Myelopathy Associated with Cervical Spondylosis: A Frequently Unrecognized Disease

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Cervical spondylosis or chronic diskogenic disease of the cervical spine is a relatively common cause of myelopathy, but it is often not recognized or is incorrectly diagnosed. The clinical presentation may mimic several types of neurological disease including multiple sclerosis and amyotrophic lateral sclerosis. Even more frequently, and especially early in the course of the disease, neurologic impairment is not recognized and the symptoms are thought to be due to osteoarthritis. Early recognition of this condition is important since adequate treatment can prevent slowly progressive neurologic impairment. Knowledge of the pathophysiology of myelopathy due to cervical spondylosis and adequate radiographic evaluation will often lead to treatment that can prevent progressive spinal cord damage. Cervical spondylosis with myelopathy is one of the most frequently unrecognized and misdiagnosed, yet treatable, conditions affecting the nervous system.

Cervical spondylosis is a degenerative disease of the cervical spine which causes myelopathy if the degenerative process injures the spinal cord, or radiculopathy, if nerve roots are damaged in the spinal canal or as they leave the spinal canal. When this condition presents with symptoms due to nerve root impairment, the correct diagnosis is usually suspected, but when cervical spine disease presents chiefly as a myelopathy, it is often unrecognized or incorrectly diagnosed. For this reason, effective treatment may be delayed, resulting in progressive, irreversible damage to the spinal cord. This paper describes the mechanism of cord damage that may result from degenerative disease of the cervical spine and discusses the most important symptoms, signs, and radiographic criteria for diagnosis of myelopathy due to cervical spondylosis.

Although spinal cord damage from bone and soft tissue abnormality in the cervical area has been recognized since antiquity,[1] an awareness of the frequency with which this condition causes neurological abnormality with an understanding of its pathology and the radiographic criteria for diagnosis is relatively recent. The first complete description of the neurological abnormalities due to cervical spondylosis was by Brain et al.[2] Several other investigators have contributed to an increased understanding of this condition.[3-6]

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Etiology and Predisposing Factors

The etiology of the degenerative bony changes in cervical spondylosis that are associated with intervertebral diskogenic disease appears to be similar to that of osteoarthritis in other parts of the body and the incidence increases with age. Recent or remote head and neck trauma may be important contributory factors because they tend to increase the rate of progression of the pathological process. Congenital abnormalities of the cervical spine increase the incidence of degenerative changes. If congenital fusion of vertebrae is present, the most prominent changes occur at the intervertebral spaces adjacent to the fused vertebrae. Some degree of cervical spondylosis can be demonstrated radiographically in many people past the age of 40.[7,8] However, it usually is not associated with spinal cord pathology because there is adequate room for the cord in the spinal canal, even in the presence of prominent degenerative change, but myelopathy is especially likely to occur in patients with small spinal canals.

Pathophysiology

Cervical spondylosis consists of degenerative changes in the intervertebral disks and vertebrae associated with changes in adjacent soft tissue (Figure 1). As the disk degenerates it becomes thinner and this causes some buckling and posterior bulging of the annulus fibrosis and the posterior spinal ligament. There are bony changes in the margins of the vertebral bodies adjacent to the degenerating disk. These changes consist chiefly of irregular bone proliferation causing formation of osteophytes, which may project dorsolaterally into the vertebral foramina, or posteriorly into the spinal canal. These osseous changes along with the posterior bulging of the annulus fibrosus and posterior spinal ligament produce osseofibrous ridges, sometimes referred to as transverse bar formation when seen on posterior-anterior views by myelography. These projections into the spinal canal may decrease its diameter sufficiently to damage the spinal cord by compression or by interfering with its blood supply. These changes are usually greatest at the 4th, 5th, and 6th interspaces where the cervical spine is

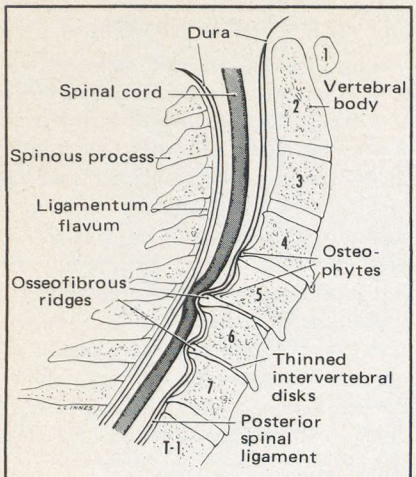

Figure 1. Midsagittal section of cervical spine and cord illustrating degenerative bone and disk changes causing spinal cord compression at the $C_{5,6}$ interspace. There is thinning of the disk with bulging of the annulus fibrosis, osteophyte formation, and vertebral subluxation causing decrease of spinal cord space.

most mobile during flexion and extension. As the disk deteriorates there is decrease in height of the disk space with some associated loss of joint stability, and this often results in malalignment of the vertebral bodies, thus further decreasing the space available for the spinal cord. During flexion and extension there may be considerable anterior-posterior displacement (subluxation) of one vertebra on another. These changes cause some thickening and indentation of the dura and there may be adhesions between the dura and the arachnoid.

Myelopathy may be exaggerated by compromise of the radicular arteries by foraminal stenosis produced by bony proliferation. This could render the cord marginally ischemic.

The spinal cord within its meningeal covering is well protected by the bony spinal canal. The average transverse diameter of the canal of the inter-pedicular distance in the cervical area is 30 to 34 mm.[9] Compromise of this diameter sufficiently to damage the spinal cord rarely occurs but shortening of the anterior-posterior or sagittal diameter is not infrequent and is often a predisposing cause of cervical spondylotic myelopathy because in canals with a small sagittal dimension osteophyte formation and soft tissue hypertrophy are more likely to compress the cord or interfere with its blood supply. Wolf et al[3] measured the anterior-posterior diameter of the cervical canal in 200 adults on films taken with a 72-inch tube to film distance. The average sagittal diameter at levels of 4th, 5th, 6th, and 7th cervical vertebrae was 17 mm (range 12 to 22 mm) when measured from the most posterior portion of the vertebral body to the most anterior portion of the spinous process at the above levels.

Payne and Spillane[4] reported that in patients with cervical spondylosis with myelopathy the canal diameter is smaller and averaged slightly greater than 14 mm at the midpoint of the body of the 6th cervical vertebra, so less space is available for the spinal cord. This measurement did not take into account the decrease of diameter of the spinal canal due to osseofibrous ridges at the intervertebral spaces, which further compromises the space for the spinal cord. Wolf et al[3] suggest a sagittal diameter of the spinal canal as projected on plain cervical spine films of 10 mm or less at any point is likely to be associated with cord damage, whereas a minimum diameter of 13 mm or greater suggests that there is adequate space for the spinal cord. These measurements (Figure 2) are helpful in determining which patients should have myelography but are not completely diagnostic in themselves because there may be considerable encroachment on the space available for the spinal cord by soft tissue not visible on plain radiograms (Figure 2). For this reason the cord space may be compromised even when the plain films suggest that it is adequate. In those patients with a spinal canal of short anterior-posterior diameter, the decrease in size appears to be due to shortened pedicles related to congenital and growth factors which in most cases are not well understood and are usually unassociated with other abnormalities. Decreased size of the spinal canal is often found in association with some dysplasias such as achondroplasia,[10] mucopolysaccharidosis[11,12] and fibrous dysplasia.[7]

Failure to recognize the importance of the sagittal diameter of the cervical spinal canal and its relation to the space required for the spinal cord is largely responsible for lack of recognition of cervical spondylosis as a cause of cord damage. This has apparently led to the conclusion by some investigators that cervical spondylosis is a relatively benign condition because in some cases there is no myelopathy, even though severe degenerative bone and disk changes are seen.[13] Minor degenerative changes in a small spinal canal may cause severe myelopathy, whereas severe bone and disk changes in a large canal may be relatively asymptomatic.

Symptoms and Signs

Symptoms and signs of cervical spondylosis with myelopathy are usually those of upper motor neuron impairment of the lower extremities. These consist of varying degrees of stiffness, slowness, clumsiness, and incoordination of movement associated with hyperreflexia, spasticity, and pathological reflexes. Sphincter impairment may occur in patients with more severe cord damage. Sensory symptoms and signs may be present but these are usually relatively minor compared with the motor system abnormalities. Decrease of vibration and position sense may occur. Impairment of touch and pain sensation are less frequently found. The upper extremities are often involved, but to a lesser degree than the lower extremities. Symptoms in the upper extremities usually consist of some clumsiness and slowness of movements associated with hyperactive reflexes. Tremor and mild ataxia may be present. There may also be considerable loss of strength and muscle bulk. If the cervical nerve roots are involved, pain and paresthesias often occur in the upper extremities and in some instances decrease of sensation in the area supplied by the involved nerve root. Often there is weakness and decrease of deep tendon reflexes due to lower motor neuron impairment at the level of the cervical cord and root pathology. In these cases there may be a combination of upper and lower motor neuron abnormalities in the upper extremities. Neck and shoulder pain and headache are frequently associated symptoms when radiculopathy is also present.[14] The headache is chiefly in the occipital region but may also spread to other parts of the head. The headaches are often diagnosed incorrectly as "tension headaches" or when they are unilateral they are sometimes called "occipital migraine." The pains in the

shoulder, medial scapular area and upper arm are thought by Cloward[15] to be due to referred pain secondary to involvement of structures supplied by the sinuvertebral nerves which transmit pain sensation from the intervertebral disks.

Unusual and difficult to explain symptoms sometimes occur. Cervical spondylosis with myelopathy, as well as cervical cord disease due to other etiologies, may rarely cause pain in the lower extremities and be confused with lumbar disk disease, especially if asymptomatic lumbar diskogenic disease is demonstrated radiographically. With proper clinical evaluation, however, they can be differentiated. As pointed out by Langfitt et al,[16] pain in the legs from cervical cord disease is of a different quality than pain due to nerve root disease in the lumbosacral area. It has more of a deep, burning, boring, and poorly localized quality than radicular pain, and it is not associated with other symptoms and findings of nerve root involvement in the lumbosacral region. The cause of the pain is not known but it may be related to spasticity in the lower extremities due to upper motor neuron impairment. Other symptoms that are sometimes associated with cervical spondylosis, but for which the cause is poorly understood, are dizziness and true vertigo and occasionally tinnitus. When these symptoms are associated with cervical spondylosis they are often relieved by surgical treatment of the cervical spine disease, and sometimes they are temporarily relieved after greater occipital nerve block, when this is done for symptomatic relief of the associated occipital headache.

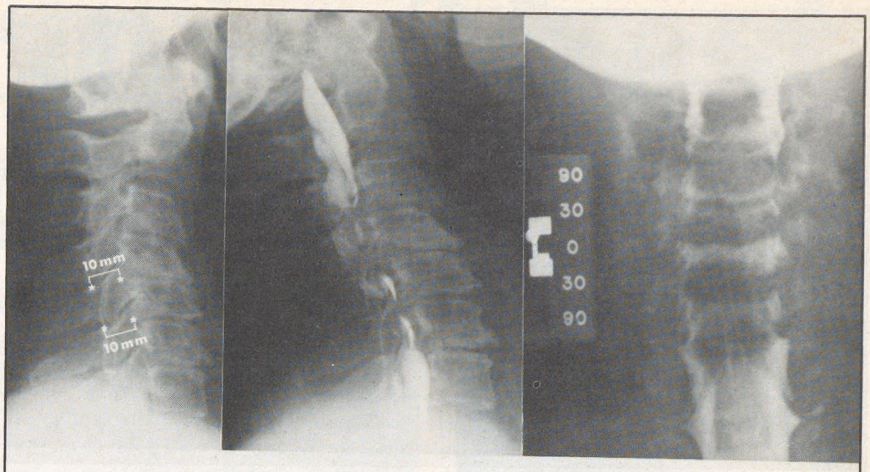

Figure 2. Plain x-ray and myelogram views of the cervical spine of a patient with myelopathy. The cord space is decreased to 10 mm on the plain film. On the myelogram contrast material does not flow between the cord and osseofibrous ridges.

Radiographic Examination

When disease affecting the spinal cord in the cervical area is suspected after neurological evaluation, radiological examination is very helpful in determining whether or not it is caused by cervical spondylosis. In any case where there is less than 11 mm of space available for the spinal cord when measured at the site of greatest narrowing due to osseofibrous ridge or osteophyte formation on lateral cervical spine films, myelopathy is likely to be present. Cervical myelography, by either positive contrast or air techniques, helps confirm the diagnosis and is especially helpful in cases with involvement at multiple levels because myelography helps identify the levels where the cord is most likely to be compressed. It cannot be too strongly emphasized that the severity of the degenerative changes, including osteophyte formation, spurring, bridging, thinning of the disk, subluxation, and "hypertrophy of the ligamentum flavum" as seen on plain radiograms and by myelography, is of much less importance than the space available for the spinal cord, since it is cord damage and not bone and disk degeneration per se which produces the impairment of the function due to cervical spondylosis with myelopathy. The measurements of the sagittal diameter of the spinal canal referred to above apply to plain films taken at 72 inches and not to lateral myelogram views taken at a lesser distance. Figures 2 and 3 illustrate radiographic changes of cervical spondylosis.

Although the importance of the sagittal dimension of the canal and cord space has been emphasized by several investigators,[3,5,8] it is still not generally recognized and commonly no reference is made to this important parameter of cervical spine radiography in reports of cervical spine x-rays. Inadequate interpretation of x-rays of the cervical spine is a major factor in failure to recognize myelopathy due to cervical spondylosis.

Treatment

Treatment of cervical spondylosis can be either medical or surgical. Medical treatment consists in general of immobilization by use of a cervical collar to prevent trauma and to hold the head in a neutral position. Bradshaw[17] reported that some patients with myelopathy improved or remained unchanged when treated with a neck collar, but many others deteriorated after 6 to 18 months. The majority of those with spondylosis at two or more levels did badly in that the impairment of function in their legs progressed, but more than half of those with involvement at one level did not get worse and some improved. Other methods of treatment include analgesics and antispasmodics for symptomatic relief of pain and to decrease muscle spasm. Traction, muscle strengthening exercises, and maintenance of proper posture may in some cases decrease the rate of degenerative changes. These methods are inadequate if there is spinal cord damage.

More effective treatment consists of increasing the space available for the spinal cord by surgery. Surgery should be considered, especially in those cases with early myelopathy, for by this means irreversible damage to the cord may be prevented. Surgical therapy consists of either laminectomy by the posterior approach, anterior interbody

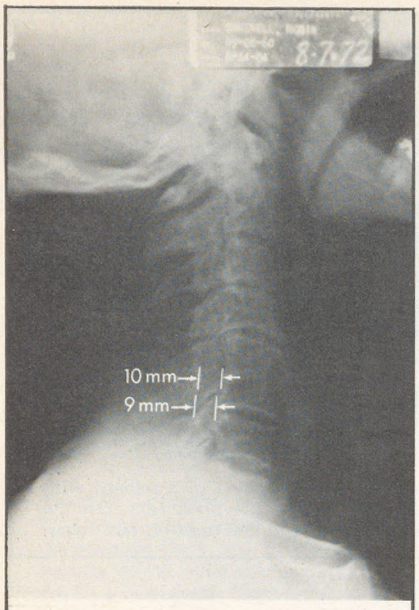

Figure 3. Lateral cervical spine x-ray of a patient who has been incorrectly diagnosed as multiple sclerosis for ten years. Degenerative changes are mild but the sagittal diameter of the spinal canal is very small. Congenital fusion of $C_{5,6}$ is present.

fusion by the method of Smith and Robinson[18] or anterior diskectomy and interbody fusion by the method of Cloward.[19] To a large extent posterior surgical approach by laminectomy has given place to the anterior approach with diskectomy and fusion. Although the type of surgical procedure depends somewhat on the experience of the operator and the presentation of the patient, good results are usually obtained by anterior diskectomy and interbody fusion,[5,15] and this appears to be the treatment of choice. Most effective management in each case can be best determined after neurosurgical consultation with consideration given to the degree of impairment, rate or progression of disease, age of the patient, and other variables.

Prognosis

Reports in the literature regarding prognosis of cervical spondylosis reveal considerable difference in opinion. Lees and Turner[13] reported a study of the natural history of cervical spondylosis in 44 patients with myelopathy and 51 patients with symptoms referable to the neck, shoulders, arms, and hands which were described as cervical spondylosis without myelopathy. These investigators found that nonprogressive disability was the rule in patients with myelopathy and none of the patients of the non-myelopathy group developed any myelopathic symptoms during the period of observation. This report does not include any reference to the dimensions of the cervical canal of the patients.

If the spinal canals of the patients in this series were adequate, there was little risk of myelopathy, even with severe bone and disk changes. Many investigators found that the course of cervical spondylosis with myelopathy is much less benign.[2,5,17,20] It is not unusual to find patients with slowly progressive deterioration to complete incapacity due to loss of function of the lower extremities, sometimes associated with sphincter loss, from myelopathy due to cervical spondylosis that could have been effectively treated surgically if it had been recognized earlier. Prognosis is usually adversely affected by increased age, advanced degenerative changes, trauma, and long duration of symptoms. Some of these factors, however, are relatively unimportant in themselves as causes of myelopathy unless the patient has a small spinal canal.

Persons with mild myelopathy or those who have no symptoms but have marginal cord space may suffer severe damage from acute trauma; especially hyperextension injury. This type of injury may cause sudden cord compression resulting in quadriparesis, sphincter impairment and sensory loss below the level of the lesion, even without fracture or dislocation of vertebrae.

Prognosis for cervical spondylosis with myelopathy when treated surgically by anterior diskectomy and interbody fusion is usually good in that progression of the myelopathy is often stopped and in many cases there is some improvement, especially in decrease of spasticity and pain.[5] Severe cord damage, if present, cannot be expected to improve significantly, and for this reason early diagnosis and treatment are important.

Summary

Although degenerative disease of the cervical spine as a cause of myelopathy has been known for many years, its frequency and clinical presentation and the criteria for radiographic diagnosis are often not recognized. There is some controversy regarding most effective management but early diagnosis by proper neurological evaluation of the patient with this condition usually leads to treatment that can prevent progressive impairment of function. Cervical spondylosis with myelopathy is one of the most frequently unrecognized and misdiagnosed, yet treatable, conditions affecting the nervous system.

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