Compressive Myelopathy Due to Ossification of the Ligamentum Flavum: Case Report and Review of the Literature

Mielopatia compressiva devido à ossificação do ligamento flavo: relato de caso e revisão da literatura

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Abstract

Ossification of the ligamentum flavum (OLF) is a rare condition in which the ligamentum flavum, due to mechanical, biological and genetic factors, becomes ossified. Due to its nature and anatomic location, OLF produces symptoms characteristic of spinal cord compression. The diagnostic confirmation is based primarily on imaging tests such as computed tomography (CT) and magnetic resonance imaging (MRI). Ossification of the ligamentum flavum most often affects Asian populations, rarely occurring in black people. The authors report a case of a 61-year-old black man with progressive paraparesis due to OLF, and review the literature regarding the pathology's prevalence, pathogenesis, clinical features, diagnosis, treatment and prognosis.

Keywords
- ossification of the ligamentum flavum
- myelopathy
- paraparesis
- ligamentum flavum
- laminectomy
- thoracic spine

Resumo

A ossificação do ligamento flavo (OLF) é uma doença rara na qual o ligamento flavo se torna ossificado devido a fatores mecânicos, biológicos e genéticos. Devido à sua natureza e localização anatômica, a OLF produz sintomas característicos de compressão da medula espinhal. A confirmação diagnóstica baseia-se principalmente em exames de imagem, como tomografia computadorizada (TC) e ressonância magnética (RM). A OLF afeta mais comumente populações asiáticas, raramente sendo observada em pacientes negros. Os autores relatam o caso de um homem negro de 61 anos com paraparesia progressiva decorrente de OLF com uma revisão da literatura a respeito da prevalência, patogênese, aspectos clínicos, diagnóstico, tratamento e prognóstico desta patologia.

Palavras-chave
- ossificação do ligamento flavo
- mielopatia
- paraparesia
- ligamento flavo
- laminectomia
- coluna torácica

Introduction

Ossification of the ligamentum flavum (OLF) was first described by Polgar in 1920, and it has been recognized as a potential cause of compressive myelopathy.[1–8] This entity is relatively common in Asia, with a reported prevalence in China of 4% in the general population, and of 8% in people older than 45.[3] Approximately 90% of the reports of this condition in the literature include the Japanese population.[2,3,6,9]

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It has been suggested that a genetic component may explain the increased prevalence of OLF in certain ethnic and racial groups.[10–12] Despite this evident geographic distribution, some authors have reported OLF in Caucasians,[13–15] Hispanics,[1,16,17] Afro-Caribbeans,[6,18] as well as in subjects from the Middle East,[19] India,[20,21] North Africa,[2,22] North America,[23] and South America.[24]

The aim of the authors is to review the literature concerning the epidemiology, natural history, treatment strategies and prognosis of this relatively uncommon disease, and to present a case of OLF causing compressive myelopathy in a Brazilian patient.

Case Report

A 61-year-old black man presented with progressive paraparesis over a period of 5 years. Two years ago, he started walking with crutches and complaining of urinary incontinence, and over the past two months he was bound to a chair. In the past four months, he noticed successive transient electric-like shocks in the back triggered by trunk extension, as well as spasms on both lower limbs. No intestinal or sexual dysfunctions were reported. A neurological examination revealed a sensory level at T10, and loss of position sense in both lower extremities. A lower extremity motor examination revealed a left side weakness greater than the right side one, grading ⅖ and ⅗ respectively, associated with spasticity, clonus, and Babinski sign bilaterally.

Due to the severe obesity of the patient, magnetic resonance imaging (MRI) could not be performed. The patient underwent a computed tomography myelogram (CT-M), which demonstrated a significant thoracic spinal stenosis in T10-T11 due to OLF (►**Fig. 1**). No spinal instability was observed, and there was no stenosis among the other levels.

The patient was submitted to a surgical procedure. It consisted of T10-T11 laminectomies and removal of an ossified ligamentum flavum by microsurgical technique, with wide spinal canal decompression in this level. Due to obesity, the patient was operated in the lateral position on the surgical table. A posterior midline subperiosteal dissection was performed, and the T9 (partially), T10 and T11 laminas were exposed. Using a 3-mm burr and Kerrison punches, we started the decompression at the superior part of the T10 lamina until exposure of the dura mater. Subsequently, a partial laminectomy of the T11 lamina was performed, and the dura mater bellow the calcified ligament was exposed. Finally, the T10-T11 OLF was removed using a careful microsurgical technique. There was no intraoperative complication. At the end of the decompression, the dura expanded to fill the laminectomy, and was noted to be pulsatile. No intraoperative neurophysiological monitoring was used in this case. There was no postoperative complication. A progressive improvement in strength was observed immediately after the surgery. Twelve months' follow-up revealed persistent spasticity and hypoesthesia in the lower limbs, and the patient returned to walk without assistance with a mild spastic gait.

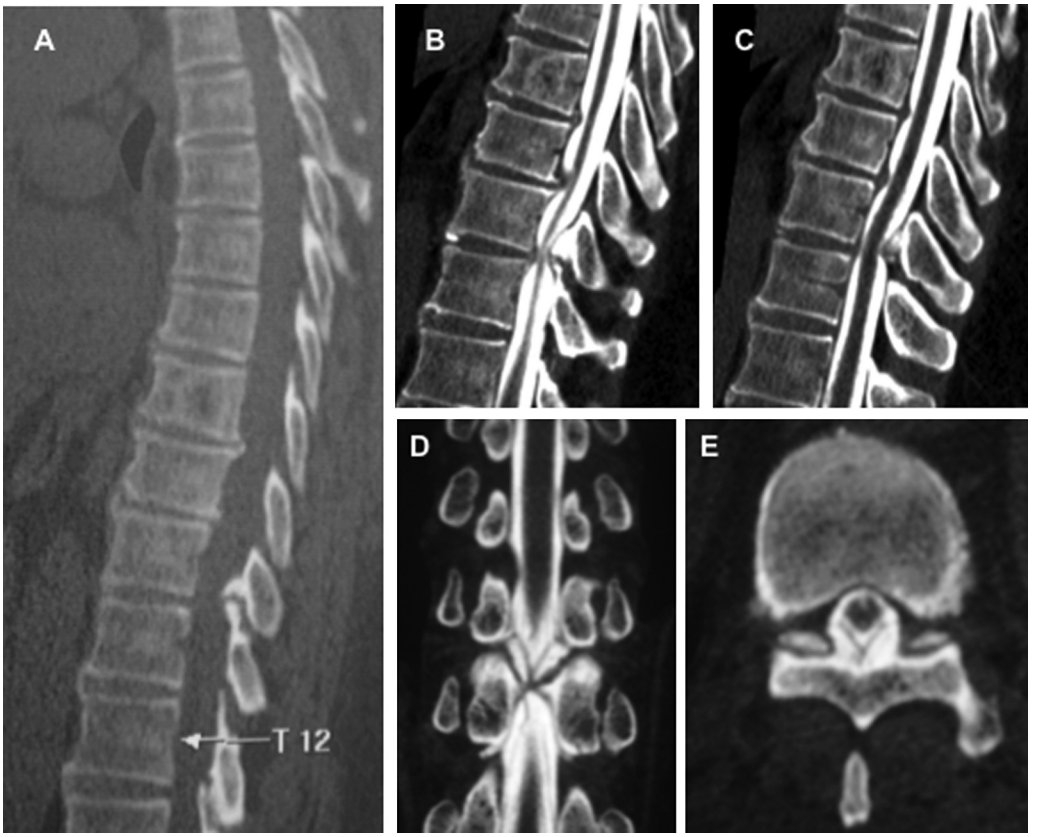

Fig. 1 (A) Computed tomography (CT) scan showing ossification of the ligamentum flavum (OLF) at T10-T11. Sagittal (B, C), coronal (D) and axial (E) CT myelogram demonstrating significant thoracic spinal stenosis in T10-T11 due to OLF.

Discussion

The ligamentum flavum consists of a group of paired ligaments that connect adjacent spinal column laminae, extending from C2 to S1.[1] In OLF, the ligamentum flavum becomes ossified through a process of ectopic bone formation, which occurs through hypertrophy of the ligament, proliferation of chondrocytes and ossification, characterizing a process of endochondral ossification.[25,26]

Even though 90 years have passed since its first description, the pathophysiology of OLF is not yet totally understood.[14] Many authors have postulated that it derives broadly from mechanical stress, but other metabolic and genetic factors may also be of relevance.[3,10,11,27–32] Histologically, the lesion often presents with degeneration and disorganization of elastic fibers.[12,25,26,33,34] Yoshida et al[33] and Yayama et al[12] have shown increased production of collagen fibers in the lesion. Several authors demonstrated that altered expression of bone morphogenetic protein (BMP-2), transforming growth factor β (TGF-β) may play a role in the process that leads to OLF.[12,27,28] It has been shown that genetic polymorphism in collagen-related genes may also contribute in that aspect.[29,30] Although OLF has been reported as an isolated form of spinal column ossification, many publications proposed the existence of an interrelation with conditions such as diffuse idiopathic skeletal hyperostosis (DISH), ankylosing spondylitis, and metabolic disorders. Disorders such as hypoparathyroidism, X-linked hypophosphatemia, Paget's disease, vitamin D-resistant rickets, non-insulin-dependent diabetes mellitus, and calcium and fluoride derangements, as well as other spinal ligamentous ossifications.[4,5,20,34–46] Finally, it has been suggested that the genetic background may explain the increased prevalence of OLF in certain ethnic and racial groups.[10–12]

Ossification of the ligamentum flavum is a major cause of myelopathy in Japan. An epidemiological study conducted by Sato et al in Japan showed that 64% of surgeries for thoracic myelopathy were due to OLF.[47] Another similar study in Japan showed the presence of OLF in 52% of thoracic myelopathy surgical procedures.[48] Guo et al[3] reported the prevalence of OLF in 1,736 Chinese volunteers using the MRI. They demonstrated a prevalence of OLF in 3.8% (66 volunteers) of the sample. Of the 92 affected segments, 87 (94.5%) were located in the thoracic region, with more than half of those (48 segments) located on the lower thoracic spine. In that study, isolated OLF was present in 68.2% of the cases, with continuous and non-continuous multilevel lesions present in 16.7% and 15.2% of the cases respectively.

Several other authors have asserted the isolated form as the most prevalent, and that the lower thoracic spine, specially T9-T10 and T10-T11, is the most affected region.[1,2,6,12,14,49] These data are also supported by a review published by Xu et al.[14] This prevalence occurs probably because this transitional level presents a high load and less anatomic protection from the rib cage, making it more prone to degenerative processes and mechanical stress, which in turn leads to ossification.[3,31,32]

Ossification of the ligamentum flavum is very rare among black patients, with only a few reports in the literature.[8,50–54] In 1998, Pascal-Mousselard et al reported an unusual OLF in the thoracic spine in a black patient presenting with progressive spastic paraparesis.[8] Because of its rarity in black patients, OLF is a diagnosis of exclusion in this population.

When OLF lesions are small, patients may be asymptomatic.[3] Once the lesions grow enough to significantly affect the spinal canal, patients often present with symptoms secondary to myelopathy. These include motor and sensory dysfunctions and bladder impairment.[1,2] Since the majority of these cases occurs at lower thoracic levels,[5,55] the most common symptoms are uni- or bilateral lower limb weakness,[2,6,8,12,14,18,56] pain[6,8,18,56] and sensorial loss,[2,6,8,56] unsteady gait,[6,8,14] brisk reflexes with positive Babinski,[8,56] and urinary frequency and urgency, often accompanied by incontinence.[6,8,14,18,56] In cases in which OLF presents at upper levels, upper limb and neck involvement may occur.[1,6] Advanced OLF can also cause paraplegia, as reported by Ben Hamouda et al[2] and Okada.[5]

Plain radiographs are not sensitive enough to diagnose OLF in most of the cases, since its radiopaque shadow can be obscured by bony structures.[4] Computed tomography and MRI are the best imaging modalities to establish the diagnosis.[14] Computed tomography is more accurate,[14] revealing characteristic intense radiodense lines along the laminae.[1,6] The lesion most commonly presents in a V-shaped fashion on axial imaging,[1,2,6] but it may also present as nodular, mound-shaped lesions.[14,57] The CT is also useful in determining if the dura-mater is involved in the OLF or not.[1] Both the T1- and T2-wheigted MRIs are used mostly to evaluate spinal cord involvement, showing a hyperintense signal in the affected parts. [1,2,6,15,58]. The ossification itself presents a hypointense signal in this imaging modality.[2,3,14] A myelogram can determine the presence of spinal cord compression, but it often fails to define the nature of the lesion. Thus, the myelogram is often accompanied by CT imaging.[2,6,8] A retrospective analysis by Muthukumar et al[59] established two radiological signs of dural ossification related to OLF: the "tram track sign" and the "comma sign." The former consists of a hyperdense bony excrescence with a hypodense center, with the latter being evidence of ossification on one half of the circumference of the dura mater.[59]

Ossification of the ligamentum flavum can often be confused with calcification of the ligamentum flavum (CLF),[2,6] which is a rare disease that occurs through a deposit of calcified granules along the ligamentum flavum, with no bone formation.[2] Since both lesions appear as hypointense formations on the T1- and T2-weighted MRIs, the diagnosis can be confirmed according to CT imaging, with CLF being discontinuous with the laminae, opposite to OLF.[3,4,14,60] It's also worth noting that the majority of cases of CLF occur in the cervical spine.[2,61]

To this date, there are no efficient pharmacological therapies to treat OLF.[14] Due to the nature of the disease, the treatment consists mostly of simple surgical decompression.[1,2,6,14,49] The majority of these cases does not present with spinal instability and does not require instrumented

fusion. The literature suggests laminectomy, laminoplasty, or fenestration at the affected level (or levels) as valuable surgical techniques.[1,5,6,14,32,49,62] A large retrospective study by Li et al[32] compared the outcomes of laminoplasty and laminectomy. The authors described a 25% improvement with the former technique against an 83% improvement with the latter. Fenestration may be performed in situations in which the OLF is laterally located and not fused at the middle of the spinal canal, often presenting with radicular pain.[2,49]

Adherence of the dura is reported in 11 to 62% of OLF surgeries.[59] Meningeal involvement can often difficult the surgical procedure.[32] Cerebrospinal fluid leakage following disruption of the dura mater is one of the major intraoperative complications.[1,49] Cerebrospinal fluid (CSF) leakage can lead to CSF fistula formation, pseudomeningocele, meningitis, arachnoiditis and epidural abscess.[63]

Inamasu and Guiot[64] recently conducted a systematic review concerning the factors that influence the outcome after surgery for OLF. The authors reviewed 31 articles, and suggested that gender, age, the level of the ossified lesion, the number of OLF-affected segments, the coexistence of an ossified posterior longitudinal ligament, OLF classification on CT, and the presence of a high intensity signal are unlikely to modify the outcome after surgery. They also suggested that the duration of the symptoms and the neurological score may influence the outcome. Altogether, the literature strongly suggests that the preoperative duration of the symptoms,[48,49,55] the severity of the neurological deficit,[48,49] and the presence of hyperintense signals[6,15,65] in the spinal cord can influence the outcome. This was reaffirmed in a retrospective analysis of 85 cases conducted by Li et al.[7] Surgical decompression, particularly through laminectomy, generally results in improvement or disappearance of the symptoms in most cases.[2,6,14,32,49]

Conclusion

Ossification of the ligamentum flavum has been well-established as a cause of myelopathy. The pathogenetic mechanisms of the disease are not well understood, but they most likely include different mechanical and biological factors. Although OLF is more common in Asian populations, it can also be present in different ethnic groups. We reported a rare case of thoracic OLF in a black patient. Symptomatic patients should be surgically treated.

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