Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI:10.69980/88xdse27

OSSIFIED ANTERIOR LONGITUDINAL LIGAMENT: A COMPREHENSIC STUDY IN NORTH INDIA

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ABSTRACT

INTRODUCTION: The examination of the vertebral column and the characteristics of individual vertebrae is a fundamental component of anatomical education. The vertebral column is composed of 33 vertebrae that are aligned vertically and interconnected through intervertebral joints, supported by various ligaments, primarily the anterior and posterior longitudinal ligaments. Pathological conditions affecting these ligaments can result in a range of issues, from back pain to structural deformities and nerve compression.

AIMS AND OBJECTIVES: This study aims to investigate the ossification of Anterior and Posterior longitudinal ligaments, focusing on the prevalence of different ossification types and associated features across various segments of the vertebral column.

MATERIAL AND METHODS: The research involved the analysis of 20 articulated and 30 disarticulated bone sets sourced from North India. Results: Among the 50 dry vertebral sets examined, only 2 sets exhibited signs of ossified ligaments at different levels.

CONCLUSION: The ossification of the anterior spinal ligaments is uncommon. Identifying and addressing the underlying causes is essential to enhance and maintain flexibility, as well as to prevent the onset of deformities and neurological complications.

KEYWORDS: Anterior longitudinal ligament; Intervertebral joints; Vertebral spine.

INTRODUCTION

The human vertebral column comprises a series of vertebrae that are securely interconnected through joints and ligaments. Among these ligaments, the Anterior and Posterior longitudinal ligaments play a crucial role in maintaining the alignment of the vertebral bodies and preventing anterior and posterior displacement of the vertebrae relative to one another. The anterior longitudinal ligament is one of the important ligaments in the spinal column that provides stability to the spine which runs along the front of each vertebral body and disc, extending from the base of the skull to the sacral promontory. The anterior longitudinal ligament (ALL) is a robust, flat band that extends from the second cervical vertebra (axis) to the sacrum, positioned along the anterior surface of the vertebral bodies, with its greatest thickness observed in the thoracic region. Conversely, the posterior longitudinal ligament originates at the axis and continues as the tectorial membrane down to the

sacrum, running along the posterior surface of the vertebral bodies. When these ligaments experience ossification or calcification, the normal alignment of the vertebrae is disrupted, resulting in alterations to posture and gait.

MATERIAL AND METHODS: The study was conducted over a period of September 2025 to March 2026 months in the Department of Anatomy, Saraswathi Institute Of Medical Sciences Hapur. A total of 50 vertebral column specimens were examined, comprising 20 articulated vertebral columns and 30 sets of disarticulated vertebrae. All specimens were dry adult human bones of unknown age and sex. Detailed morphological examination was performed on each specimen. Particular attention was given to the margins of the vertebral bodies and the laminae, to identify the presence of ossified remnants of spinal ligaments, especially the anterior longitudinal ligament (ALL).
The presence, distribution, and pattern of ossification were carefully observed and documented at different vertebral levels (cervical, thoracic, and lumbar regions).

RESULT: All vertebrae were examined thoroughly and findings were tabulated

TABLE:1 Distribution of Anterior Longitudinal Ligament (ALL) Ossification Across Vertebral Levels

S. No	vertebral level	vertebral number	SPECIMEN-1	SPECIMEN-2
1	CERVICAL	C1-C4	ABSENT	ABSENT
		C5-C7	PRESENT	ABSENT
2	THORACIC	T1	ABSENT	ABSENT
		T2-T6	PRESENT	ABSENT
		T7-T12	PRESENT	ABSENT
3	LUMBER	L1-L3	PRESENT	PRESENT
		L4-L5	PRESENT	ABSENT

The distribution of anterior longitudinal ligament (ALL) ossification across different vertebral levels demonstrated a distinct regional pattern between the two specimens. In the cervical region, no ossification was observed at the upper levels (C1–C4) in either specimen. However, at the lower cervical levels (C5–C7), ossification was present in Specimen 1 while remaining absent in Specimen 2, indicating localized involvement.
In the thoracic region, both specimens showed absence of ossification at T1. A marked difference was observed in the mid and lower thoracic segments, where Specimen 1 exhibited continuous ossification from T2 to T12, whereas Specimen 2 showed complete absence of ossification in these segments. This suggests a more extensive and progressive pattern of ligament ossification in Specimen 1.
In the lumbar region, ossification was consistently observed at L1–L3 in both specimens, indicating a common predilection for involvement at these levels. However, at L4–L5, ossification was present only in Specimen 1 and absent in Specimen 2, further reinforcing the comparatively widespread involvement in Specimen 1.
Overall, Specimen 1 demonstrated a more extensive, multi-regional pattern of ALL ossification, involving cervical, thoracic, and lumbar segments, while Specimen 2 showed limited ossification confined mainly to the upper lumbar region (L1–L3).

TABLE: 2 Morphological Characteristics of Vertebrae Showing ALL Ossification

S. No	PARAMETERS	CERVICAL C5-C7	THORACIC T2-T6	THORACIC T7-T12	LUMBER L1-L3
1	Ossification of ALL	CENTRE ALRS	ALRST2-T6, ALLS T2-T3	ALRST7-T12, ALLS T10-T11	ALRS, ALLS, CENTRE

2	Supraspinatus ligament ossification			T8-T12	
3	Intervertebral space	PRESENT	PRESENT	PRESENT	PRESENT
4	Interspinous ligament ossification	ABSENT	ABSENT	ABSENT	L2-L3
5	Vertebral canal narrowing	ABSENT	ABSENT	ABSENT	ABSENT
6	Intervertebral canal narrowing	ABSENT	ABSENT	ABSENT	ABSENT
7	Costovertebral joint ossification			LT 12^{th} costovertebral joint	
8	Zygapophyseal joint ossification	LT AT C5-C6 INCOMPLETE FUSION	T4-T5 BOTH SIDE	RT AT T10-T11 INCOMPLETE	L2-L3 BILATERAL COMPLETE

The morphological analysis of vertebrae exhibiting ALL ossification revealed characteristic patterns across different spinal regions. In the cervical region (C5–C7), ossification was predominantly central and anterolateral, suggesting localized ligamentous calcification. Additionally, incomplete fusion of the zygapophyseal joint at C5–C6 (left side) was observed, indicating early degenerative or ossific changes.

In the thoracic region, ossification showed a predominantly anterolateral distribution. In the upper thoracic levels (T2–T6), segmental anterior ossification was noted particularly at T2–T3, while in the lower thoracic levels (T7–T12), ossification extended further with segmental involvement at T10–T11. Notably, supraspinous ligament ossification was present from T8 to T12, indicating posterior ligament involvement in addition to anterior ligament ossification. Furthermore, costovertebral joint ossification at the left 12th rib articulation and zygapophyseal joint changes (bilateral at T4–T5 and incomplete fusion at T10–T11) were observed, suggesting multi-structure involvement in the thoracic spine.

In the lumbar region (L1–L3), ossification exhibited a combined pattern involving central, anterolateral, and segmental components, indicating advanced ligamentous ossification. This region also showed interspinous ligament ossification at L2–L3 and bilateral complete fusion of the zygapophyseal joints at L2–L3, reflecting more pronounced structural changes.

Importantly, intervertebral disc spaces were preserved across all regions, and no evidence of vertebral canal or intervertebral foraminal narrowing was observed. This preservation suggests that the

ossification pattern may be non-degenerative in nature, consistent with conditions such as Diffuse Idiopathic Skeletal Hyperostosis rather than classical degenerative spondylosis.



FIGURE-1 2 sets of vertebral columns showing ossification of Anterior Longitudinal Ligament (ALL)

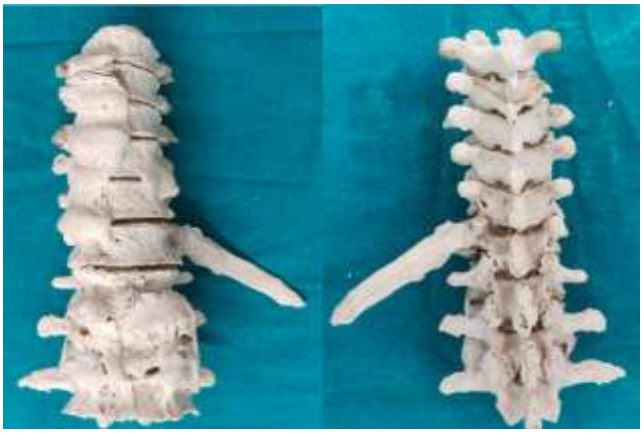


FIGURE-2 SPECIMEN1: OSSIFICATION of ALL at level of T7-L3 (anterior & posterior view) along with ossification of left costovertebral joint of 12th rib

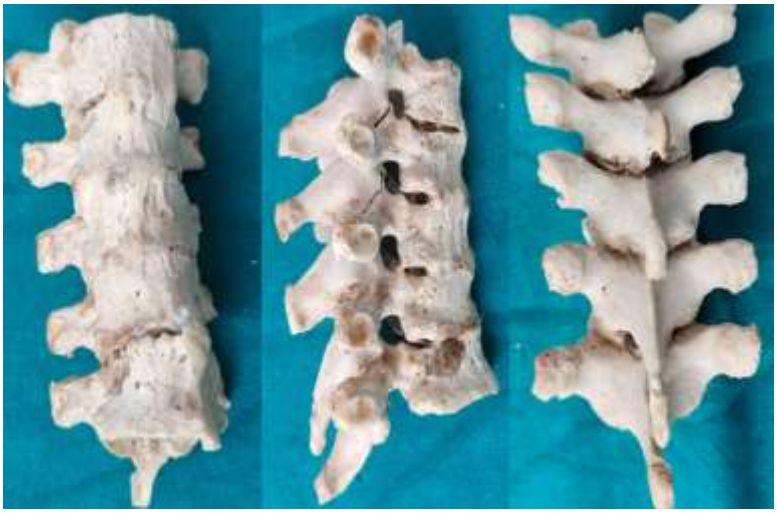


FIGURE-3 Specimen1: ossification of ALL at thoracic level T2-T6 (anterior, lateral and posterior view)

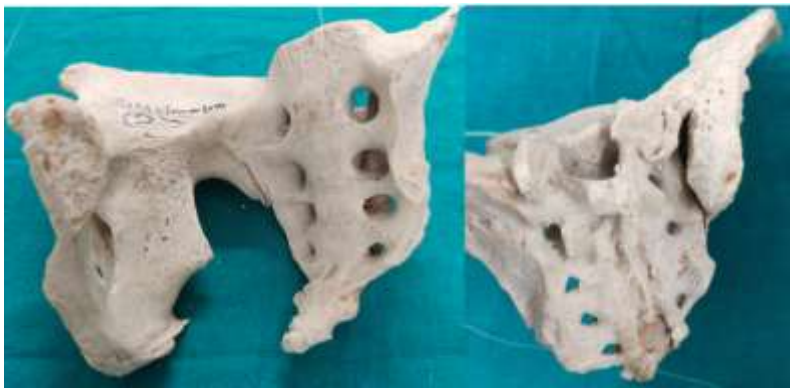


FIGURE-4 Ossification of Right sacroiliac joint (anterolateral and posterolateral view)



FIGURE-5 SPECIMEN-2: SHOWING ossification of ALL (lumber region L1-L3) anterior & posterior view

DISCUSSION:

Abnormal ossification of the anterior longitudinal ligament found in 2 sets of vertebral columns may indicate a type of arthritis that causes your soft tissues ligaments, tendons, and joints to stiffen and calcify known as Diffuse Idiopathic Skeletal Hyperostosis (DISH). It is a condition characterized by the abnormal ossification of ligaments and tendons, particularly in the spine. First described in recent decades, DISH has been referred to by various names, including Moniliform Hyperostosis[1], Senile Ankylosing Vertebral Hyperostosis, and Forestier's disease[2]. The term DISH[3], coined by Resnick et al., accurately describes the condition's hallmark feature: the ossification of the anterior longitudinal ligament with preserved disc space. It can be easily confused with degenerative disease.[4]

The anterior longitudinal ligament's strong adherence to the intervertebral disc, hyaline cartilage end plates, and adjacent vertebrae. The fibres of ligament merge with subjacent periosteum, perichondrium and margins of annular fibrosus[5] make it susceptible to hyperostosis, a reparative response to mechanical stress.[6] In DISH, osteoblasts migrate into the intact periosteum, forming new bone in tendons and ligaments near stressed areas. The spine, particularly the thoracic region, is most commonly affected.[7] DISH includes the characteristic "candle wax dripping down the spine" appearance of the ossified anterior longitudinal ligament in gross as well as radiological findings.[8] Studies have reported varying prevalence rates, ranging from 2.9% in Korean populations to 27.3% in European and Caucasian populations.[9-11] The current study found a prevalence rate of 4%.

DISH typically exhibits male preponderance[12], with thoracic vertebrae involvement being the most common.[11] Bilateral ossification is frequently observed, with T7-T10 levels being most affected.[13-14] The exact cause of this pattern remains unclear, but the descending thoracic aorta's role in preventing left-sided ossification has been suggested.[15] Usually, Posterior longitudinal ligament ossifies more than ALL.

Rarely, DISH has been reported in paediatric cases.[16] Extensive ossification can lead to restricted respiratory movements and pulmonary disease. The current study observed various types of ossifications, including segmental, continuous, and mixed patterns, mainly in thoracic and lumbar segments.

DISH's etiopathogenesis is attributed to hypercalcemia and disorders of pyrophosphate metabolism. Differential diagnosis from ankylosing spondylitis is crucial, as DISH lacks genetic transmission and organ involvement. It is also associated with Diabetes mellitus, Obesity, and Gout with increased incidence.

CONCLUSION: DISH's ossification of ligaments disrupts vertebral alignment and flexibility, leading to potential complications such as low backache, dysphagia, and nerve damage. Diagnosis is often made through imaging modalities like X-ray, CT, or MRI due to vague, non-specific symptoms.

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