Congenital Stenosis of the Cervical Spine: Diagnosis and Management

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An analysis of 11 cases of congenital stenosis of the cervical spine seen over the past three years is reported. The authors' experiences at an urban community hospital, as well as a large Veterans Administration Hospital, lead them to conclude that this disorder is a neurologically significant anomaly which is probably more common than published reports would imply. It can be clinically and radiographically distinguished from "pure" cervical spondylosis, to which it is related, and its treatment should be appropriately modified. It appears to have a predilection for young adult black males, and cervical myelopathy is the predominant clinical feature. Varying degrees of trauma, a disease endemic to the inner city, plays a major role in precipitating the neurological catastrophes associated with this potentially correctable disorder. Proper management of this entity demands a heightened awareness of its existence as well as a high standard of neurological and roentgenographic diagnosis, and operative performance. A flexible operative strategy which takes into account the specific biomechanical factors involved in this disorder as well as the patient's individual physiological and social status is imperative. Surgery offers a good opportunity for improving neurological function.

Constriction or narrowing of the cervical spinal canal has become recognized as the most common cause of cervical cord and nerve root diseases developing during and after middle age.[1-4] One acquired form of this lesion, cervical spondylosis, is by far the most common etiology of this disorder and its clinical and radiographic features have been well described.[1] In cervical spondylosis the constrictive process results from degenerative changes in the lower cervical intervertebral disks with subsequent development of bony hypertrophic spurs along the margins of affected interspaces. Narrowing of neural foramina is the most common sequella of this disease and results when the osseous spurs protrude laterally. Narrowing of the cervical canal results when these bony spurs protrude posteriorly into the spinal canal itself. There is usually an excellent correlation between the severity of these hypertrophic degenerative changes seen on plain film examinations of the cervical spine and the degree of encroachment on neural tissue.[5]

In the evaluation of compression of the spinal cord, the most critical radiographic measurement in the cervical region is the sagittal diameter.[6,7] Average values for this measurement are 22-23 mm for C1, 20-20.5 mm for C2, 18.3-18.5 mm for C3, and 17.0-17.8 mm for C4 through C7 vertebral levels. Values below 14 mm at any cervical segment fall below two standard deviations from normal.

In patients with congenital or developmental narrowing of the cervical canal, the sagittal diameters of the vertebral segments are constitutionally 14 mm or less and the volume capacity of the canal is congenitally markedly reduced. Consequently, minor encroachments on an already compromised canal can lead to spinal cord compression and major neurological sequellae in the face of deceptively unremarkable plain film x-rays of the cervical spine. Unfortunately, in the absence of the severe degenerative osteoarthritic changes characteristic of cervical spondylosis, the significance of the congenitally stenotic cervical canal is often not fully appreciated.

Although most studies dealing with large series of patients with cervical spondylosis have also included patients with congenital stenosis of the cervical spine,[3,5,8-12] there are relatively few published reports which deal specifically with the clinical features of the latter disorder.[7,13-17] Experiences at a 500-bed urban community hospital as well as a large, 1,400-bed Veterans Administration Hospital have led us to conclude that congenital or developmental stenosis is a neurologically significant anomaly which is more common than has heretofore been recognized, and especially in black males. It is the intent of this report to review our experiences with 11 cases of this disorder, as well as the experiences reported by others. Illustrative cases are described.

Congenital cervical stenosis should be distinguished from pure cervical spondylosis, to which it is related, and its surgical management should be appropriately modified.

Clinical Methods and Materials

This study was conducted during 36 months (1975-1978). It is comprised of all patients who were found to have anatomical sagittal diameters of the cervical canal of less than 14 mm in one or more spinal segments. Measurements were made on standard length

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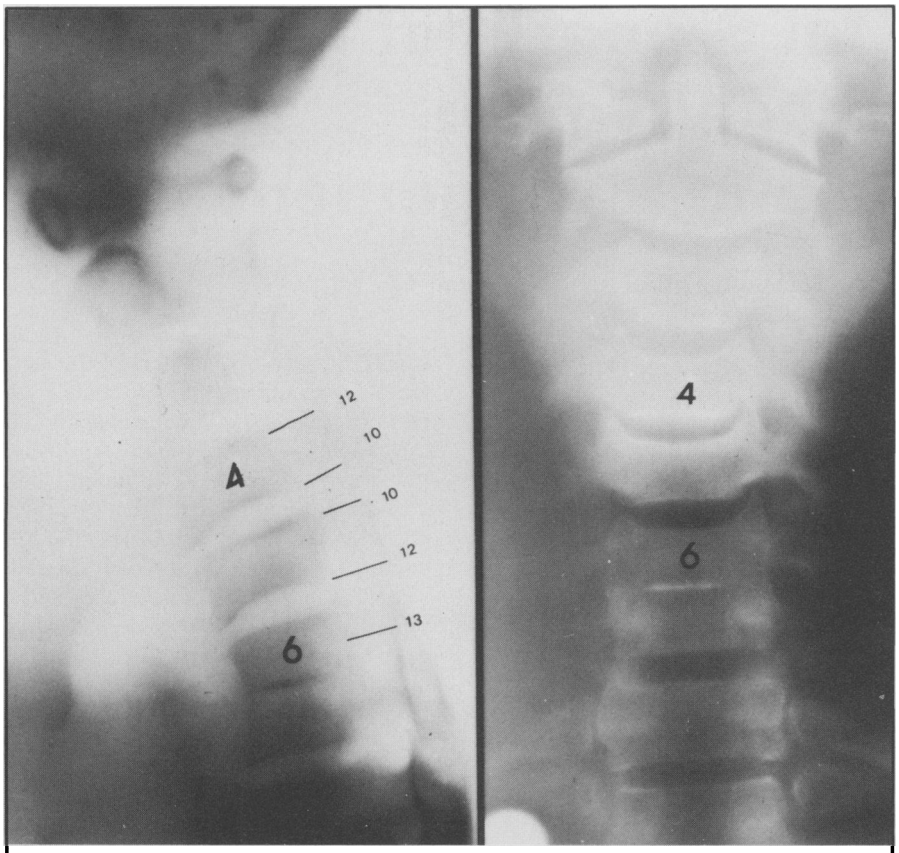

Figure 1. Lateral and A-P views of cervical spine in Case 1. There is congenital narrowing of C3 through C7 with modest posterior lipping of C4 and C5 vertebral bodies. C6 and C7 are congenitally fused. Osteoarthritic changes are conspicuously absent.

lateral radiographs from the posterior margin of the vertebral body to the cortical line at the site of fusion of the spinous process and the laminae. The functional sagittal diameters were also tabulated in these patients and were obtained by measuring from the posterior margin of osseous spurs to this cortical line at the junction of the laminae. Plain films with the neck in the neutral position as well as in flexion and extension, tomograms, and myelograms were reviewed by the authors. All of the patients were examined preoperatively as well as on subsequent postoperative evaluations by one of the authors. All of the surgical patients were operated upon by experienced attending neurosurgeons. Seven of ten patients were operated upon personally by one of the authors.

Results

Sex

All patients were male. Seven patients were seen at a large Veterans Administration Hospital and four were seen at an urban community hospital.

Age

The ages of the patients ranged from 12 to 58 years. There were five men in the 30-45 year age group, and four men between 46 and 55 years of age. One patient was 58 years old and one was 12 years old.

Race

Nine of the patients were black and two were white.

Symptoms

All of the patients had symptoms of spinal cord dysfunction. In two patients, the prominent subjective complaints were referable to radicular pain and/or weakness in the upper extremities. In the remaining nine patients, gait difficulties or generalized weakness were the prominent complaints. Sphincter disturbances occurred in four patients and was most often expressed as urgency incontinence. Only one patient complained of neck pain.

Duration of Symptoms

In 10 of the 11 patients, there were premonitory symptoms from four weeks to 11 years prior to establishing the correct diagnosis. One patient had acute onset of symptoms after minor trauma and was found to have an acutely ruptured cervical disk (of modest proportions).

Precipitating Events

In all of the 11 patients, a history of trauma surrounding the onset of symptoms was elicited. In seven patients, trauma resulted from a minor fall. One of the patients had three episodes of dense tetraplegia after falls. The third neurological insult in this particular patient led to his death. One patient had a seizure disorder which resulted in multiple falls. One patient with a history of repeated episodes of head trauma related his symptoms to two of the more severe events.

Two patients' symptoms were precipitated by moderately strenuous activity. One was lifting a heavy cooking pot over his head. The other patient was using a power chain saw when his symptoms first occurred. None of the patients was routinely involved in heavy manual labor.

Frequent abuse of alcoholic beverages was suspected in nine of the 11 patients.

Physical Findings

All 11 patients had objective evidence of myelopathy on examination. This was most commonly manifested by a spastic gait, hyper-reflexia and hypertonia in the lower extremities, and extensor plantar responses. In four patients, plantar responses were surprisingly equivocal or absent despite prominent corticospinal tract signs in the legs. Each of these patients was found to have an associated stenosis of the lumbar spine with compression of multiple lumbar roots which were otherwise asymptomatic.

Nerve root signs in the upper extremities were prominent in only two patients and correlated well with advanced spondylotic changes in the cervical spine on plain film examinations in addition to the constitutional stenosis of the spinal canal.

Other long tracts of the spinal cord were affected in the majority of cases. Sensory findings were rarely crisp or profound. No particular pattern was seen with any regularity and Brown-Séquard, anterior spinal artery, and central cord syndromes were found in several of the patients. These vagaries in presentation accounted for the frequent confusion in diagnoses and many of the patients had been initially thought to have multiple sclerosis, amyotrophic lateral sclerosis, syringomyelia, or subacute combined degeneration.

Painful or limited neck motion was found in three patients. One patient had a Lhermitte sign on neck flexion and another experienced "electric-like" shocks in his hands and feet on neck extension.

Laboratory Findings

CSF Protein

The cerebral spinal fluid was evaluated in eight patients. The protein was elevated in three patients, but did not correlate with the severity of the myelopathy.

Plain Spine Films

All of the patients had multiple stenotic vertebral segments. One patient had only two segments involved and one patient had six segments involved in addition to a stenosis of the foramen magnum.

Four patients had spondylotic ridges apparent on plain films. None of the spurs protruded posteriorly more than 3 mm. One patient had spondylotic retrolisthesis of C3 on C4. Six patients had an associated congenital stenosis of the lumbar canal. One patient had a blocked cervical vertebrae. No other spinal anomalies were noted.

Myelography

All patients had pantopaque myelopathy. Ten were done from a lumbar injection and one via a lateral C1-2 puncture. All patients had evidence of significant encroachment of the cervical spinal canal. In nine patients there was evidence of cord widening and/or myelographic block. In seven patients there appeared to be both dorsal and ventral encroachment of the canal; in three patients the protrusions were solely ventral; and in one patient there was dorsal encroachment exclusively. Although five patients were felt to have myelographic evidence for a bulging soft disk, in only one patient was the disk frankly herniated.

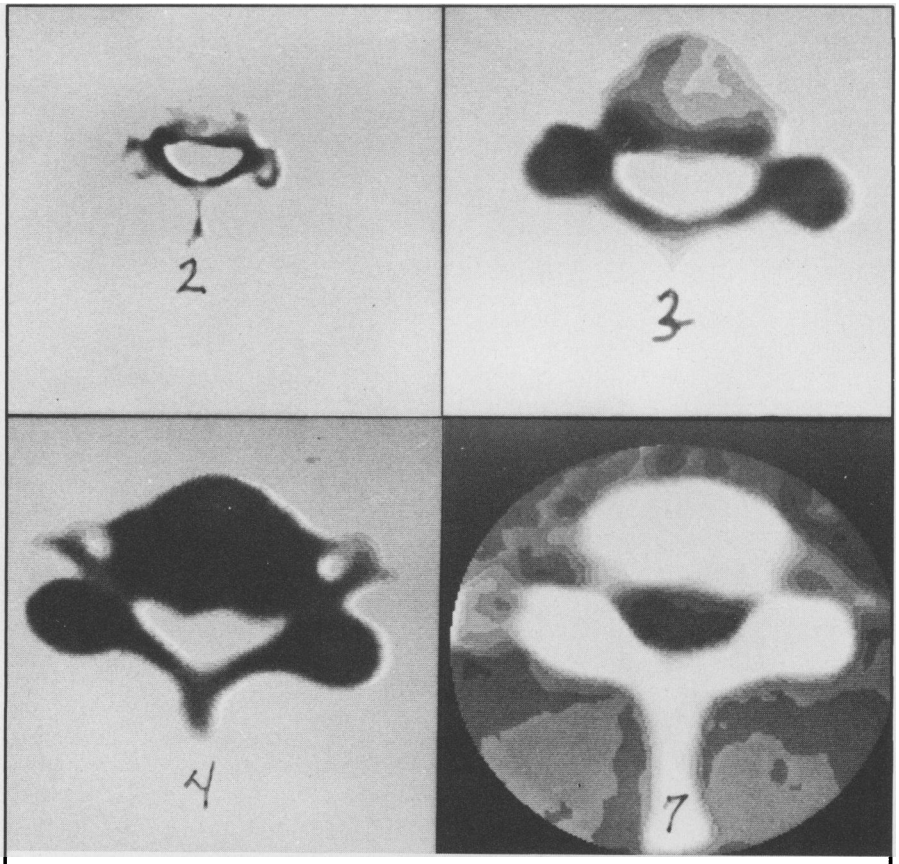

Figure 2. CAT scan of cervical vertebrae in Case 1. The markedly diminished sagittal diameters and volume capacities of the cervical canal is demonstrated. Further compromise of the intraspinal space by modest bony ridges can be seen at C4.

Surgery

Ten patients had operations. Nine patients had decompressive laminectomies, four of which had excision of soft disks with dural grafts. One patient whose medical condition was deemed too fragile for extensive laminectomy in the sitting position underwent a two-level anterior discectomy and interbody fusion.

One patient refused surgery and subsequently died from the consequences of his disease.

Postoperative Results

There were no operative deaths.

Two patients worsened initially after operation but recovered to a degree superior to their preoperative status.

One patient progressively deteriorated after operation. Nine of the ten patients were felt to be improved after operation in terms of objective findings and functional capacities to walk and care for themselves independently.

In one patient with an 11-year history of stepwise deterioration, the relentless preoperative decline in spinal cord function was arrested after decompressive cervical laminectomy. He is now independent in gait and activities and lives alone.

Case Reports

Case 1 (EK)

A 33-year-old white man was admitted to the hospital with the sudden onset of quadriplegia and sphincter loss after a fall and a hyperextension injury to his neck. He reported a similar episode five years previously which had completely resolved in 48 hours. On examination the patient had a dense, spastic, hyper-reflexic quadriplegia with a C4-5 motor/sensory/reflex level. Though sensation to pin and touch, and to joint movement were severely impaired they were still appre-

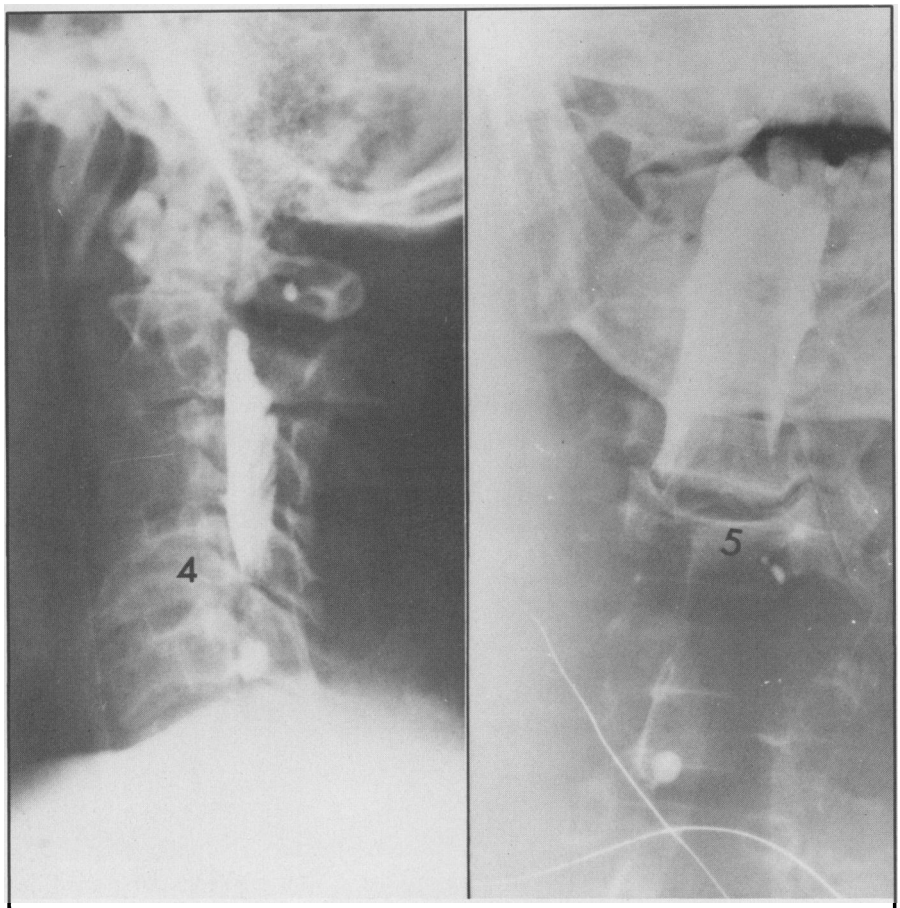

Figure 3. Lateral and A-P view of myelogram in Case 1. A high-degree partial myelographic block at C4 with cord widening is seen.

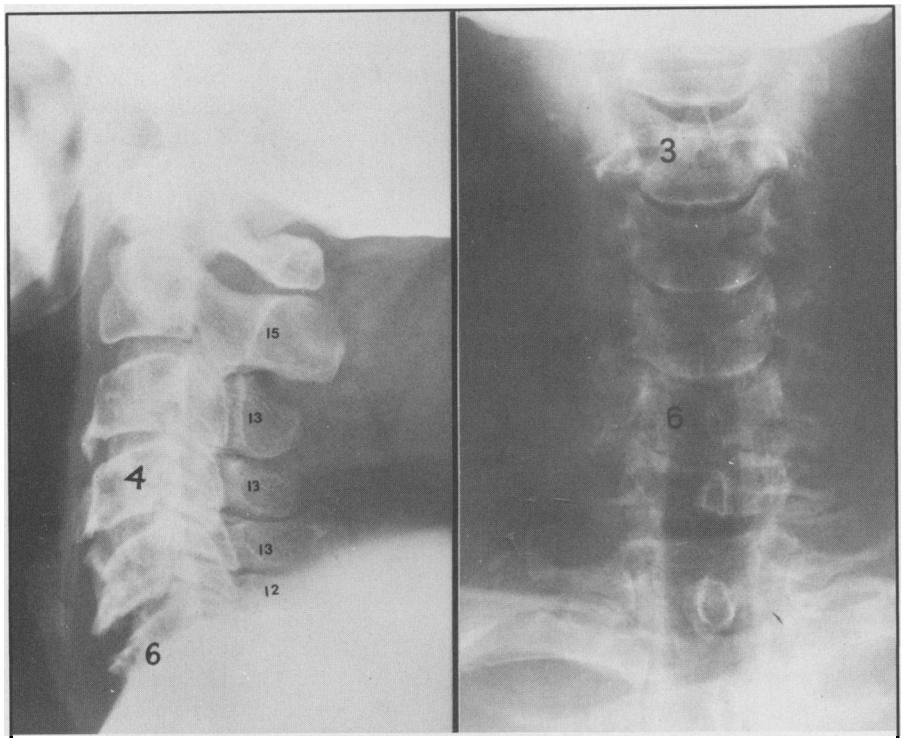

Figure 4. Lateral and A-P view of cervical spine in Case 2. The spinal canal is congenitally narrowed from C3 through C7. Though some degenerative changes are seen, there are no osseous spurs protruding posteriorly into the spinal canal.

ciated. Twenty-four hours after admission there was some visible movement in the lower extremities and sensation below C7 was improved. The clinical picture was felt to be consistent with a central cord syndrome.

Plain films of the cervical spine demonstrated a congenital narrowing of the cervical canal from C3 through C7 spinal segments (Figure 1). There was modest posterior lipping of the vertebral bodies at C4-5 and the functional diameter of the canal measured at these ridges was 10 mm. The 6th and 7th vertebral bodies were congenitally fused. A computerized axial tomography (CAT) scan of the cervical spinal canal demonstrated the markedly diminished sagittal diameter and volume capacity of the canal (Figure 2). The modest ridge at C4 was seen and its dramatic effect on further compromise of the volume capacity of the spinal canal at that level was graphically illustrated. Pantopaque myelography revealed a high degree partial block at the C4-C5 cord segments and a widened cord (Figure 3).

Decompressive laminectomy was offered to the patient, but he refused. The patient spontaneously made some impressive gains in motor power in his legs over the next eight weeks. However, while trying to transfer from bed to wheelchair, he fell and developed a complete motor sensory loss below the C4 cord segment. Respiratory problems developed and he expired shortly afterwards.

Case 2 (CG)

A 42-year-old black man was admitted to the hospital with complaints of progressive weakness of his arms and legs for ten years previously. His course over the years had been one of stepwise deterioration and characterized by episodes of sudden worsening followed by plateaus at a lowered level of function. He related many of these episodes to minor injuries or falls and often noted numbness and weakness in his arms and legs when he looked up. He had been disagnosed as having multiple sclerosis five years previously.

On examination, he had a severely spastic gait and required moderate assistance even to stand. He was quadriparetic with bilateral hyperreflexia and hypertonia in all four extremities. There were extensor plantar responses bilaterally. There was in-

consistently diminished sensation to pin and touch below the C5 cord segment and position and vibratory sense were severely impaired in both arms and legs. There was full and painless range of motion of his neck. However, on hyperextension of his neck he experienced "electric-like" shocks down into both arms and legs.

Radiographs of the cervical spine revealed a congenitally narrowed cervical canal from C3 through C7 (Figure 4). There was diminished height in the disk spaces from C3 through C7. However, no impressive posterior ridging was noted. Pantopaque myelography demonstrated an atrophic cervical and dorsal cord. With extension of the neck there was dorsal impingement on the cervical cord by infolding of the ligamentum flavum and laminae (Figure 5). Cerebrospinal fluid analysis was completely normal.

Decompressive laminectomy of C3 through C7 resulted in substantial neurological improvement and the patient became independent in gait and the activities of daily living. He has been followed for three years and has had no repeat episodes of weakness and enjoys unrestricted movements of his neck.

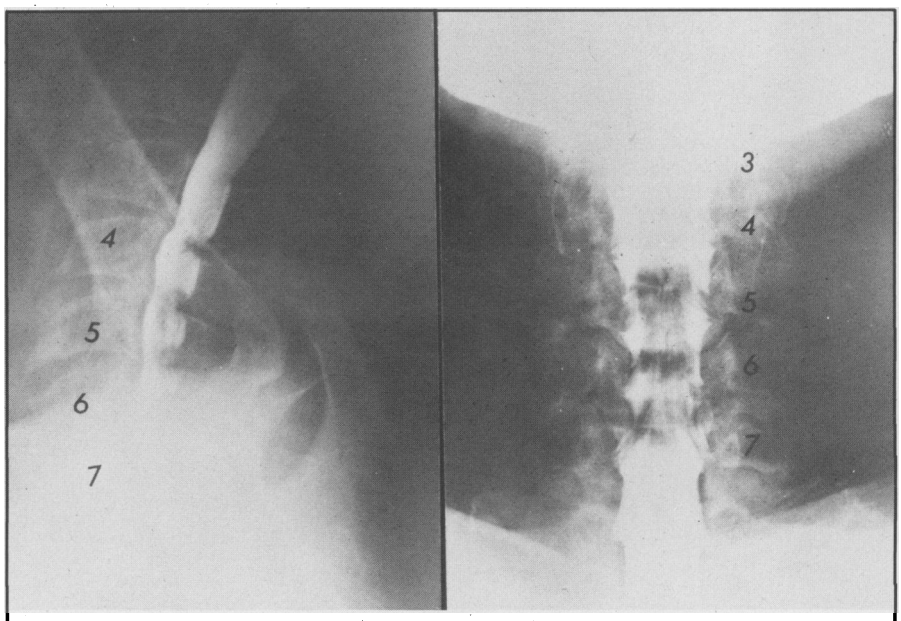

Figure 5. Lateral and A-P views of cervical myelogram in Case 2. Marked dorsal encroachment into the spinal canal is demonstrated when the neck is minimally extended. No significant ventral protusions in the dye column are demonstrated.

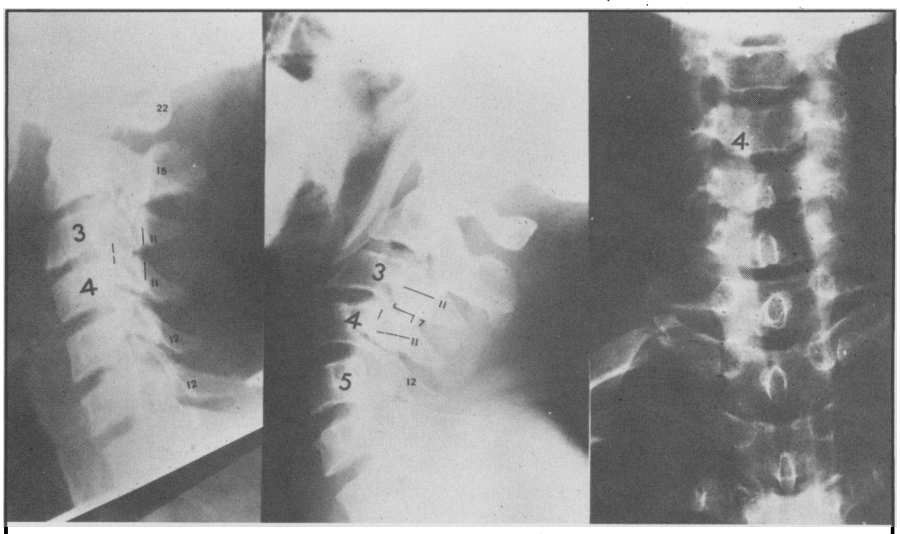

Figure 6. Lateral cervical spine films in neutral and extension, and A-P view in Case 3. The cervical canal is congenitally narrowed from C3 through C7. With extension of the neck there is modest retrolisthesis of C3 vertebral body on C4 which reduces the functional diameter of the canal at this segment to 7 mm.

Case 3 (HS)

A 41-year-old black man was admitted to the hospial after a closed head injury with impairment of consciousness for 24 hours. He had a past history of a "stroke" at age 36 with a residual left hemiparesis. On admission he was found to be severely quadriparetic with a C4-5 motor/reflex cord level and bilateral extensor plantar responses. Plain films of the cervical spine showed a constitutionally narrowed canal from C3 through C7 vertebral segments (Figure 6). There was mild retrolisthesis of C3 on C4 when the neck was extended. This rendered the functional diameter of the canal at that level to 7 mm. Myelography revealed marked dorsal and ventral impingement of the spinal cord at that level and congenital stenosis of the lumbar canal as well (Figure 7).

Decompressive laminectomy of C3 through C7 was performed. The patient made progressive improvement postoperatively and has become independent in gait and activities. Serial x-rays of the cervical spine over the three years since operation have shown no progression in his retrolisthesis.

Case 4 (AJ)

A 58-year-old right-handed, black, male housepainter was admitted to the hospital with a history of progressive gait difficulties for four years and pain and weakness in his left hand for six to eight months prior to admission. A history of alcohol abuse had contributed to a diagnosis of alcoholic peripheral neuropathy two years previously.

On examination he had bilateral root signs in the C6-T1 dermatomes, a spastic gait, hyper-reflexia in the lower extremities, and equivocal plantar responses bilaterally. Cervical spine films showed a congenitally narrowed canal from C3 through C7 and maximal at C3-4 (Figure 8). In addition, spondylitic foraminal narrowing at C5-6, 6-7, and C7-T1 was evident radiographically. Plain films of the lumbar spine showed congenital lumbar stenosis as well. Myelography revealed ventral and dorsal cord compression from C3 to C5 with a widened cord (Figure 9). There were defects in the nerve root sleeves at C5-6, C6-7, and C7-T1 bilaterally, left more than right. There was constriction of the lumbar theca with

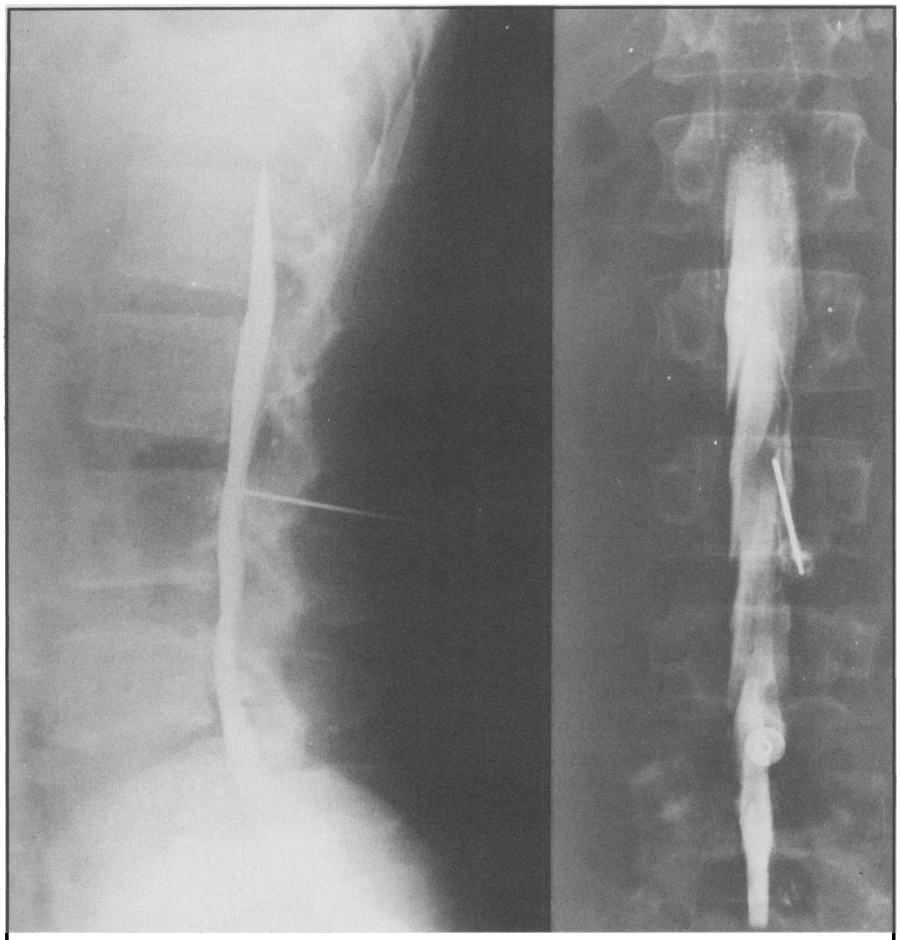

Figure 7. Lateral and A-P view of lumbar myelogram in Case 3. Congenital stenosis of the lumbar canal and constriction of the lumbar theca is demonstrated.

multiple ventral bulges in the dye column.

This patient was felt to have a myelopathy on the basis of his congenital spinal constriction and a radiculopathy of the lower cervical roots as a consequence of his superimposed cervical spondylosis. He underwent decompressive cervical laminectomy and bilateral foraminotomies from C3 through C7. He made remarkable neurological gains postoperatively and was able to return to work eight weeks later. Persistently absent plantar responses, diminished ankle jerks, and occasional low back pain have been attributed to his lumbar stenosis.

Discussion

Congenital stenosis of the cervical spinal canal is distinguishable clinically and radiographically from "pure" cervical spondylosis and is treated differently.

Spondylosis is essentially a disease of late middle-aged and older people.[1-4] Although brachioradiculopathies, myeloradiculopathies, and myelopathies may be associated with this disorder, cervical radiculopathy, particularly of lower cervical segments, is the most common neurological sequella of this disease.[1,4] In these cases neck pain and radicular pain in the upper extremities are prominent features and foraminal narrowing by vertebral osteophytes is easily recognized on plain film x-ray examinations of the cervical spine (Case 4). Myeloradiculopathy also commonly occurs in this disorder, usually in older patients. This neurological picture is usually associated with even more severe degenerative changes in the spine and osteophytes are seen radiographically to encroach upon the spinal canal as well as the neural foraminae in these patients. Pure myelopathy without prominent root signs and symptoms is notably uncommon in spondylosis.

In congenital spinal stenosis cervical myelopathy appears to be the dominant clinical feature.[14,16] Such was the case in all 11 patients in this study. This was manifested most frequently by gait difficulties, weakness or clumsiness of all four extremities, urinary incontinence, and prominent corticospinal tract signs on physical examination. Although involvement of sensory tracts was also a common finding, sensory changes were rarely crisp or profound and no particular syndrome was seen with any reliable regularity. It is important to note that more than half of the 11 patients had an associated congenital stenosis of the lumbar spine with evidence of multiple lumbar root compression on myelography. Equivocal or absent plantar responses or disproportionately diminished ankle jerks seen in several of these patients with prominent signs of myelopathy were attributed to this associated lumbar anomaly.

Neck pain and root signs in the upper extremities were conspicuously uncommon in these patients. In the two patients who manifested a brachioradiculopathy, spondylotic osteophytic narrowing of the cervical foraminae was seen radiographically in addition to the constitutional constriction of the spinal canal. Both of these patients were in their sixth decade. A positive Lhermitte sign was elicited in two of the 11 patients.

It is important to note that ten of the 11 patients were under the age of 55, and eight were less than 50 years old. Moreover, nine of the patients had had symptoms of myelopathy from four to 11 years before the correct diagnosis was made. Apparently the myelopathy of congenital cervical stenosis tends to occur in a younger age group than does that of cervical spondylosis and represents an important distinguishing feature. It is also notable that in each of the 11 patients, trauma of varying degrees was invariably related either to the onset or to the worsening of the myelopathy. The heavy preponderance of black males in this study has not been noted by other authors.

In contrast to spondylosis, plain film examinations of the cervical spine in congenital cervical stenosis may be deceptively unremarkable even in the face of profound neurological deficits. Although minor degenerative changes may be seen, the diagnosis is made on careful measurements of the sagittal diameter of the cervical canal.[7,13-17] Computerized axial tomography of the cer-

vical spine has also proven to be a valuable diagnostic tool. Contrast myelography is essential in demonstrating the abnormal biomechanics responsible for the clinical picture.

In congenital spinal stenosis, the volume capacity of the canal is constitutionally greatly reduced. This situation renders the cervical cord exceptionally vulnerable to relatively minor additional infringements into the intraspinal space. Lesions which would be mechanically insignificant in a normal-sized canal, therefore, take on momentous import in this developmentally compromised situation. Modest ventral encroachments into these constricted canals as by minor osteoarthritic vertebral body spurs (Case 1), relatively small bulges of intervertebral disks, evaginated posterior longitudinal ligaments, or minor degrees of vertebral malalignment or slippage[13,18] may result in significant compression and injury to the cervical cord (Case 3). Likewise, dorsal encroachments into the canal in these situations take on heightened significance as well (Case 2). Infolding of hypertrophied or redundant ligamentum flava, thickened dorsal laminae, or simple hyperextension of the neck may result in grave intrusions into the stenotic canal and catastrophic cord compression and injury may result.[13-15]

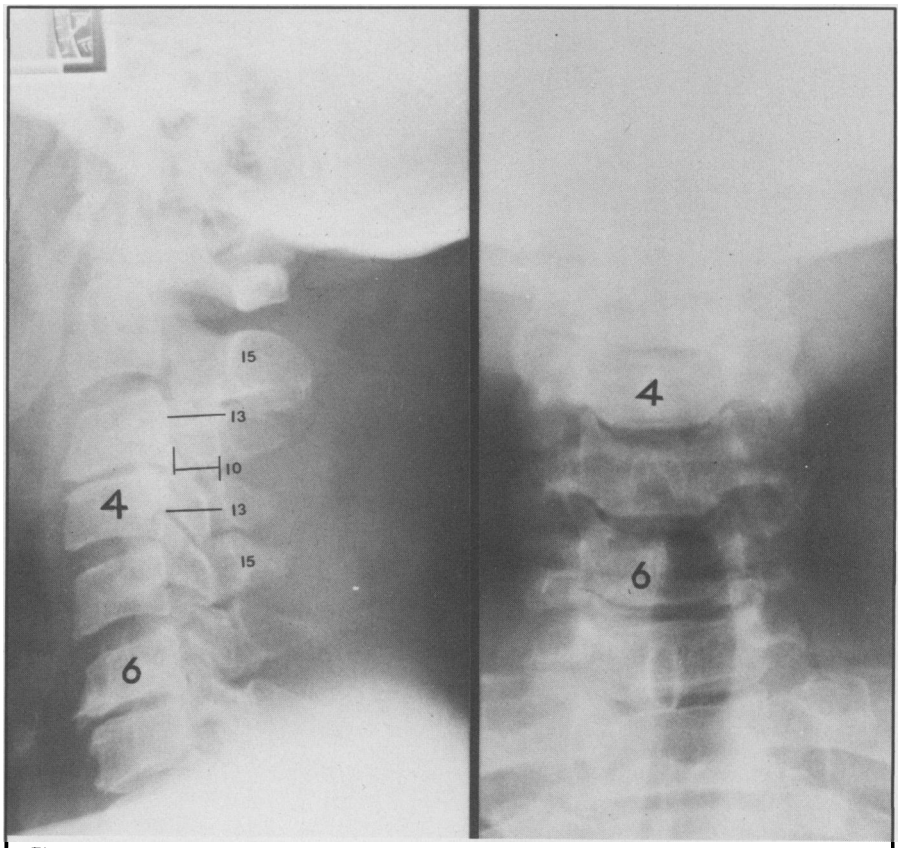

Figure 8. Lateral and A-P views of the cervical spine in Case 4. The cervical canal is congenitally narrowed from C3 through C7. A small arthritic ridge at C3 protrudes into the canal and reduces the functional diameter at this level to ten mm. Disk space collapse at C6-7 and hypertrophic changes in the uncovertebral joints in the lower cervical segments are also seen.

In all 11 patients, the manifest cervical myelopathy appeared to result from one or more of these mechanisms described. More importantly, relief of the compressive and/or intrusive lesions to the cord by enlarging the cervical canal resulted in the arrest of neurological deterioration and improved cord function in nine of the ten patients who were operated upon. Although a localized compression of the cord may be demonstrated myelographically, it should be recognized that all stenotic vertebral segments represent a threat to compromised cord function and future cord injury. Consequently, the goals of surgical management are twofold: (1) to relieve the demonstrated compressive lesion(s) on the cord; as well as (2) to prophylactically protect the cord from subsequent injury by all stenotic vertebral segments which are recognized for their pernicious potential.

Anterior operative approaches to the cervical spine, which have become very popular in the surgical management of cervical spondylosis, have significant limitations in the treatment of the congenitally stenotic cervical spine.[11,19,20] First, the marked constriction of the bony canal affords a small degree of tolerance for surgical instrumentation from this approach and severe and irreversible cord injury may result during the operative procedure itself. Secondly, although the anterior approach can remove ventral lesions protruding into the canal, it can only restore the canal to its original constricted state. Thirdly, the anterior approach limits the surgeon to correcting only two, and possibly three, vertebral segments and is insufficient treatment in most cases in which five and six vertebral segments are involved. Fourthly, anterior surgical procedures offer inadequate protection from the potentially injurious intrusions into the canal by dorsal spinal elements.

Enlarging all portions of the constricted canal by extensive decompressive laminectomy best affords achievement of the goals of surgical therapy. In the authors' experience as well as that of others,[15,16] this has yielded gratifying results. In situations where ventral lesions are of such an extent that after posterior decompression the dural tube remains distorted and nonpulsatile, two additional alternatives are available. The dural tube can be enlarged with replacement grafts with or without removal of soft disks from the posterior approach.[18] Or, anterior discectomy and interbody fusion can be performed at subsequent operation with a reduced hazard of cord injury from instrumenting a canal which has now been enlarged.[17,18]

In situations where patients are deemed physiologicaly poor risks to withstand such a major procedure as extensive laminectomy and/or the sitting position, or when the ventral lesion is of such proportions as to seem unlikely to be benefited by posterior decompression, removal of the ventral lesion may be attempted through the anterior approach. Although this procedure is performed with an acknowledged increase in risk and limitations of operative goals, dissection with the

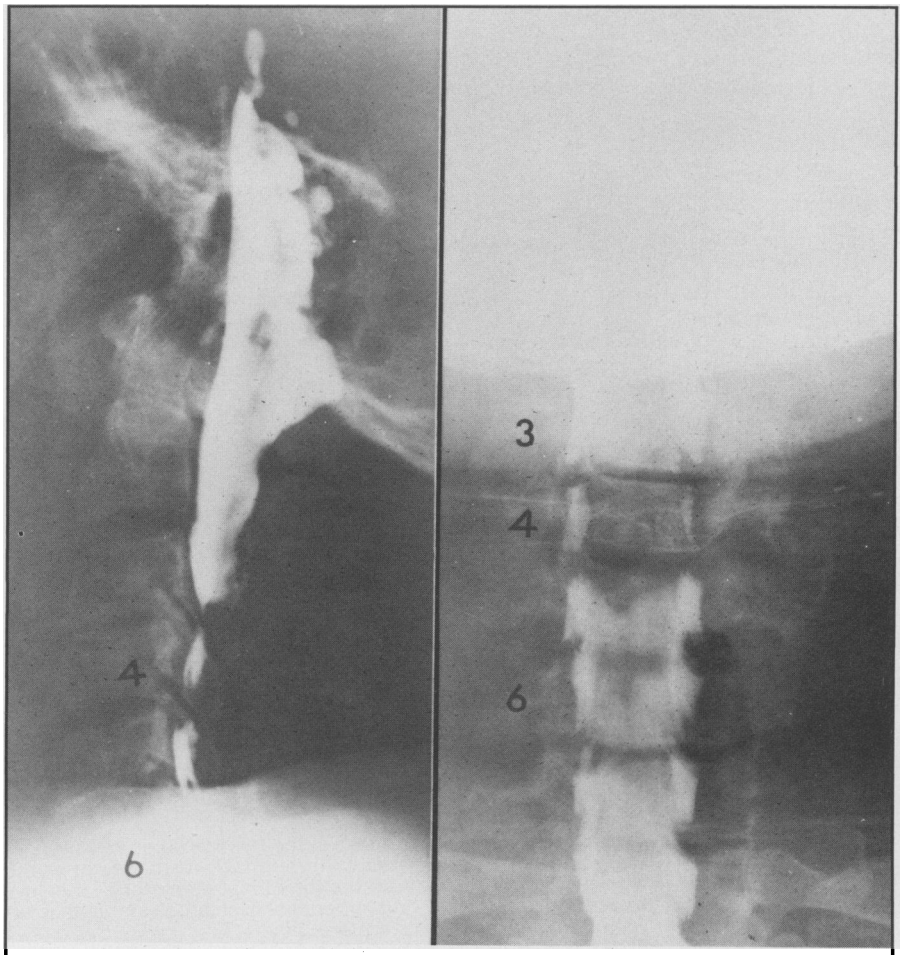

Figure 9. Lateral and A-P view of cervical myelogram in Case 4. There is ventral and dorsal cord compression at C3 to C5 with a widened spinal cord. In addition, prominent defects in the root sleeves are seen at C5-6, C6-7, and C7-T1, left more than right.

operating microscope may greatly reduce the hazards of operative injury.[21] With removal of the ventral lesion improved cord function may be anticipated. However, the risk of future neurological catastrophe from minor trauma or degenerative changes in the spine at other levels of involvement remain an ever present threat.[11,18]

Even in patients with prominent signs of root disease in the lower extremities from an associated congenital lumbar stenosis and multiple lumbar root compression, improved function has been achieved after the cervical myelopathy has been relieved. In those situations where lower motor neuron signs in the legs persist to an extent as to impair the patient's functional ability, or disabling back pain eventuates, extensive decompressive lumbar laminectomy is advised.

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