vertebra, Cadaveric Spine

Introduction:

An osteophyte or bone spur is defined as a fibrocartilage capped bony outgrowth. These osteophytes can be classified into three types: a) Traction osteophytes: present at the insertion of tendons and ligaments; b) Inflammatory spur: represented by the syndesmophyte at the insertion of ligaments and tendons to bone; c) Genuine osteophyte or osteochondrophyte (chondro-osteophyte): arising in the periosteum overlying the bone [1]. Osteophytes are found to be usually associated with osteoarthritis and are said to be formed probably in response to abnormal strains on the joint [2]. Studies show that osteophytes are found in at least one vertebral body in 25% of spines aged 20 to 29 years and in 90% of spines aged over 60 years [3] which indicates that the risk of development of osteophytes in the vertebral column increases with the age [4].

In most cases, osteophytes remain asymptomatic, but they are of clinical importance as they have significant clinical impact and can be a source of pain and loss of function depending on their location. They may cause nerve compression, limitation of joint mobility and obstruction of tissues and organs. Many authors have reported the incidence of lumbar pain and abdominal pain resulting from vertebral osteophytes [5-7]. Cervical osteophytes can cause vocal cord paralysis [8] and vertebral artery compression [9]. Differences in the human population are likely to be another important contributing factor for the occurrence of osteophytes because many studies on various human populations show different prevalence of vertebral osteophytes [10, 11].

Thus, the appearance of osteophytes in the spinal column is a paradox to anatomists, clinicians and surgeons because they might result in medical problems or can be present without any adverse effects. Despite these statements, its real significance is yet far from clear. During our literature review, we found that cadaveric studies of osteophytes are very rare, and most of the clinical studies have focused on cervical and lumbar osteophytes. There are no reports on the histopathology of these osteophytes. Addressing to these lacunae, we conducted this detailed morphometric and histological study of thoracic osteophytes in the cadaveric vertebral column to understand their development; frequency of their occurrence and distribution; and their possible effects on the surrounding structures of the posterior mediastinum.

Material and Methods:

During routine cadaveric dissections, we noticed the high prevalence of osteophytes in thoracic vertebral bodies. Hence, we conducted this systematic study wherein we examined the frequency of occurrence of osteophytes in 50 cadavers of Indian origin over a period of five years. The cadavers were obtained from the Department of Anatomy. The approximate age of the cadavers ranged from 50-80 years. The thoracic part of the vertebral columns was dissected, and the posterior thoracic wall was exposed. The soft tissue and fat were removed. There were no signs of any degenerative changes or congenital anomalies in any of the specimens. Each thoracic vertebra in the vertebral column was examined. When osteophytes were found to be present, their vertebral level, exact distribution on the vertebral body (anterior, lateral or posterior), and its vertical and transverse diameters in centimeters were recorded using a scale. A small piece of the osteophyte was removed and preserved in 10% formalin. It was processed using the standard procedure, embedded in paraffin and sections were obtained on clean glass slides. The sections were stained with Haematoxylin & Eosin (H&E) stains and examined under the microscope using different magnifications for histopathological studies and photographs were taken.

Results:

Gross anatomy findings:

In the 50 specimens studied by us, we observed the occurrence of osteophytes in 7 thoracic vertebral specimens (14%) which shows the high incidence of occurrence of osteophytes in the thoracic part of the vertebral column. Detailed morphometric measurements of these osteophytes, with their vertebral levels and distribution are shown in Table 1. All osteophytes were present on the anterior or lateral side of the vertebral bodies. One osteophyte was present at the costovertebral junction at the level of T11. We also observed that osteophytes were mostly seen in the lower thoracic vertebral bodies (T6-T12) with a high incidence at T10 and T11 vertebral levels (29.4%), followed by T9 and T12 levels (11.8%)(Fig.1). Our next important observation was that the occurrence of osteophytes was mostly on the right side of the vertebral bodies (58.8%) with very few on the left side (11.8%). Remaining osteophytes were seen on the anterior aspect of vertebral bodies (29.4%). Mean values of the vertical and transverse diameters of the osteophytes are shown in table 2 with the maximum vertical diameter being 2.3 cm and maximum transverse diameter of 3.3 cm. Photographs of the thoracic vertebral column showing the presence of osteophytes at different levels are shown in fig.2-6.

Histological findings:

H&E stained sections of the osteophytes showed features which resemble a cancellous bone. A network of bony trabeculae with the nuclei of the osteocytes in the lacunae was seen. The spaces between the trabeculae enclosed bone marrow in which numerous fat cells were present (Fig. 7). These areas also contained few hematopoietic

elements with few blood vessels and were surrounded by fibro-collagenous stroma. A layer of hyaline cartilage with foci of degeneration overlying trabecular bone was also observed (Fig.8). These features strongly indicate that the osteophytes are in development stage, and they develop by the process of endochondral ossification.

Table 1: Showing the Occurrence and Distribution of Thoracic Osteophytes and their Detail Morphometric Measurements

Specimen number	Position	Vertebral level	Morphometric measurements (cm)
1(osteophytes: 1)	Left, lateral side of vertebral body	T10	V= 1.5, T= 2.5
2(osteophytes: 2)	Costovertebral junction	T11	V= 1.2, T= 1.8
	Anterior side of vertebral body	T9	V= 1.5, T= 2.5
3(osteophytes:3)	Right, anterolateral side of vertebral body	T10	V= 2, T= 4
	Right and left, anterolateral side of vertebral body	T11 (bilateral)	Right: V= 3, T= 5 Left: V= 2, T= 2.5
	Right, lateral side of vertebral body	T12	V=2, T= 3.6
4(osteophytes:1)	Right, lateral side of vertebral body	T10	V=2, T= 2.2
5(osteophytes: 2)	Right, lateral side of vertebral body	T10	V=1.2, T= 2.5
	Right, lateral side of vertebral body	T11	V= 1, T= 1
6(osteophytes: 7)	Right, lateral side of vertebral body	T6	V= 1.5, T= 2.5
		T7	V= 2, T= 2.8
	Anterior side of vertebral body	T8	V= 2.2, T= 3
		T9	V= 3, T= 3.6
		T10	V= 2, T= 3.5
	Right, Anterolateral side of vertebral body	T11	V= 2, T= 1
	Right, lateral side of vertebral body	T12	V= 1, T= 1
7(osteophytes: 1)	Anterior part of vertebral body	T11	V= 2.5, T= 4

V=Vertical, T=Transverse

Table 2: Showing the Average Measurements of the Thoracic Osteophytes

Position of osteophytes	Mean value (cm)
Anterolateral (n=4)	Right: V= 2.3 cm, T= 3.3 cm
	Left: V= 2 cm, T= 2.5 cm
Lateral (n=8)	Right: V= 1.5 cm, T= 2.2 cm
	Left: V= 1.5 cm, T= 2.5 cm
Anterior (n=5)	V= 2.2 cm, T= 3.3 cm

V=Vertical, T=Transverse

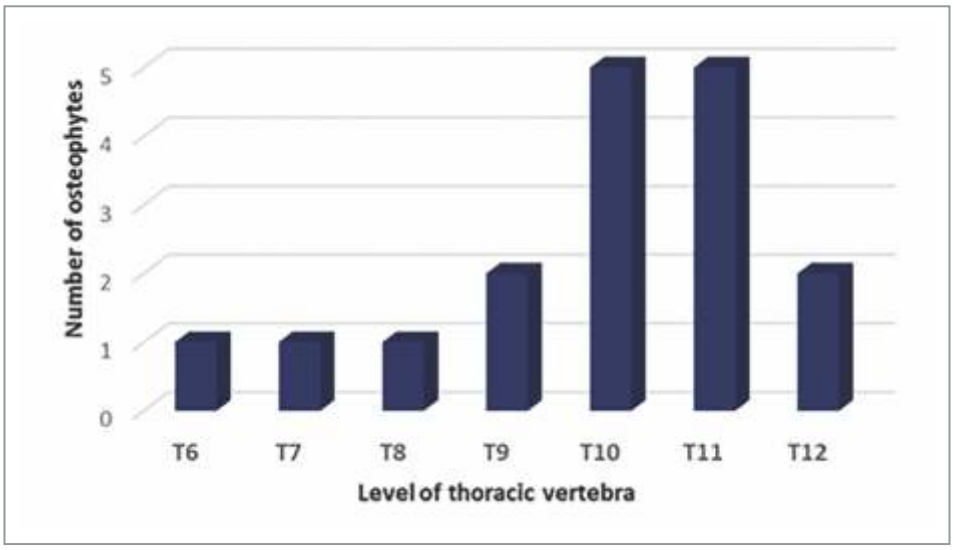

Fig. 1: Showing the Frequency of Osteophytes Distribution in Lower Thoracic Vertebral Levels

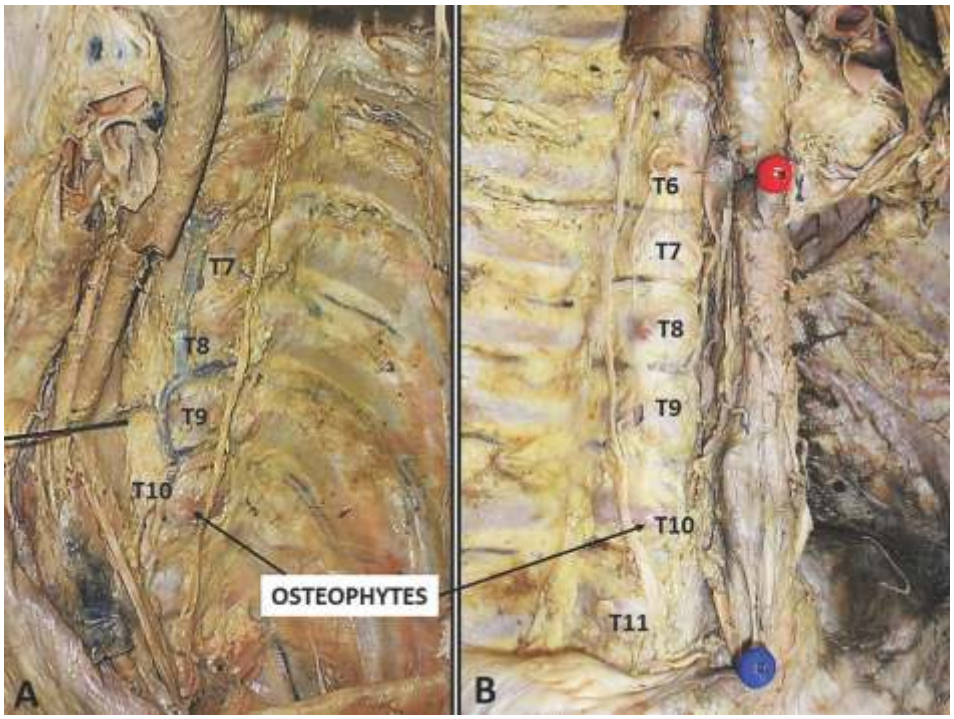

Fig. 2: Dissection of the Thoracic Vertebral Column showing the Osteophytes on its Left Side (A) And Right Side (B).

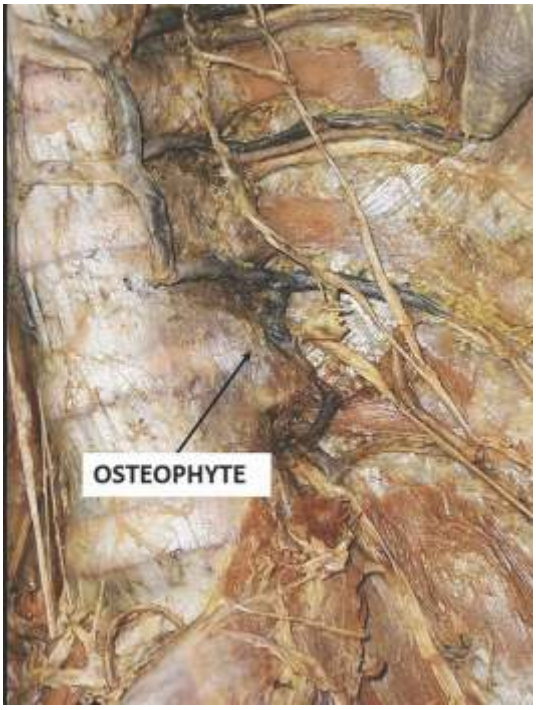

Fig. 3: Showing the Occurrence of Osteophyte at the Costovertebral Junction

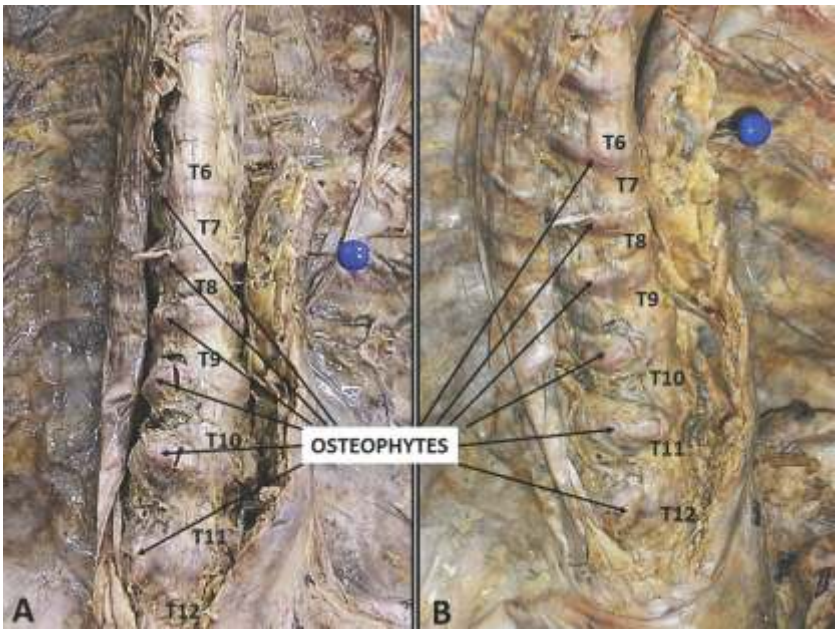

Fig. 4: Dissection of the Thoracic Vertebral Column showing Multiple Osteophytes at Various Thoracic Vertebral Levels. A: Front View, B: Side View.

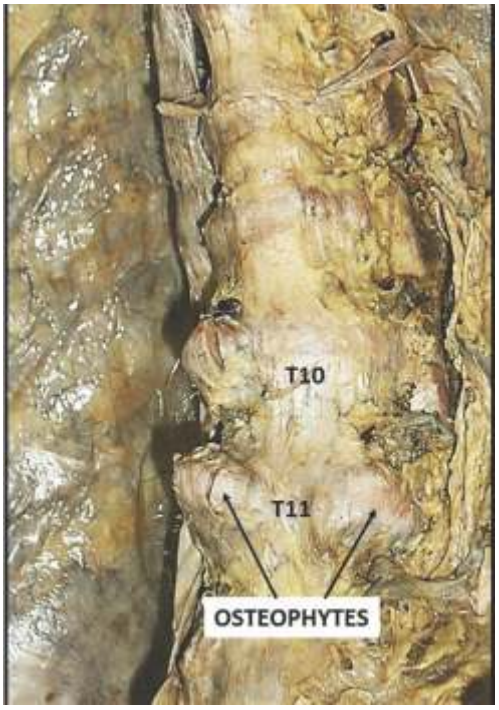

Fig. 5: Dissection of the Thoracic Vertebral Column showing Bilateral Osteophytes at the Level of T11

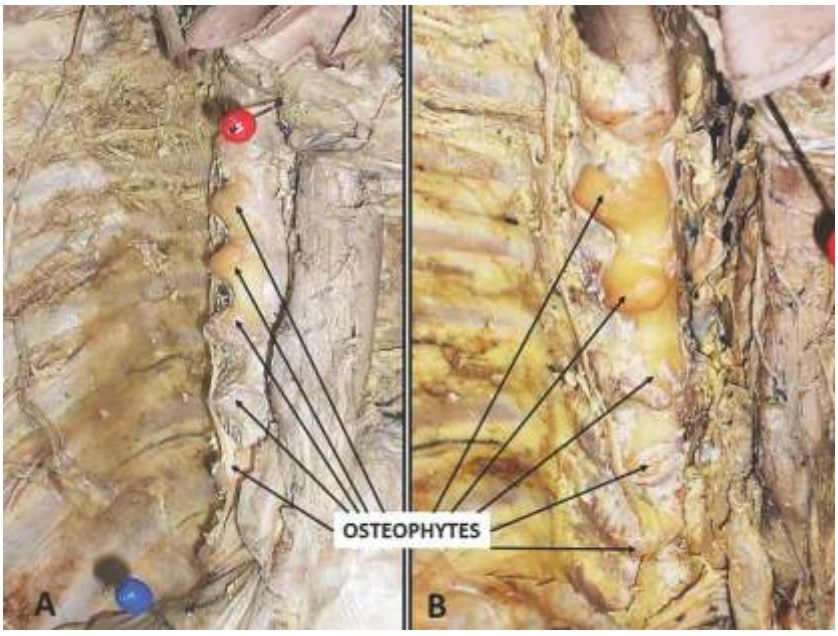

Fig. 6: Dissection of the Thoracic Vertebral Column Showing the Morphology of Osteophytes after the Removal of Fascia and Fat. A: Front View, B: Closer View.

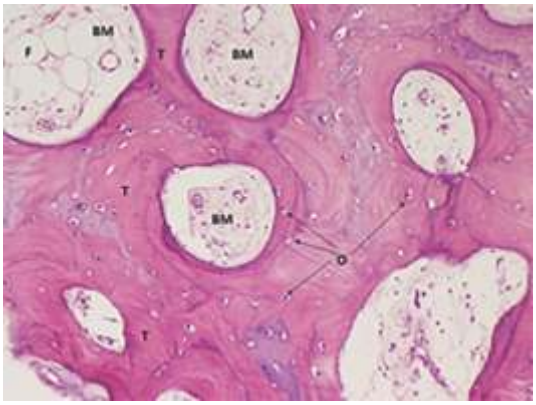

Fig. 7: Photomicrograph Showing the Section of Osteophyte Stained Using H&E Stain. The Section shows the Typical Features of A Cancellous Bone wherein Network of Trabeculae (T) is Seen. Nuclei of the Osteocytes (O) are Present Within the Trabeculae. Spaces are Filled with Bone Marrow (BM) Containing Numerous Fat Cells (F) and Few Blood Vessels. (Magnification: 20X)

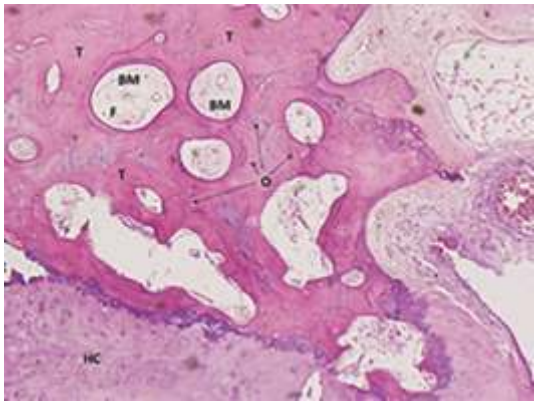

Fig. 8: Photomicrograph showing The Section of Osteophyte Stained Using H&E Stain. The Section shows a Layer of Hyaline Cartilage (HC) over the Trabecular Bone Containing A Network of Trabeculae (T), Nuclei of the Osteocytes (O) and Bone Marrow (BM) Containing Numerous Fat Cells (F) and Few Blood Vessels. (Magnification: 10X)

Discussion:

Osteophytes or "bone spurs" are outgrowths of bone tissue that are found to develop as a compensatory response to bone and ligament damage. Joints of the spine are more prone to damage from overuse or arthritis and thus are more likely to develop osteophytes. Many authors have acknowledged this fact and have studied the development of the osteophytes, particularly their frequency and distribution. But, most of these studies are radiological studies. Cadaveric studies in this regard are very limited. Key thing to note is that there are no studies on microscopic anatomy of the osteophytes. In our study, we have tried to examine the osteophytes histologically. Another difference is that previous reports mainly focus on osteophytes in the cervical part of the vertebral column or lumbar part. Studies on thoracic osteophytes are not dealt with in detail. Although we are not sure for the above reason, the high incidence of thoracic osteocytes in our study mandates further studies in this region.

Osteophyte formation of the vertebral body is a very common change that occurs with the age and closely resembles the process of chondrogenesis and endochondral bone formation as it can be seen during embryogenesis [12]. This fact was evident in our histological analysis of osteophyte wherein we found a layer of hyaline cartilage capping the trabecular bone, which is an indication of endochondral ossification. The formation of osteophytes is linked mainly to growth factors. Uchino et al. demonstrated that both Transforming Growth Factor-β1 (TGF-β1) and basic Fibroblast Growth Factor (bFGF) is expressed in osteophytes [13]. Few authors have also opined that degeneration of intervertebral discs or excessive compression forces on vertebral end-plates may lead to the development of osteophytes [3].

Spondylosis deformans are bony osteophytes that develop in the region of the vertebral bodies. These manifestations represent chronic degenerative changes, which is predominantly located in the cervical, lower thoracic and lumbar regions of the spine [14]. In our study, the highest incidence of osteophytes was found in the lower thoracic levels especially T10 and T11. The same finding was also seen by Natan in their study [3]. It assumes that pressure is the most important etiological factor for the development of osteophytes and might be the reason for the presence of osteophytes mostly on the anterior part of the vertebral body wherein the pressure is greatest. The sites of highest incidence also correspond with the normal concavities of the vertebral column wherein the pressure is greatest.

Patients with osteophytes may present with a wide spectrum of symptoms among which, pain is the most common complaint due to the compression of the spinal nerve roots [15]. The present study found the incidence of anterior and lateral osteophytes in greater numbers than posterior osteophytes. These osteophytes can compress the thoracic aorta leading to ischemia or perforation and thus aorta becomes more susceptible to infection by blood-borne bacteria [16]. Previous reports indicate that anterior osteophytes can also cause dysphagia [17, 18], esophageal food impaction [19], focal fibrosis in the adjacent pulmonary tissue and collapse of the subpleural alveolar space [20]. It might also affect the sympathetic trunk and splanchnic nerves. Nathan in his study of 1,000 cadavers observed compression of sympathetic structures in 655 specimens [21]. A case in which an anterior thoracic osteophyte on T6–T7 obstructed the right main stem bronchus, resulting in chronic obstructive pneumonia has also been reported [22]. Radiologists should be aware of occurrence of multiple thoracic osteophytes as they can look like an anterior mediastinal mass on chest X-ray and ought to be part of a differential diagnosis. Studies have found that osteophytes occur predominantly on the right side of the thoracic vertebrae because, the descending aorta runs on the left side and its pulsations prevent bone formation [23]. This was very well documented in our study as we observed most osteophytes on the right side. Study of osteophytes is important not only from the clinical or surgical point of view but also to anthropologists because, they postulate that skeletal thoracic-osteophyte findings can be used for age-at-death estimations [24, 25]. Knowledge regarding osteophytes is necessary to enhance the understanding of these age-related processes, their progression across the lifespan and for the prevention and management of common degenerative conditions affecting the vertebral column.

Conclusion

We found a high incidence of thoracic vertebral osteophytes in our study. Although speculative in nature, these cadaveric reports deserve further attention given their potential clinical implications.

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