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Endogenous-Lesioned Cervical Disc Herniation: A Retrospective Review of 9 Cases

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The purpose of this study was to analyze the pathogenic mechanisms, clinical presentation, and surgical treatment of cervical disc herniation without external trauma. Between 2004 and 2008, 9 patients with cervical disc herniation and no antecedent history of trauma were diagnosed with cervical disc herniation and underwent surgical decompression. Pathogenic mechanisms, clinical presentation, surgical treatment, and prognosis were analyzed retrospectively. In 6 patients, herniation resulted from excessive neck motion rather than from external trauma. An injury from this source is termed an *endogenous-lesioned injury*. Patients exhibited neurologic symptoms of compression of the cervical spinal cord or nerve roots. In the other 3 patients, no clear cause for the herniation was recorded, but all patients had a desk job with long periods of head-down neck flexion posture. After surgery, all patients experienced a reduction in their symptoms and an uneventful recovery. Cervical disc herniation can occur in the absence of trauma. Surgical decompression is effective at reducing symptoms in these patients, similar to other patients with cervical disc herniation. Surgical treatment may be considered for this disorder when the herniation becomes symptomatic.

Key words: Cervical disc herniation – Endogenous injury – Cervical decompression – Etiology

Several types of cervical disc herniation can occur. Acute cervical disc herniation is a soft herniation that is often caused by an external force, such as impact, a traffic accident, or a fall. These occurred in contrast to the disc herniation seen in hyperostosis of the posterior aspect of the vertebrae secondary to cervical degeneration in elderly patients or cervical disc herniation associated with hypertrophy or calcification of the posterior longitudinal ligament.[1] The diagnosis and treatment of traumatic cervical herniation have been studied extensively.[2–5] In contrast, soft cervical disc herniation that occurs

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with minor or no external trauma is rare and has not been systematically investigated. A search of the literature (NIH PubMed) revealed a dearth of publications about nontraumatic cervical disc herniation, and most existing studies are case reports. Song and Lee reported a case of nontraumatic 2-level and single-level cervical disc herniation.[6] In their case, the patient experienced no trauma but had posterior neck pain 6 weeks before visiting the clinics, and had worsened pain at the posterior neck and shoulders in the morning 1 day before visiting the clinics. Ueyama reported a case of nontraumatic cervical disc herniation in a 61-year-old female with progressive paraplegia for 1 day; the patient had experienced minor local neck pain during exercise 2 months before admission to the hospital.[7] In addition, Goh and Li reported that a 57-year-old Chinese male with no antecedent history of trauma or cervical spine problems presented with neck pain for 2 days and increasing numbness over the right side of his body; the left upper limb of the patient was diagnosed to have cervical disc herniation at the C4–C5 and C5–C6 level. The patient was also diagnosed to have obstructive sleep apnea, which was postulated by the authors to result from compression of cervical disc herniation.[8] Given the scarcity of literature about nontraumatic cervical disc herniation, we investigated the causative factors, pathogenesis, prevention, and treatment of this disorder.

Methods and Results

Patients

Between 2004 and 2008, we collected 9 patients (5 males and 4 females) diagnosed with cervical disc herniation without an antecedent history of trauma. Their ages ranged from 22 to 42 years, with a mean age of 33.4 years. Table 1 lists details about these patients. All patients were confirmed by magnetic resonance imaging (MRI) to have cervical disc herniation and spinal cord compression. No patient experienced external trauma such as head/neck fall injury or a fall from height. Before visiting the hospital, 6 patients experienced neck activities clearly related to their symptoms, including sudden neck turning during work in 4 patients and neck extension-rotation during driving or studying in 2 patients (Table 1). Four of these 6 patients visited the hospital for neck discomfort, another 2 patients for weakness of upper limbs. The other 3 patients (1 teacher, 1 businessman, and 1 clerk) could not describe a clear history of excessive neck motion or fatigue, but their careers all involved long periods of desk-job work (Table 1). These 3 patients all experienced neck discomfort before visiting the hospital.

The patients reported 2 types of onset. In the 6 patients who had a history of causative neck motion, discomfort occurred immediately or several days after the neck motion (Table 1). This was soon followed by symptoms indicative of nerve compression, including neck and upper limb pain, stiffness, or impaired motion of the neck and paraplegia. In the 3 patients without a clear history of excessive neck motion, neck discomfort occurred without clear causative factors. Initially, these patients experienced mild symptoms, such as neck pain or stiffness; symptoms of nerve compression then gradually developed in the short term. For all patients, the interval from the occurrence of neurologic symptoms to the hospital visit ranged from 1 to 28 days, with a mean interval of 10.3 days.

Clinical presentation

Patients experienced 1 of 3 types of neurologic symptoms, each indicating a different mode of nerve compression. Four patients had symptoms of cervical cord compression, including tendon hyperreflexia, muscular hypertonia, and pathologic reflexes. Among them, 1 patient also experienced weak urination and a staggering gait. Two patients had symptoms of nerve root compression, including pain and numbness, with weakness in 1 upper limb in 1 patient and pain and numbness in both upper limbs in the other patient. In these 2 patients, the pain was severe, and shoulder and elbow joints showed impaired motion caused by pain and muscular weakness. The other 3 patients had mixed symptoms of cervical cord compression in conjunction with nerve root compression.

Imaging

On lateral plain films, 2 patients presented with cervical kyphosis and 5 patients presented with disappearance of the usual lordotic curvature in combination with slight narrowing of the intervertebral space. The other 2 patients appeared generally normal. No bone abnormalities (*i.e.*, fracture, dislocation, and clear hyperostosis of the vertebrae) were detected in any patient.

Both T1- and T2-weighted MRI revealed different patterns of herniation that were correlated with patients' clinical symptoms. Patients with symptoms of cervical cord compression showed clear central

Table 1 Summary of patient characteristics

No. of patient	Age/sex	Occupation	Causative factor and cervical position	Interval from symptoms to hospital visit, d	Main symptoms and signs	Plain film findings	Herniated segment (MRI imaging)
1	M/29	Automobile repairer	Neck rotation with head-down reflexion	2	Neck pain, right upper limb weakness, muscular hypertonia, pathologic reflex, pathologic reflex positive	Normal physiologic curvature, intervertebral space narrowing	C5–C6, C6–C7
2	M/30	Teacher	No	13	Neck stiffness, bilateral lower limb weakness, muscular hypertonia	Disappearance of physiologic curvature	C4–C5, C5–C6
3	F/41	Teacher	Neck rotation at neutral position	28	Neck pain and stiffness, right upper limb pain	Cervical kyphosis	C4–C5
4	M/42	Accountant	No	18	Neck pain and stiffness, pathologic reflex positive	Normal	C3–C4
5	F/22	Secretary	No	1	Neck pain, bilateral upper limb pain	Disappearance of physiologic curvature	C5–C6
6	F/35	Office clerk	Neck rotation with head-down reflexion	7	Muscular hypertonia of 4 limbs, drunken gait, weak urination	Cervical kyphosis	C5–C6
7	M/38	Driver	Neck rotation at neutral position	3	Neck stiffness and pain, muscular hypertonia of four limbs	Normal	C4–C5, C5–C6
8	F/33	Pianist	Neck rotation at neutral position	6	Neck pain and stiffness, right upper limb weakness, pathologic reflex positive	Disappearance of physiologic curvature, intervertebral space narrowing	C4–C5, C5–C6
9	M/31	Automobile repairer	Neck rotation with head-down reflexion	15	Muscular hypertonia of 4 limbs, pathologic reflex positive	Disappearance of physiologic curvature	C5–C6

Fig. 1 T2-weighted sagittal image showing single-level herniation at C5–C6 in a 35-year-old female patient (No. 6).

Fig. 2 T2-weighted axial image showing a protruded nucleus pulposus and severe central compression of the ventral aspect of the cervical cord (the white arrow) in a 35-year-old female patient (No. 6).

Fig. 3 T2-weighted sagittal image showing 2-level herniations at C5–C6 and C6–C7 and compression of the ventral aspect of the cervical cord in a 29-year-old male patient (No. 1).

protrusions compressing the ventral aspect of their cervical spinal cord (Figs. 1 and 2). Patients with mixed symptoms showed similar central protrusions compressing the ventral aspect of their cervical spinal cord, but the protrusions were more diffuse and extended toward 1 side. In patients with symptoms of nerve root compression, the protrusions were moderate in size, extended unilaterally or bilaterally, and compressed the respective nerve root but not the ventral aspect of the cervical cord (Figs. 3 and 4).

MRI analysis revealed that 5 patients had single-level herniation, and the other 4 patients had 2-level herniation with a relatively mild herniation adjacent to a severe one. Herniations were located at C4–C5 in 1 patient, C5–C6 in 3 patients, C3–C4 in 1 patient, C5–C6 combined with C4–C5 in 3 patients, and C5–C6 combined with C6–C7 in 1 patient. On T2-weighted images, 5 patients exhibited clear changes in the cervical cord at the herniated segments.

Treatment and Results

All patients underwent routine surgical decompression. Table 2 lists details about surgeries that were

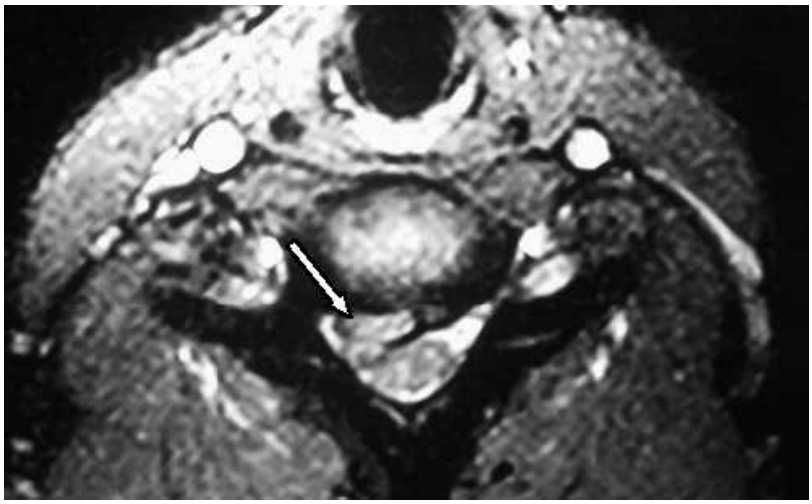

Fig. 4 T2-weighted axial image showing the extruded nucleus pulposus compressing the ventral aspect of the cervical cord and a nerve root (the white arrow) in a 29-year-old male patient (No. 1).

performed to decompress the cervical cord or nerve root. Patients underwent either discectomy or subtotal vertebrectomy depending on the location of herniation, and then the spine was grafted with autologous iliac bone and was internally fixed using titanium plates. In patients undergoing regular discectomy, the posterior longitudinal ligament was partially resected to facilitate surgery, because in some cases, the posterior longitudinal ligament was ruptured, and the disc was extruded into the canal. In patients undergoing subtotal vertebrectomy, the posterior longitudinal ligaments were partially resected, and the nucleus pulposus tissue was removed. In all patients, no calcification of the disc or posterior longitudinal ligament was observed during surgery, and the excised tissues were

Table 2 Details of surgical treatments

No. of patient	Treatment	Follow-up, months	JOA scores		Complications
			Preoperative	Postoperative	
1	Subtotal vertebrectomy of C6, bone autografting, and internal fixation with titanium plates	31	13	16	No
2	Subtotal vertebrectomy of C5, bone autografting, and internal fixation with titanium plates	30	14	17	No
3	Discectomy at C4–C5, bone autografting, and internal fixation with titanium plates	41	14	17	Anterior hyperostosis at the adjacent segment
4	Discectomy at C3–C4, bone autografting, and internal fixation with titanium plates	33	14	17	Bone screw loosening
5	Discectomy at C5–C6, bone autografting, and internal fixation with titanium plates	10	12	15	No
6	Subtotal vertebrectomy of C5, bone autografting, and internal fixation with titanium plates	6	9	14	No
7	Subtotal vertebrectomy of C5, bone autografting, and internal fixation with titanium plates	16	12	15	No
8	Discectomy at C5–C6, bone autografting, and internal fixation with titanium plates	17	13	16	Cervical kyphosis
9	Discectomy at C5–C6, bone autografting, and internal fixation with titanium plates	14	14	16	No

JOA, Japanese Orthopaedic Association.

identified as degenerative discs or connective tissues by pathologic examination.

No intraoperative or postoperative complications were observed. Radiographic follow-up (6–41 months, mean 22 months) revealed signs of bone healing and no dislocation of bone grafts or internal fixation devices. One patient showed degeneration at the segment adjacent to the original area of herniation, and another showed cervical kyphosis. In another patient, loosening of a bone screw was observed, but the position of the hardware remained acceptable. Soon after surgery, all patients resumed their usual routine and showed clear improvement in neurologic symptoms, as indicated by their Japanese Orthopaedic Association (JOA) scores (Table 2). Finger numbness remained in 2 patients, and tendon hyperreflexia continued in 4 patients, but all had normal muscle strength and tension. Patients were followed for 6–41 months Longer follow-up is under way.

Discussion

To our knowledge, this is one of the few studies to systematically investigate cervical disc herniation without external trauma, such as impact, a traffic accident, or a fall. In this work, we categorized these traumatic forces as ''external trauma.'' Patients in this study were relatively young, with the youngest patient being 22 years old. Patients had no hyperostosis of the vertebrae, indicating that the disc herniation was not secondary to cervical degeneration. MRI confirmed that the extruded material was soft disc. Cervical hyperostosis or ossification of the posterior longitudinal ligament was excluded by X-ray findings. Additionally, no bony abnormities, such as facet dislocation or bone defects, occurred; these have been reported to exist in 54–80% of patients with traumatic cervical disc herniation.[9–12]

The 9 patients in this study showed differences in the natural history of disc herniation compared with patients with traumatic herniation. First, instead of external trauma as described earlier, herniation was caused by forces generated by their own cervical muscles and applied to their cervical discs and annulus fibrosus. Second, most patients experienced neck discomfort before the onset of the disorder, and their daily activities involved long periods of a head-down neck flexion position, which might have gradually caused neck strain.

In 6 patients, herniation resulted directly from sudden neck extension-rotation. Normal physiologic neck rotation should not cause injury, but in these patients, sudden neck rotation beyond the normal range generated burst compressive-shear stress on the cervical discs. Stress was then concentrated on the nucleus pulposus tissue and ruptured the annulus fibrosus; the posterior longitudinal ligament was ruptured in some cases. The major characteristic of this injury is that damaging stress on the cervical discs was applied by the patient's cervical muscles instead of by external trauma, such as impact, a traffic accident, or a fall. Essentially, this mode of injury was not external-traumatic. The force that lesioned the cervical disc was the power of muscles in the neck region. We named this type of injury *endogenous-lesioned injury* to differentiate it from injury caused by external trauma.

In young patients under these circumstances, the development of cervical disc herniation is associated with 2 conditions: (1) the muscles/ligaments around the cervical vertebra have been maintained at an abnormal position and thus became fatigued; (2) the compliance and reactivity of muscles/ligaments have decreased, and the disc nucleus and annulus fibrosus have degenerated, both as the result of mechanical fatigue. These conditions may be analogous to the cervical herniation associated with Klippel-Feil syndrome. In that syndrome, partial fusion of cervical vertebrae results in hypermobility of other vertebral segments and thus abnormal fatigue damage of the disc nucleus and the annulus fibrosus. Samartzis *et al* reported that a 16.8-year-old boy with Klippel-Feil syndrome had a C3–C4 cervical herniation following an 8-foot-high rooftop jump. The authors suggested that hypermobility associated with the nonfused cervical segment was the pathologic mechanism in this case.[13]

We hypothesized that accumulation of fatigue damage is the cause of this mode of injury. The long period of a head-down flexion position may be responsible for the herniation present in the other 3 patients without a clear history of excessive neck motion. In such a position, the posterior cervical muscles were under constant isometric contraction and could easily fatigue. This position also might result in bleeding and swelling of muscle fibers, gradually diminishing their strength and elasticity. Excessive tension of the cervical ligaments (*e.g.*, ligamentum flavum; nuchal, supraspinal, interspinal, and posterior longitudinal ligaments) might gradually result in laxity and loss of mechanical strength. The magnitude of the force is below the threshold value to cause immediate damage but may cause cervical disc herniation in persons with fatigue

damage. (The force does not immediately cause injury, but may gradually induce fatigue damage to the nucleus pulposus and the annular fibrosus, as well as to the posterior longitudinal ligaments.)

Pathophysiologic and mechanical mechanisms in the development of these disc herniation cases are suggested on the basis of anatomy, biology, and biomechanics, and will be verified by future studies.

In this study, most herniations were observed at C4–C5 and C5–C6, probably because of their biomechanical conditions. Of all cervical segments, C4–C5 experiences the greatest stress when the neck is in a highly extended position, and C5–C6 experiences the greatest stress in a head-down flexed position.[14] As a result, most herniations occurred at these segments. Moreover, because of protection of the uncovertebral joints, most herniations extended posteriorly, but only slightly toward 1 side.

In patients with traumatic soft cervical disc herniation, Debios *et al*[15] found a significantly smaller sagittal diameter of the spinal canal and area of the bony cervical spinal canal compared with healthy individuals; they reported a linear correlation between the sagittal diameter of the bony cervical spinal canal and that of the herniation. In this study, correlations between the size of the nontraumatic herniation and the severity of clinical symptoms, as well as between the herniation size and the sagittal diameter of the spinal canal, were not determined because of lack of statistical power. We intend to investigate this when more cases become available.

We suggest that surgical decompression should be considered when cervical disc herniation and compression of the spinal cord or nerve roots are clearly present based on imaging analysis, even if symptoms are mild. In treatment of myelopathy caused by soft cervical disc herniation, Kim *et al* suggested that the prognosis might be improved when patients are treated earlier or the symptoms remain mild.[2] In addition to decompression, other surgical procedures may be used, including cervical disc replacement or discectomy with internal fixation with cages, allografts, and synthetic bone grafts.

Patients who seek treatment because of neck discomfort are becoming younger, and most of their symptoms can be traced to long periods of adverse neck positions. Currently, no standard is available for the evaluation of neck health in specific population groups, particularly those who experience long periods of head-down neck flexion during work. One might surmise that those groups have higher risk of cervical vertebrae or cervical spinal cord disorders. Furthermore, it is difficult to overcome these adverse neck positions because of the nature of the work required; however, neck symptoms may occur repeatedly. Our study emphasized the potential risk of cervical disc herniation in patients without a history of trauma. Clinicians should be especially aware of the importance of management of patients with myelopathic symptoms. We suggest early intervention in appropriately selected patients, as well as appropriate education for these individuals.

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