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Cervical Spondylotic Myelopathy

JOON Y. LEE, MD
Associate Professor, Department of Orthopaedic Surgery, University of Pittsburgh

CHRIS A. CORNETT, MD
Assistant Professor, Department of Orthopaedic Surgery and Rehabilitation, University of Nebraska Medical Center, Omaha

JASON O. TOY, MD
Spine Fellow, Department of Orthopaedic Surgery, University of Pittsburgh

Cervical Spondylotic Myelopathy (CSM) is a progressive, degenerative disease that results in the compression of the cervical spinal cord and can result in irreversible neurologic deficits. It remains the leading common cause of acquired spinal cord compromise and is thought to be due to age-related arthropathic changes of the cervical vertebral column. These changes typically include degeneration of the vertebrae, intervertebral discs, facet joints, and uncovertebral joints. The subsequent wear of the three-joint complex, and loss of disc height, secondarily stimulate stiffening and buckling of the ligamentum flavum and posterior longitudinal ligament (PLL), each of which further contribute to narrowing of the cervical spinal canal.[1]

Over time, patients who have cervical canal narrowing often display pathologic changes to their spinal cord that correlate with the severity of their compression.[2] Chronic cervical cord compression is thought to induce damage via a reduction of intraparenchymal spinal cord blood flow.[3] The resulting chronic ischemia, in combination with mechanical stretch, is posited to initiate an immune response that results in a neuroinflammatory response.[4] The end result is the activation of apoptotic pathways that lead to significant white and gray matter necrosis with histology that demonstrates anterior and posterior horn atrophy, gliosis, vacuolations, and axonal and neuronal loss.[4-6]

Progression of the disease is highly unpredictable, and its severity can vary by patient. Symptoms typically progress either steadily or with periods of stability interrupted by rapid neurologic decline. In a study of 120 patients with degenerative

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cervical myelopathy, 75% deteriorated episodically, 20% underwent steady decline, and 5% experienced a rapid decline followed by stability.[7] Acute worsening can often occur following a fall from a resultant hyperextension- or flexion-type injury.[8,9] Patients who are diagnosed with CSM generally do not display symptoms until the age of 40.[8,10] The mean age of diagnosis is 64, with a male to female ratio of 2.7:1.[10]

Diagnosis of CSM is made clinically, and is based on a patient's symptoms and history, physical examination, and imaging studies. Delays in diagnosis are common, and often exceed 2 years and 5 physician visits.[11] Patients often report a subtle onset of symptoms, which can include a constellation of neck pain, decreased dexterity, upper limb pain, upper and/or lower limb weakness, stiffness, impaired balance, and altered sensation.[8]

Symptoms also may include autonomic dysfunction, such as increased urinary frequency, urgency, and incontinence.[5] Moreover, additional questioning often reveals gait imbalance and difficulty with writing, buttoning shirts, or fine motor tasks.[5]

Physical examination often reveals several findings suggestive of cord compression. Therefore, a thorough examination should include testing of motor function, sensation, deep tendon reflexes, gait, balance, and alignment. Findings suggestive of myelopathy typically include brisk reflexes, a Babinski sign (upgoing plantar reflex), a Hoffman sign (reflex contraction of the thumb with flicking of the terminal phalanx of the long finger), and a dysfunctional tandem gait. Of the aforementioned, the Hoffman sign is particularly invaluable because it is more likely to be positive compared to the Babinski sign. Houten and Noce reported that MRI is positive for cervical cord compression in 91% of patients with a positive Hoffman sign bilaterally.[8] Once established, assessing the clinical severity can be accomplished with the use of several scales, including the Japanese Orthopaedic Association (JOA) scale, the modified JOA scale, and the Nurick classification system. However, these scales are more often reserved for research purposes than the usual clinical setting.[8]

Radiographic modalities can be used to assist in the diagnosis of CSM, and often include radiographs, MRI, CT myelography, nerve conduction studies, and electromyography.

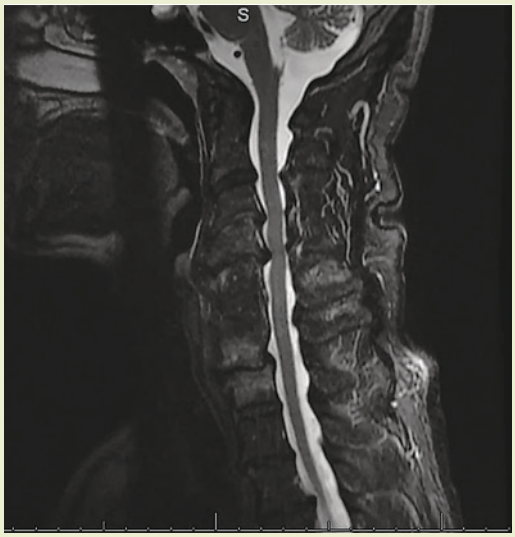

FIGURE 1 (above): **Preoperative sagittal T2-weighted MRI of a cervical spine demonstrates multilevel cervical spondylosis and severe spinal cord compression.**

FIGURE 2 (right): **Postoperative lateral radiograph of a cervical spine following multilevel posterior laminectomy and instrumentation.**

Plain radiographs should be obtained for most patients in whom CSM is suspected. Radiographs must include AP, lateral, and flexion/extension views. Plain radiography can help with the evaluation of degenerative disc disease, stenosis, overall alignment, and deformity or instability. Stenosis can be assessed on plain radiographs via the Torg-Pavlov ratio, which is calculated by measuring the midsagittal diameter of the spinal canal and dividing it by the AP diameter of the corresponding vertebral body. Values below 0.82 indicate concern for cervical stenosis. Of all the radiographic studies, MRI remains the most useful in confirming a diagnosis of CSM. MRI is able to reveal the extent of degenerative disease, cervical stenosis, and cord compression (see Figure 1, Page 2). The addition of a hyperintense signal on a T2-weighted sequence has been shown to correlate with a worse postoperative prognosis.[12] If MRI is unobtainable, CT myelography remains another imaging modality that can be utilized. However, its use is associated with additional risk to the patient since it requires intrathecal contrast. While nerve conduction studies and electromyography have been used to assist in diagnosing nerve-related pathology, their use is best for ruling out other diagnoses.

Treatment of cervical myelopathy has increasingly focused on surgical management, given its unpredictable and progressive course. Nonsurgical modalities such as physical therapy, spinal injection, immobilization by collars, and cervical traction have a limited role and are typically reserved for the treatment of mild myelopathy.[13] For moderate and severe myelopathy, surgical decompression remains the standard and has demonstrated improved neurologic and functional status.[14] Spinal cord decompression can be accomplished via a posterior or anterior cervical approach. While both approaches are similarly effective with regard to outcomes,[15] the decision of which approach to use requires the consideration of multiple variables. These include the position of the compressive elements, sagittal alignment, focal versus diffuse disease, age, patient comorbidities, nature of the patient's pain, and the surgeon's comfort with the planned approach.

The anterior cervical approach was originally described by Robinson and Smith[16] and Cloward[17] as techniques for anterior cervical discectomy and fusion (ACDF). Since then, numerous modifications have been made, with the overall technique remaining largely unchanged since its description in the 1950s.[18] This procedure continues to be the most common procedure for spine surgeons, and is preferred for treatment of one- or two-level disc CSM and in patients with cervical kyphosis. This allows for removal of the anterior structures implicated in cord compression, which include disc contents, posterior osteophytes, and the PLL. Once these structures have been removed, distraction of the disc space allows for an indirect decompression of the spinal canal and foramen. This decompression is then maintained by the insertion of a bone graft, which is recommended to be 2 mm larger than the initial disc height.[19] It is important to note that ACDF does not alter the AP diameter of the spinal canal and thus has a limited role for patients with severe multilevel spinal stenosis.

For patients with multilevel disc CSM in neutral or kyphotic sagittal alignment, corpectomy and fusion via an anterior approach (ACCF) provides a more reliable approach when compared to multilevel ACDF. Corpectomy is particularly useful in patients with significant bony compression at the level of the vertebral body. As a result of the vertebral resection, a large decompression is achieved while providing adequate autograft. In comparison to multilevel ACDF, ACCF is thought to provide a higher fusion rate since the procedure relies on only two interfaces for bony union.[20] However, accompanied with this is a higher risk for excessive bleeding and graft displacement. To mitigate these complications, some have advocated for a hybrid discectomy-corpectomy technique, which has been reported to yield less blood loss and fewer complications when compared to multilevel ACCFs.[21]

A posterior cervical approach may be better suited for patients with multilevel congenital stenosis in whom a three-level fusion or greater is required (see Figure 2, Page 2). Sasso et al. noted a 6% complication rate for a two-level ACCF, which dramatically increased to 71% in those patients who underwent a three-level ACCF.[22] More specifically, higher rates of nonunion, adjacent segment disease, dysphagia, and pain have been reported in patients who underwent multilevel ACCF when compared to multilevel posterior procedures.[23,24] When considering a posterior approach, two procedures are typically utilized: laminoplasty or laminectomy with fusion. While the goal of either procedure is to allow for spinal cord decompression, laminoplasty is generally avoided in patients with posterior neck pain or instability secondary to trauma or inflammatory disease. In these patients, supplementation with fusion sacrifices motion but effectively prevents subsequent postsurgical kyphosis. Beyond this, the decision of which posterior procedure to use is largely influenced by surgeon preference,

as both procedures are ultimately effective at improving disease severity, functional status, and quality of life in patients with CSM.[25]

In summary, cervical spondylotic myelopathy is the byproduct of degenerative changes that reduce the spinal canal and lead to cervical cord impairment. Surgeons must be familiar with its presentation and recognize patients who need immediate treatment or referral. If surgical intervention is warranted, decompression can be safely achieved by either an anterior or posterior approach, each of which is effective in appropriately selected patients.

Case Presentation

A 65-year-old female patient presented with a gradually progressive history of clumsiness in gait of 6 months duration, and difficulty with fine motor tasks. When questioned, she reported weakness in her hands, and difficulty with buttoning shirts and dropping objects. Her bladder and bowel continence were well preserved.

On examination, she was found to have positive Hoffman's signs bilaterally, and lower limb hyperreflexia.

Romberg's sign was positive with her eyes closed. She was noted to have profound difficulty while performing a tandem-walk. The patient underwent investigations in the form of plain radiographs, and magnetic resonance imaging (MRI) of the cervical spine. Her imaging tests revealed the presence of significant central canal stenosis at the C4-7 levels causing compressive myelopathy (Figure 3).

Case Resolution

The patient subsequently underwent a C4-7 laminectomy, and posterior spinal fusion. At 1-month follow-up, she was found to have significant improvement of her gait unsteadiness and finger grip. A postoperative plain radiograph revealed satisfactory stabilization and alignment of her posterior cervical hardware (Figure 4).

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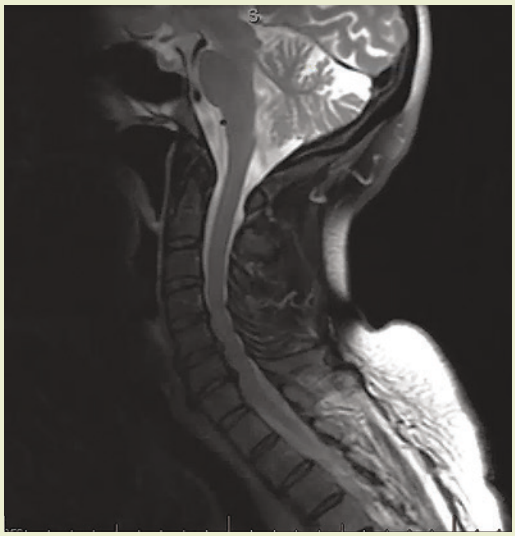

FIGURE 3 (above): **MRI showing C4-7 central canal stenosis.**

FIGURE 4 (right): **Postoperative x-ray showing laminectomy and alignment of hardware.**

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University of Pittsburgh
School of Medicine
Department of Orthopaedic Surgery
Pittsburgh, Pennsylvania

Freddie H. Fu, MD, DSc (Hon), DPs (Hon)
Chairman

ADDRESS CORRESPONDENCE TO:
Department of Orthopaedic Surgery
Kaufmann Medical Building
3471 Fifth Ave., Suite 1010
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