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Calcification of Anterior Longitudinal Ligament in Lumbar Vertebrae

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Abstract

Introduction: Examining and analysing the characteristics features of the vertebral column of human is an important part of the study in anatomy. The vertebral column includes 33 vertebrae that are arranged one upon the other and joined to each other by means of the intervertebral joints and ligaments, of which includes anterior and posterior longitudinal ligaments. Diseases involving the ligaments end in numerous spectrums of ailments extending from backache to deformities and nerve entrapments.

Material and methods: The current study was conducted on 25 dry bone sets. The anterior longitudinal ligaments were studied to find out if there was any change in texture; they were inspected and palpated for any sign of ossification. The study was done randomly at Deccan College of Medical Sciences, Hyderabad

Result: Only 5 of the 25 dry sets of vertebrae examined had indications of ossified ligaments at varying levels.

Conclusion: Inflammation and ossification of the anterior ligament rarely cause symptoms or major functional issues in the patient. In exceedingly rare circumstances, these processes may be linked to the development of a degenerative back problem, however these instances are infrequent.

Keywords: Vertebral columns • Intervertebral joints • Anterior Longitudinal Ligaments • Ossification • Inflammation.

Introduction

Human vertebral column is made up of a series of vertebrae which are held together by ligaments and joints. Anterior and posterior longitudinal ligaments are important in keeping the bodies of vertebrae in alignment and preventing anterior or posterior dislocation of vertebrae over each other. Anterior longitudinal ligament is a flat, strong wide band that runs along the anterior surface of vertebral bodies from the second cervical vertebra (axis) to sacrum. In thoracic region, it is thickest. When these ligaments undergo ossification or calcification, as a result of post inflammatory changes, the normal alignment of vertebrae is deranged leading to disturbance in posture and gait associated with pain in the back.

Aims & objectives

The purpose of this study is to know the probable deformities of anterior longitudinal ligament of lumbar vertebrae and their complications.

To discuss their implications in medical and surgical aspects.

Methodology

Human torsos from the people who approached the anatomy department through donations were included in this study. Not a comparative study. During their lives, they gave written informed approval to enable their entire bodies to be used for educational and research interests. The current study was conducted on 25 dry bone sets collected randomly at Deccan College of Medical Sciences, Hyderabad. The anterior longitudinal ligaments in the cadavers were viewed and palpated for texture changes to see if there was any sign of ossification. The margins of the body of the vertebra and the borders of the lamina along with other parts of the vertebrae were inspected in dry bones for ossified remains. The ones who have not given consent were not included. Organization Ethical committee approval was taken for the study. Blinding is not used as it was observational study.

Results

Out 5 of the 25 dry sets of lumbar vertebrae examined had indications of ossified ligaments (Figures 1 and 2) at varying levels. The prevalence rate in the current study was 9%. In one set bodies along with the spines, superior and inferior articular processes are fused sparing the transverse processes (Figure 1). In two sets only anterior ligament is ossified without ossification of any other ligament (Figure 2), hence no fusion of any parts of vertebrae. In one of the sets in present study anterior longitudinal ligament along with posterior longitudinal ligament are fused and the bodies, lamina, pedicles, transverse processes, intervertebral foramens, superior and inferior articular surfaces of the vertebrae are also fused, hence the vertebra is completely fused except the spines (Figure 3). In other set complete bodies, articular surfaces and transverse processes are fused without fusion of spines and intervertebral foramen of vertebrae (Figure 4). Rest of the sets were not showing any signs of ossification of any ligament

Discussion

Intervertebral disc, hyaline cartilage end plates, and borders of adjacent vertebrae are strongly adherent by anterior longitudinal fibers, which are loosely linked to the intermediate level of bodies. Anterior Longitudinal

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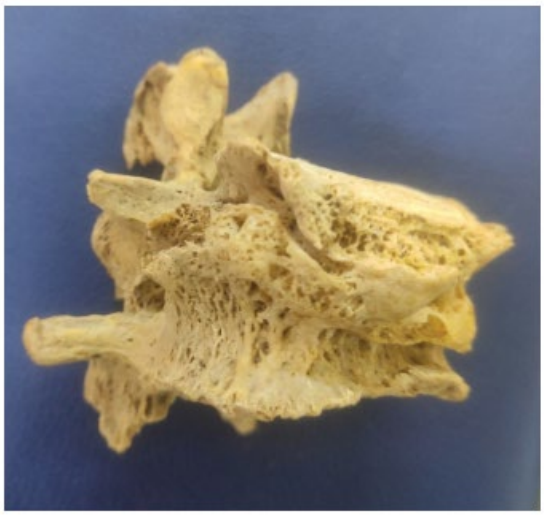

Figure 1. One set bodies along with the spines, superior and inferior articular processes are fused sparing the transverse processes.

Figure 2. In two sets only anterior ligament is ossified without ossification of any other ligament hence no fusion of any parts of vertebrae.

Ligament is a strong continuous wide tedious band present on the anterior surfaces of the vertebrae. Ligamentous fibers merge in various levels with the periosteal, perichondrium, and periphery of the annulus fibrosis. As hyperostosis is a healing response to tendons and ligaments that have been subjected to mechanical stress, osteoblasts from mesenchyme precursor cells migrate into the intact periosteal and generate new bone formation in tendons and ligaments near to the bone that is under stress in this case. DISH (Diffuse Idiopathic Skeletal Hyperostosis) syndrome is caused by the ossification of the Anterior Longitudinal Ligament Ossification of ligaments, tendons, and joint capsule insertion is prevalent in DISH (Diffuse idiopathic skeletal hyperostosis), and is commonly seen in the thoracic vertebra [1]. Pappone N, et al. [2] observed a prevalence of 27.3 percent in the European and Caucasian population, while Seong-Kyu K, et al. [3], Malik VS, et al. [4] do not give a proportion for the Indian population. The prevalence rate in the current study was 9% in south Indian population. According to Anneloes WI, et al. [5], DISH has a male prevalence compared to females. Musset A [6] attributed thickening and calcification of the lumbosacral ligament, ligament fava for certain types of enuresis [7-9]. According to Anneloes WI, et al. [5] and Nafziger HC [10] attributed thickening and calcification of the lumbosacral ligament, ligament flava for low-back pain; nevertheless, both Musset A [6] and Resnick D, et al. [1] observed that this lesion can occur without any clinical symptoms. According to Le Musset A [6] when ligaments are subjected to greater tension, or strained, or are involved in vertebral bone or joint diseases, they might tend to calcify or ossify. He concluded that ligament calcification and ossification are healing processes that help to strengthen a compromised vertebral column, and that they are associated to other vertebral diseases. Estier reported the newly developed bone in DISH "pushing" the ALL to the left in 1950, and Vernon-Roberts detailed it in 1974 [7-9].

According to Schmorl G [9], increasing tension on particular longitudinal ligament fibres causes the production of osteophytes at the vertebral margins [10]. The calcification and ossification of longitudinal ligaments does not induce back pain or radicular signs by itself. Radicular neuritis can sometimes be caused by calcified or ossified ligament flava, however it can also persist without causing symptoms [11] Vertebral mobility is normal in the presence of calcified or ossified ligaments unless the epiphyseal joints or the vertebral bodies are damaged at the same time. In cases involving Strumpell-Marie disease, complete stiffness of the spine was noted in the absence of calcification or ossification of ligaments. In vertebral segments that have been immobile for a long time, ligaments typically ossify or calcify. It is assumed that calcification or ossification of vertebral ligaments is not the cause of decreased vertebral mobility, but rather the outcome of it [2] Beadle claimed that vertebral osteophytes, one of the most common spine ailments, are actually ossified anterior longitudinal ligament fibres in 1932. The most important thing to note from all of the discoveries is the critical role of intervertebral discs in maintaining the normal shape of the spine during the countless variations in shape, compressions, extensions, and torsions it experiences throughout its functional life. The extreme receptivity of the discs to senile alterations, long before these emerge in other tissues, demonstrates how demanding the efforts to prevent it [12] In one of the sets in present study anterior longitudinal ligament along with posterior longitudinal ligament are fused and the bodies, lamina, pedicles, transverse processes, intervertebral foramens, superior and inferior articular surfaces of the vertebrae are also fused, hence the vertebra is completely fused except the spines (Figure 3) which may have produced any symptom as there was compression of spinal nerves. Symptoms like pain, mobility dysfunction or paralysis of limbs are produced only when there is complete compression of nerves due to ossification. In other set complete bodies, articular surfaces and transverse processes are fused without fusion of spines and intervertebral foramen of vertebrae (Figure 4). In one set bodies along with the spines, superior and inferior articular processes are fused sparing the transverse processes (Figure 1). In all the above cases the ligaments between the joints are calcified and ossified, hence fusion has occurred. Except in one case (Figure 3) the intervertebral foramen is not fused and is wide open which may not have produced any symptoms. Ossification of anterior longitudinal ligament started as a result of insult to the ligament may lead to restricted mobility which in turn leads to more accumulation of calcium deposits and the vicious cycle goes on increasing the damage to the ligaments

Figure 3. Anterior longitudinal ligament along with posterior longitudinal ligament are fused and the bodies, lamina, pedicles, transverse processes, intervertebral foramens, superior and inferior articular surfaces of the vertebrae are also fused.

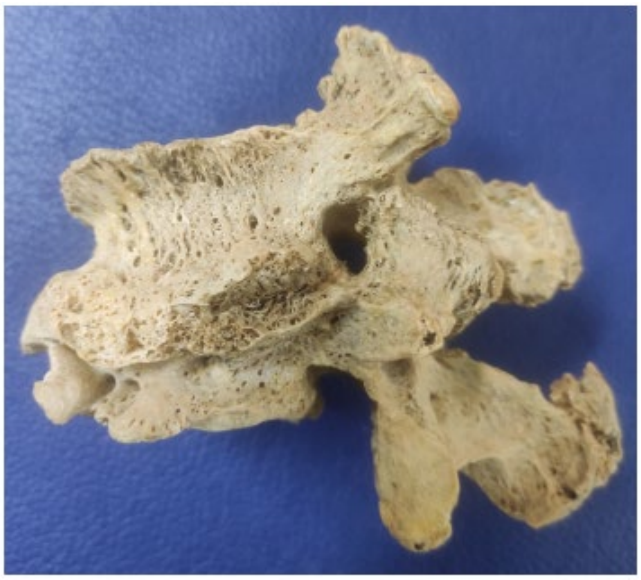

Figure 4. Complete bodies, articular surfaces and transverse processes are fused without fusion of spines and intervertebral foramen of vertebrae.

and ultimately making the patient completely immobile and paralyzed. Absorption of cartilage between the articular facets occurs in the spine, starting in the lower lumbar area and proceeding upward. This causes a narrowing of the joint spaces and is frequently linked with articular surface irregularity. The ligaments in the spine become calcified, and the involvement begins in the lower lumbar region and progresses higher. The illness process, on the other hand, it is stopped at any point throughout its progression, thus the entire spine does not have to be implicated [13]. Spondylitis ossificans ligamentosa, or calcification or ossification of the spinal ligaments, is neither a clinical nor a pathologic entity and should not be considered an independent or unique disease, as it is frequently a late reaction. Its presence frequently implies the presence of a spinal bone or joint lesion [11]. The initial symptom of Spondylitis ossificans ligamentosa is Sacro-iliac joint disease, which can be present as a useful diagnostic indicator for several years before the back is affected. The degree of activity of the process in the Sacro-iliac joints is thought to provide some indication of the disease's severity and prognosis [14]. Hirano H, et al. [15] reported that 8 1/2 years after surgery, one of his patients developed a recurring osteophyte at the surgical site, but the patient was asymptomatic. Suzuki K, et al. [16] reported that one of his two patients developed ossification of the anterior longitudinal ligament with dysphagia 11 years after the initial surgery, necessitating reoperation. The process of ligamentous ossification continues until stiffness is achieved. Recurrence is anticipated if no fusion is involved. Following simple bone excision, regrowth of osteophytes along the anterior vertebral edge has been described. Osteophyte recurrence is gradual, therefore surgical resection appears to be the best option for symptom reduction [17]. The radiographic evaluation in a patient's spine studied by CF Corke revealed the characteristic signs and symptoms of ankylosing hyperostosis. Although there was no clinical evidence of past lumbar spine immobility, the lumbar spine seemed to be ankylosed. After a fall, the spinal fracture occurred was of the "long bone" kind, which is common in the inflexible spine of people with nkylosing spondylitis. The fracture occurred after a mild impact, and neurological indications appeared a few days later. Both of these characteristics - minor trauma and delayed onset of neurological impairment - are common in spinal fractures aggravating ankylosing spondylitis and can make diagnosis challenging. The consequences of a delayed diagnosis could be significant neurological impairment. In cases of severe ankylosing vertebral hyperostosis, the possibility of fractures should be recognized, and the patient should be treated as soon as possible [18]. A case studied by Yagan R and Karlins N [19] with a back strain complained of discomfort and numbness in his extremities, as well as difficulties in walking. The results of the physical examination revealed myelopathy characterized by weakness in both upper extremities and a reduction in mobility. All of the limbs were diminished in sensations. A simple film examination revealed that the posterior longitudinal ligament has thickened into a rod-like ossification. The ossified posterior longitudinal ligament was confirmed on CT, causing considerable constriction of the vertebral canal and compression of the spinal cord [18]. In patients with severe spinal ankylosis, a more damaging process affecting the disco vertebral junction of the vertebral end plates has been observed by Gelman MI and Umber JS [19] in ankylosing spondylitis, fractures through the disc or juxta-end plate region of the vertebra, as well as the posterior elements, could be seen in the thoracic and lumbar spine. These are frequently accompanied with worsening pain and do not result in neurologic deficits, and may require orthopedic stabilization to cure. Pseudarthrosis might cause irregularity and sclerosis at the margins, which should not be confused with a pyogenic or granulomatous infection. Because the axis of flexion and extension in the ankylosed spine has shifted away from its normal placement in the centre of the nucleus pulpous, these fractures resemble the "seat belt type" or Chance fracture [20]. The vascular outer component of the annulus fibrous adheres to the antero superior and antero inferior corners of the vertebral bodies at points of attachment, resulting in the typical squaring of the vertebral bodies after minor trauma [21,22].

Conclusion

Natural pattern of vertebrae arrangement in the human spine provides springiness, flexibility, and strength to the vertebral column; this is made possible by the many ligaments and joints that connect the vertebrae. As a result of ligament ossification, it not only affects the alignment of the vertebrae but also the flexibility of the entire spine's movements. Forestier's disease, also known as Diffuse Idiopathic Skeletal Hyperostosis (DISH), and is characterized by ossification of the anterior longitudinal ligament. In most cases, the posterior longitudinal ligament; supraspinatus ligament, cost transverse, and cost vertebral joint are unaffected. Such ossifications are linked to low back pain, dysphagia, odynophagia, and brachial plexus compression (cervical region) which results in nerve weakness. Immobility or decreased mobility of vertebra is also a major cause for development of calcification and ossification of the vertebrae. Factors which lead to calcification and ossification should be prevented and frequent mobility of vertebral joints should be taken into consideration rather than doing surgeries frequently. Minimal trauma can also lead to fracture and other complications which could be fatal in cases of ankylosing spondylitis. Individuals having DISH must take extra precautions to prevent circumstances that could result in back strain or damage.

Acknowledgment

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Data Availability

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