Acute Quadriplegia Caused by Calcification of the Entire Cervical Ligamentum Flavum in a White Female—Report of An Unusual Case And A Brief Review of the Literature

Case Report

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Study Design. Case report.

Objectives. To describe an extremely unusual case of acute quadriplegia in a white female caused by calcification of the ligamentum flavum (LF) from C1 to T2, and to review briefly the pertinent literature.

Summary of Background Data. Diseases characterized by abnormal calcium deposition on the spinal ligaments have an unclear etiology. The overwhelming majority of these cases has been reported in people of Asian descent and has a predilection for the thoracic spine. Multilevel involvement of the cervical LF in white patients is exceptionally rare. To our knowledge, complete calcification of the entire cervical LF has not been previously reported in the literature.

Methods. The history, physical examination, and radiographic studies of a 64-year-old white female with a history of scleroderma are described. The patient presented with neck pain and acute quadriplegia caused by spinal cord impingement by calcified cervical LF from C1 to T2. The patient underwent emergent C3–C7 laminectomy and C2–C7 posterior spinal fusion.

Results. Operative intervention resulted in marked neurologic improvement and relief from neck pain. Histopathologic examination of the calcified LF showed that the deposits consisted of hydroxyapatite crystals exclusively with no heterotopic bone. However, kyphosis did develop in the patient after laminectomy.

Conclusion. To our knowledge, this unusual case of complete calcification of the entire cervical LF has not previously been described. Multilevel laminectomy and fusion can improve neurologic function but may result in kyphosis.

Key words: cervical spine, myelopathy, quadriplegia, hydroxyapatite, calcification, ligamentum flavum. Spine 2005;30:000–000

Calcium deposition diseases of the ligamentum flavum (LF) are a group of disorders that can lead to myelopathy. The LF can undergo either calcification or ossification. These disorders have a much higher prevalence in people of Asian descent. In a radiographic study of chest radiographs of 1744 individuals, Kudo showed that 6.2% of male and 4.8% of asymptomatic female Japanese individuals had radiographic evidence of this group of diseases in the thoracic spine. When compared to the thoracic region, calcium deposition disorders are much more rare in the cervical spine. Although ossification of the LF (OLF) in the cervical spine has been described in the literature, calcification of the LF (CLF) in the cervical region is much less common. Almost all cases of CLF have been reported in Japanese patients. Therefore, myelopathy associated with cervical CLF is a rare entity. CLF is exceptionally rare in non-Japanese individuals, with only a few case reports among black patients. We are aware of only 1 case of cervical CLF with myelopathy in a white female who had cord compression secondary to an acute disc herniation in the setting of preexisting CLF develop. This predilection for Asian individuals is probably a result of underlying genetic factors, which as of yet remain to be fully elucidated. In this report, we describe a unique case of extensive cervical CLF in a white female, who presented with acute quadriplegia in the absence of an acute disc herniation or trauma. We will also perform a brief review of the pertinent literature for this interesting case.

Case Report

Clinical Presentation

The patient was a 64-year-old white female with a past medical history of scleroderma who presented to the emergency department with a several-month history of increasing neck pain. She had progressive bilateral arm and leg weakness, and difficulty with balance while walking. However, in the days before presentation, she noticed a sudden deterioration of these symptoms in the absence of any trauma. Motor examination revealed bilateral upper extremity strength to be decreased (bicep 3/5, triceps 2/5, grasp 3/5), with poor hand control. She was unable to bring her hands to her face. Bilateral lower extremity strength was decreased (quadriceps 4–5, tibialis anterior 4–5, gastrocnemius 4–5), and she was unsteady with walking. The patient also had bilateral Babinski signs and bilateral clonus with hyperreflexia. Sensation to pinprick was decreased from the chest, all the way down to the lower extremities.
Radiologic Evaluation

Because of the impending quadriplegia, urgent magnetic resonance imaging (MRI) was obtained (Figure 1). Sagittal T1 and T2-weighted images revealed severe stenosis of the entire cervical spine from C1 to T2, accompanied by a thick, dark, hypointense band along the LF. Coronal and sagittal computerized tomography (CT) showed nodular oval masses anterior to the lamina from C1 to T2, protruding into the canal (Figures 2, 3). Coexistent spondylosis was also noted at the facet joints at multiple levels. Both the anterior and posterior longitudinal ligaments did not show any evidence of pathologic changes.

Treatment

The patient was taken emergently to the operating room. Intraoperative somatosensory evoked potential monitoring was used. Baseline upper extremity somatosensory evoked potential signals were severely diminished, and the lower extremity signals were only slightly better in comparison. Decompression was achieved via C3–C7 laminectomy. As the laminae were gently lifted off, an abundant amount of thick, whitish-gray material with a chalky, pasty texture was found along the entire length of the cervical spine from C1–C7. This material, which appeared to be adherent to the LF, was gently peeled and carefully removed with a curette off the dura. No heterotopic bone was noted on the LF. After achieving complete decompression, posterior C2–C7 spinal fusion was performed.

Histopathology

The sublaminar chalky white material was sent for histopathologic analysis. Hematoxylin and eosin staining showed a hypocellular uniform, amorphous substance (Figure 4). Alcohol-cosin staining revealed that the calcified deposits consisted of hydroxyapatite crystals only. Congo red staining was negative for amyloid. Examination with polarized light showed that it did not have any birefringence and that no calcium pyrophosphate dehydrate (CPPD) or uric acid crystals were present. Gram stain was negative for organisms with rare white blood cells.

Outcome

After surgery, the patient had significant neurologic improvement. At the 9-month follow-up visit, the pa-
tient had minimal neck pain. She had some left upper-extremity residual weakness (bicep 3+/5, tricep 3+/5, grasp 3+/5), while strength in the other 3 extremities had increased to 4+/5. Her gait had improved, and she could walk independently. Kyphosis did develop after laminectomy, with no failure of instrumentation (Figure 5). Overall, she was satisfied with the outcome.

Discussion

Calcium deposition diseases of the LF have an unclear etiology.1,9 Most of these cases occur in the thoracic spine.10 The vast majority of patients with this disorder are of Asian ethnicity, and very few of these cases have been reported in individuals from other ethnic groups.11

CLF needs to be differentiated from the similar but different entity of OLF, which has been described elsewhere in the literature.12–14 Failure to distinguish between these 2 separate entities can lead to diagnostic confusion. This difference has been pointed out by several investigators in the literature.2,15 In a histologic study of 18 Japanese patients, OLF was found in the lower thoracic spine of men, whereas CLF was found exclusively in the cervical spine of older women.16 When evaluated by CT, CLF appears as a nodular mass anterior to the lamina, and histologically it consists of degenerated LF, with calcified granules in the absence of bone.8,13 In contrast, OLF is characterized by endochondral bone formation, and ossification instead of calcification is the prominent feature. Therefore, the radiographic appearance of our patient indicated calcification, not ossification. In addition, the chalky, white paste adherent to the LF noted intraoperatively is also consistent with intraoperative descriptions of calcification by others, especially in the absence of any hard, bony masses adherent to the laminae.7 Because this is a slow process, it may be many years before the calcification is of sufficient size to cause symptoms. Progressive radiculomyelopathy is the typical presentation of the CLF.

There are case reports of cervical CLF with myelopathy in Japanese and Asian patients.4,17,18 However, cases of myelopathy caused by cervical CLF in non-Asians are exceptionally rare. Cabre et al16 reported 6 cases, including 4 females and 1 male, of cervical CLF with myelopathy in black patients from the Caribbean. Pascal-Moussellard et al17 described a 72-year-old black female with C4–C5 CLF and a second 64-year-old black female with C5–C6 CLF. Both presented with myelopathy. Ellman et al19 reported 1 black female with cervical CLF. Ugarriza et al18 described a 41-year-old white female who...
presented with cord compression caused by an acute C5–C6 disc herniation with coexistent cervical CLF.

Based on the case reports, females appear to have a higher susceptibility to CLF. In the cervical spine, this disease is more common in the lower cervical region and cervicothoracic junction. Most case reports in the literature have described only segmental involvement of the cervical spine. To our knowledge, involvement of the entire cervical spine from C1 to T2 with severe myelopathy in the absence of an acute disc herniation has not been previously reported. The case presented here is unusual for several reasons. First, the patient described in this report was white. Second, not only did our patient have cervical CLF, the entire cervical spine from C1 to T2 was involved. Third, the patient presented with acute quadriplegia, without trauma. Finally, this case involved only hydroxyapatite deposition (without CPPD or uric acid) on the LF in the complete absence of heterotopic bone formation. Therefore, this was a case of CLF, not OLF.

The pathogenesis of CLF remains to be fully elucidated. It has been suggested that repetitive microtrauma to the LF is the initial inciting event, which may lead to neovascularization, and calcium crystal deposition may occur because of the increased permeability of the newly formed vessels. Others have suggested that hypertrophy of the LF is a predisposing factor for CLF. Degeneration of the LF caused by localized nutritional deficiency is yet another possible contributing factor that has been advanced as being of possible etiologic significance. Studies using radiograph diffraction and infrared spectroscopy have shown that hydroxyapatite crystals found in CLF are often surrounded by a ring of CPPD crystals. Two potential mechanisms for this finding have been suggested. First, either the hydroxyapatite crystals are formed first and then CPPD is deposited around it afterwards, or, second, CPPD is deposited first and then the core region of this deposit converts to hydroxyapatite.

It is noteworthy that in our patient, there were no CPPD deposits found, suggesting that hydroxyapatite deposition might be the primary mechanism for this process. Similar pure hydroxyapatite deposits in CLF have been reported by others previously. It is important to remember that the pathogenesis of CLF should not be confused with that of OLF, in which endochondral ossification is a key step in the pathogenesis of the disorder. The development of OLF, unlike CLF, may involve osteo-inductive agents such as bone morphogenetic proteins, cartilage-derived morphogenetic protein-1, and transforming growth factor-β. OLF has been associated with hyperostotic disorders, such as ossification of the posterior longitudinal ligament, diffuse idiopathic skeletal hyperostosis, ankylosing spondylitis, but the significance of these associations is not fully understood. On the other hand, metabolic disorders, such as diabetes, hypothyroidism, and systemic chondrocalcinosis, are frequently seen in patients with CLF. It has not escaped our attention that the patient in our report had a history of scleroderma, but obviously, this coincidence does not imply association or causality.

As shown in this report, CT is extremely useful for assessing osseous anatomy and delineating the extent of CLF. MRI can show cord impingement and edema. In our patient, these studies also showed a preexisting hyperlordosis of the cervical spine. One potential reason for this interesting deformity could be a tethering effect from the calcified LF. Our report also showed that decompression with laminectomy and instrumented fusion can improve neurologic symptoms. However, if multilevel involvement of the cervical spine necessitates extensive decompression, kyphosis after laminectomy can result. One possible reason for the development of kyphosis in our patient was the fact that although the laminectomy was performed through C7, which required removal of the C7–T1 interspinous ligament, T1 was not included in the fusion construct. As such, the placement of a long lever-arm above the destabilized segment resulted in abnormal forces at this level, contributing to the development of kyphosis.

### Conclusion

Calcification of the cervical LF, an entity of unclear etiology, is exceptionally rare in the non-Asian population. It may present with acute neurologic deterioration. Emergent decompression and fusion can lead to neurologic improvement.

### Key Points

- We present a unique and interesting case of CLF in the cervical spine of a white female who presented with acute quadriplegia.
- CT and MRI studies showed that LF was calcified along its length from C1 to T2.
- Emergent laminectomy and fusion of the cervical spine resulted in neurologic improvement. However, kyphosis did develop in the patient after laminectomy.
- To our knowledge, such an extensive amount of calcification of the cervical LF leading to acute quadriplegia in the absence of an acute disc herniation has not previously been described in the literature.

### References


AUTHOR PLEASE ANSWER ALL QUERIES

AQ1—Please note that in the sentence beginning “Therefore, myelopathy associated ...,” because Reference 6 is a duplicate of Reference 4, it has been deleted from the bibliography. References 6-28 have been renumbered in the text. Please confirm.

AQ2—Please confirm spelling of “gastrocsoleus”.

AQ3—In the sentence beginning “Examination with polarized ...” is “bifrengence” spelled correctly?

AQ4—In the sentence beginning “Cabre et al...” there are 5 cases, not “6.” Please confirm.

AQ5—Is the sentence beginning “First, either the hydroxyapatite...” correct?

AQ6—For Reference 27, please provide the publisher.