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Spastic Lower Paraparesis Due To Multiple Ossification Of The Ligamentum Flavum Of Fusion And Tuberous Type In The Thoracolumbar Region In A 42-Year-Old Woman

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Abstract.

Ossification of the ligamentum flavum (OLF) is characterized by the replacement of ligamentum flavum tissue with mature laminar bone accompanied by hypertrophy. Although rare, its highest prevalence is reported among East Asian populations, predominantly affecting males under 50 years old, and most commonly found in the lower thoracic region. Clinically, OLF presents as a slowly progressive myelopathy, yet its precise pathogenesis remains unclear. Diagnostic imaging modalities include radiography, computed tomography (CT), and magnetic resonance imaging (MRI). This case report describes a 42-year-old female diagnosed with thoracolumbar OLF based on MRI examination. The patient presented with spastic paraparesis and hypoesthesia from both feet to dermatomes Th10–11 following a history of trauma. Lumbar radiography showed only lumbal spondylosis, while thoracolumbar MRI revealed nodular thickening of the ligamentum flavum from Th6–7 to Th12–L1, resulting in spinal canal stenosis and compression of the spinal cord. Additional degenerative findings included superior endplate degeneration of L4 and multiple intervertebral disc bulging. Neurological deficits indicated myelopathy and radiculopathy due to compression of the lateral corticospinal and spinothalamic tracts. The absence of spinal cord edema on MRI suggested a chronic onset. OLF frequently coexists with vertebral degenerative abnormalities, as observed in this patient. Based on the radiologic characteristics, the lesion represented several morphological types including extended, enlarged, fused, and tuberous forms. Laminectomy performed in this case resulted in gradual neurological recovery. In conclusion, OLF is a rare but important cause of progressive thoracic myelopathy that may lead to irreversible neurological impairment. MRI evaluation plays a crucial role in preoperative assessment of spinal canal stenosis and spinal cord compression.

Keywords: *Ossification of the ligamentum flavum; thoracolumbar vertebra; myelopathy; MRI and laminectomy.*

I. INTRODUCTION

Ossification of the ligamentum flavum (OLF) was first described by Polgar in 1920 through lateral plain radiography, characterized by the replacement of the ligamentum flavum with hypertrophic and mature laminar bone tissue [1][2][3][4][5]. OLF predominantly affects males under the age of 50, most frequently occurring in the distal thoracic vertebrae, and rarely in the lumbar region [1][4][5][6]. The highest prevalence has been reported in East Asian countries, with a notably lower incidence in Western populations[1][4][6]. Clinically, OLF manifests as a slowly progressive myelopathy that may lead to significant neurological impairment if not treated promptly [1][6]. The condition is often associated with ossification of the posterior longitudinal ligament (OPLL), lumbar degenerative disorders, or both [1].Although numerous theories have been proposed regarding its etiology, the exact pathogenesis of OLF remains unclear[2][6]. Biomechanical stress, particularly tractional forces, has been suggested as one of the main contributing mechanisms [2]. The ossification process is believed to involve endochondral bone formation mediated by fibrocartilaginous metaplasia of the ligamentum flavum. Genetic factors, metabolic disorders, and chronic mechanical loading have also been implicated in OLF development [5] [7].

Several imaging modalities have been employed for the diagnosis of OLF, including vertebral X-ray, computed tomography (CT), and magnetic resonance imaging (MRI). While CT scanning provides detailed visualization of the local extent of ossification and the axial morphology of the spinal canal, MRI offers superior information on associated pathologies, such as OPLL and spinal cord compression [8][9]. A strong correlation has been reported between CT and MRI findings in determining the level, side, and severity of spinal canal stenosis caused by OLF [1]. Whole-spine imaging is recommended to identify potential multiple compression sites and related distal lumbar pathologies [9].CT imaging is also essential for differential

diagnosis and surgical planning. Decompressive surgery remains the only definitive treatment option. Prognosis following surgery is generally more favorable in OLF compared to other causes of thoracic myelopathy[2]. The severity of preoperative neurological symptoms and the duration of the disease before surgical intervention are considered the most critical prognostic factors [2][3] [1][10].The present case report discusses a 42-year-old female presenting with spastic paraparesis and hypoesthesia in both lower extremities up to the Th10–11 dermatome, caused by thoracolumbar OLF with multiple intervertebral disc bulging.

II. METHODS

The diagnostic and therapeutic methods applied in this investigation were selected based on their suitability for characterizing spinal ossification disorders and evaluating neural compression [11]. Therefore, imaging parameters were standardized according to radiological safety and diagnostic precision, ensuring minimal patient exposure to ionizing radiation. The selected modalities included plain radiography for preliminary skeletal assessment, magnetic resonance imaging (MRI) for soft tissue and spinal cord evaluation, and postoperative follow-up through clinical and rehabilitative observation. Surgical intervention using posterior decompression (laminectomy) was performed as the definitive treatment for neurological recovery.

Radiography (X-Ray)

Plain radiographs of the lumbar spine were obtained in both anteroposterior (AP) and lateral projections using a Siemens Multix Fusion DR system. Imaging parameters were standardized at 70–80 kVp and 25 mAs with a 100 cm source-to-image distance. The technique allowed assessment of vertebral alignment, curvature, and bony morphology. The radiographs demonstrated lumbar spondylosis with straightening of the lumbar curvature (Figure 1),

Fig 1. Anteroposterior and lateral radiographs of the lumbar vertebrae showing lumbar spondylosis with straightened lumbar curvature.

Indicating chronic degenerative change without acute fracture or abnormal canal opacity.

Magnetic Resonance Imaging (MRI)

MRI was performed using a 1.5 Tesla Siemens Magnetom Avanto system equipped with a spinal phased-array coil. Sagittal and axial T1-weighted (TR = 500 ms, TE = 12 ms) and T2-weighted (TR = 3500 ms, TE = 100 ms) sequences were obtained with 3 mm slice thickness and 10% interslice gap. Imaging extended from vertebral levels Th6 to L1 for detailed evaluation of the thoracolumbar region. MR myelography was also conducted to assess the integrity of the thecal sac and detect multiple posterior indentations due to ossification.Images revealed nodular hypointense lesions on both T1- and T2-weighted images consistent with ossification of the ligamentum flavum, causing spinal canal stenosis and medullary compression between Th6–L1 (Figures 2–3).

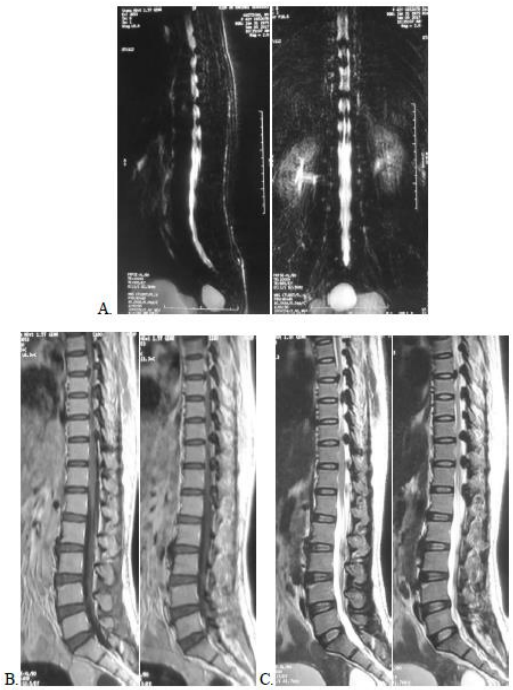

Fig 2. MR myelography and sagittal thoracolumbar MRI showing multiple posterior indentations and nodular hypointensities from Th6–L1 consistent with ossification of the ligamentum flavum (OLF) and spinal canal stenosis at Th7–11.

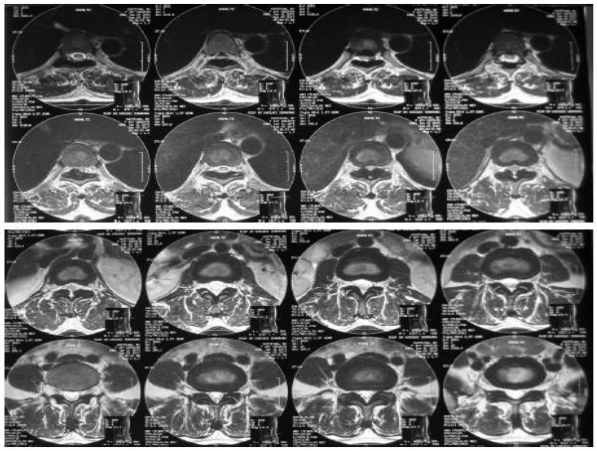

Fig 3. Axial T2-weighted MRI showing hypointense OLF compressing the spinal cord without intramedullary signal abnormality.

Additional findings included degenerative Modic Type 2 endplate change at L4 and multilevel intervertebral disc bulging from Th8–9 to L5–S1 compressing the thecal sac and neural foramina.

Surgical Decompression (Laminectomy)

Posterior decompression via laminectomy with internal fixation was performed at Dr. Kariadi General Hospital, Semarang. Intraoperative findings confirmed thickened, ossified ligamentum flavum compressing the dura mater at multiple thoracolumbar levels. Decompression involved en-bloc removal of the ossified ligament and partial facetectomy under microscopy. Hemostasis was maintained with bipolar cautery, and spinal stabilization was achieved using titanium pedicle screws and rods.

Postoperative Rehabilitation and Pharmacologic Therapy

Following surgery, the patient underwent a structured rehabilitation program including bilateral lower-limb passive range-of-motion (ROM) exercises and sensory retraining to enhance neurological recovery. Pharmacologic therapy included intravenous methylprednisolone for anti-inflammatory modulation and ketorolac for postoperative analgesia. Clinical follow-up at two weeks and one month post-operation demonstrated gradual improvement in motor power and reduction in spasticity.

III. RESULT AND DISCUSSION

Ossification of the ligamentum flavum (OLF) represents a progressive metaplastic process in which endochondral ossification leads to bone formation within the ligamentum structure, resulting in spinal canal stenosis and chronic spinal cord compression. The ligamentum flavum is a paired, yellowish structure connecting adjacent laminae and forming the posterior wall of the vertebral canal (Fig. 4).

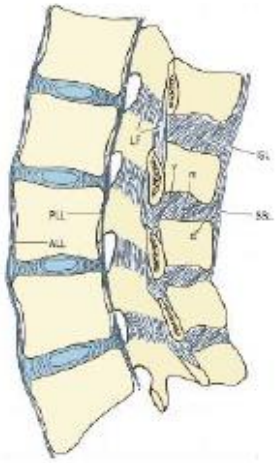

Fig 4. Median sagittal section of the lumbar vertebra showing the major spinal ligaments.

ALL: anterior longitudinal ligament; ISL: interspinous ligament; v: ventral part; m: medial part; d: dorsal part; PLL: posterior longitudinal ligament; SSL: supraspinous ligament; LF: ligamentum flavum, viewed from within the vertebral canal and along the midline sagittal plane.

Histologically, it contains approximately 80% elastin and 20% collagen fibers, with elastic fibers providing resilience and maintaining vertebral posture from flexion to extension. The elastogenesis process, as illustrated in Figure 5.

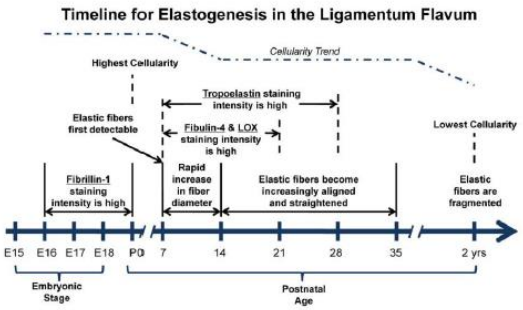

Fig 5. Timeline of elastogenesis in the ligamentum flavum during the stages of formation, maturation, and degeneration.

Begins embryonically and achieves full maturation in early postnatal life, after which degeneration gradually occurs.In normal conditions, the ligamentum flavum exhibits isointense signals on T1- and T2-weighted MRI sequences due to its low collagen content (Fig. 6).

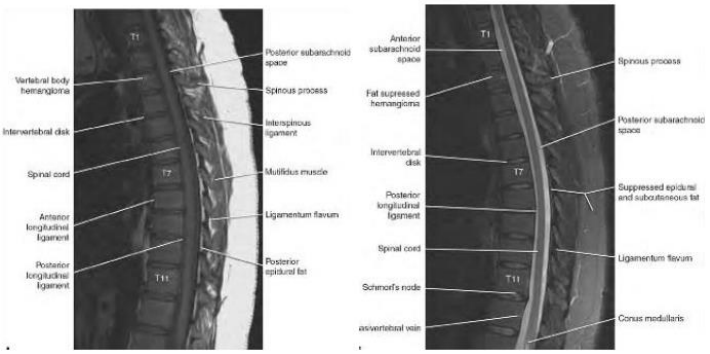

Fig 6. Normal thoracic vertebra on sagittal section. A: T1-weighted, midline. B: T2-weighted fast spin echo.[11]

Hypertrophy or ossification of this ligament, however, leads to hypointense nodular thickening on both sequences. In this case, MRI revealed multilevel OLF extending from Th6–L1 with marked spinal canal narrowing and medullary indentation, correlating with the patient's clinical manifestation of spastic paraparesis and hypoesthesia from the feet to the Th10–11 dermatomes. The chronic onset and absence of spinal cord edema indicate a long-standing compressive myelopathy.The etiology of OLF is multifactorial. Two main mechanisms are recognized: intrinsic (genetic and metabolic) and extrinsic (biomechanical stress or trauma). Extrinsic factors are currently considered predominant, as mechanical tension increases bone morphogenetic protein-2 (BMP-2), transforming growth factor-β (TGF-β), and SOX expression, which stimulate fibroblast differentiation into chondroblasts and osteoblasts, leading to ossification. The thoracic lower region is the most common predilection site, as it endures the highest tensile stress. Epidemiologically, OLF is prevalent in East Asian populations, possibly due to habitual squatting posture and specific genetic predispositions.Radiological evaluation plays a crucial role in confirming OLF. CT scan provides superior visualization of ossified lesions, while MRI offers insight into spinal cord condition and associated degenerative changes. In this patient, MRI findings indicated mixed-type OLF morphology, consisting of extended, enlarged, fused, and tuberous forms, consistent with Sato's classification (Fig. 7).

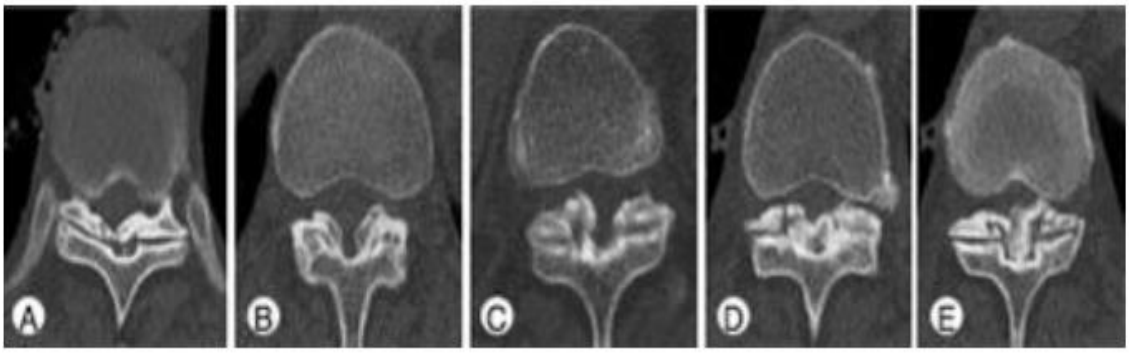

Fig 7. Sato classification based on the progression of ligamentum flavum ossification.[2]

Degenerative changes, including Modic type 2 endplate alteration at L4 and multiple thoracolumbar disc bulgings, were also present, emphasizing the association between OLF and degenerative spinal disease. Surgical decompression remains the only definitive treatment for symptomatic OLF. In this case, posterior laminectomy with internal fixation was performed, resulting in gradual neurological recovery. Early diagnosis and surgical intervention are essential to prevent irreversible spinal cord damage. Prognosis after decompression is generally favorable, particularly when the anterior spinal artery remains intact, allowing sufficient medullary perfusion. Overall, this case supports that timely MRI evaluation and decompressive surgery are key factors for optimal outcomes in thoracic myelopathy caused by OLF.

IV. CONCLUSION

Ossification of the ligamentum flavum (OLF) is a rare yet significant cause of progressive thoracic myelopathy that can lead to irreversible neurological impairment. Multi-modality imaging plays a central role in its diagnosis and surgical planning. Plain radiography, computed tomography (CT), and magnetic resonance imaging (MRI) complement each other to provide a comprehensive evaluation of spinal canal stenosis, medullary compression, and possible spinal cord edema. CT and MRI are essential preoperative tools, though distinguishing OLF from ligamentum flavum calcification remains challenging without histopathological confirmation. Conservative management offers no benefit; therefore, decompressive surgery remains the definitive treatment once myelopathic symptoms develop. Prognosis largely depends on the severity of preoperative deficits and the timing of surgical intervention early decompression yields the most favorable neurological recovery.In conclusion, this study emphasizes that accurate imaging diagnosis combined with timely surgical decompression provides the best outcome for patients with thoracic OLF, underscoring the need for early detection and multidisciplinary management.

V. ACKNOWLEDGMENTS

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