

Clinical Article

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Myelopathy Caused by Soft Cervical Disc Herniation : Surgical Results and Prognostic Factors

Objective : The purpose of this study was to investigate the surgical results and prognostic factors for patients with soft cervical disc herniation with myelopathy.

Methods : During the last 7 years, 26 patients with cervical discogenic myelopathy were undertaken anterior discectomy and fusion. Clinical and radiographic features were reviewed to evaluate the surgical results and prognostic factors. The clinical outcome was judged using two grading systems (Herkowitz's scale and Nurick's grade).

Results : Male were predominant (4:1), and C5-6 was the most frequently involved level. Gait disturbance, variable degree of spasticity, discomfort in chest and abdomen, hand numbness were the most obvious signs. Magnetic resonance(MR) images showed that central disc herniation was revealed in 16 cases, and accompanying cord signal changes in 4. Postoperatively, 23 patients showed favorable results (excellent, good and fair) according to Herkowitz's scale.

Conclusion : Anterior cervical discectomy and fusion effectively reduced myelopathic symptoms due to soft cervical disc herniation. The authors assured that the shorter duration of clinical attention, the lesser the degree of myelopathy and better outcome in discogenic myelopathy.

KEY WORDS : Cervical vertebrae · Intervertebral disc · Myelopathy.

INTRODUCTION

Cervical discogenic disease and spondylosis are associated with a variety of spinal cord syndromes and lead to spinal cord compression in several ways. Acute cervical myelopathy may result from a sizable central soft disc herniation or following minor cervical trauma in a patient with spondylosis or preexisting compromise of the spinal canal^{1,7,8}.

The patients with cervical myelopathy usually exhibit difficulty in walking, spastic weakness of upper limb and hand, hyperreflexia, and pachy sensory loss^{1,7,8,16,19}. Bladder, bowel, and sexual dysfunction are also attributable to severe myelopathy^{1,7,11,12}.

Of the causes of chronic cervical myelopathy, spondylotic myelopathy has been extensively advocated. On the contrary, soft cervical disc herniation presenting with myelopathy was not investigated sufficiently, because of low clinical attention and small case volume.

The purpose of this study was to investigate clinical characteristics, radiological findings and surgical outcome of soft cervical disc herniation patients with myelopathy, and thus to evaluate the responsible factors for outcome.

MATERIALS AND METHODS

From January 1998 to November 2004, a total of 456 patients were diagnosed as cervical disc herniation and underwent surgical procedure in our department. Among them, there were 111 patients having soft cervical disc herniation without any underlying or associated osseous disease [fracture, degenerative cervical spondylosis, ossification of posterior longitudinal ligament (OPLL), tumor and inflammation]. Within this group of patients, 26 patients presented with myelopathy. This subset of 26 patients was enrolled in this study. All patients were undertaken anterior cervical discectomy and fusion. Instruments utilized for fusion were listed as follows; Atlantis™ Anterior Cervical Plate System (Sofamor Danek, Memphis, TN) with autogenous bone (6 cases), Orion® Anterior Cervical Plate System (Sofamor Danek, Memphis, TN) with

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Table 1. Clinical features of 26 patients with myelopathy caused by soft cervical disc herniation

No. of patient	Age/Sex	Level	Follow up (month)	Chief complaint	MR imaging	Outcome		Cx
						Herkowitz's scale*	Nurick's grade†	
1	M/35	C4-5, C5-6	34	Walking difficulty	Central disc	Good	1	
2	F/56	C3-4	42	Walking difficulty	Paracentral disc	Excellent	0	
3	M/43	C6-7	56	Walking difficulty	Central disc, cord signal change	Fair	2	Malunion
4	M/45	C5-6	12	Walking difficulty	Paracentral ruptured disc	Good	1	
5	M/27	C4-5	38	Spasticity	Paracentral disc	Excellent	0	
6	M/51	C5-6, C6-7	68	Chest/abdominal discomfort	Central disc	Good	1	
7	M/40	C5-6	29	Hand numbness	Paracentral disc	Good	0	
8	M/42	C5-6	55	Walking difficulty	Central disc	Good	1	
9	F/53	C5-6	87	Walking difficulty	Central disc, cord signal change	Fair	3	
10	M/55	C5-6	19	Spasticity	Paracentral disc	Excellent	0	
11	M/32	C6-7	7	Spasticity	Central disc	Poor	5	
12	F/56	C4-5, C5-6	30	Walking difficulty	Central disc	Good	0	
13	M/39	C3-4	49	Walking difficulty	Central disc	Good	1	
14	M/55	C4-5	37	Chest/abdominal discomfort	Central disc	Excellent	0	
15	M/35	C5-6	64	Radicular pain	Paracentral ruptured disc	Good	1	
16	F/45	C5-6	51	Spasticity	Central disc, cord signal change	Poor	4	Screw loosening
17	M/57	C6-7	48	Walking difficulty	Central disc	Good	2	
18	M/61	C5-6, C6-7	54	Hand numbness	Paracentral ruptured disc	Good	2	
19	M/45	C5-6	58	Spasticity	Central disc, cord signal change	Fair	3	
20	M/36	C4-5	17	Walking difficulty	Central disc	Excellent	0	
21	F/55	C4-5	39	Radicular pain	Paracentral disc	Poor	5	
22	M/49	C6-7	47	Spasticity	Central disc	Good	0	
23	M/23	C4-5	52	Walking difficulty	Paracentral disc	Good	1	
24	M/39	C5-6	31	Spasticity	Paracentral disc	Fair	3	
25	M/50	C3-4	42	Radicular pain	Central disc	Excellent	0	
26	M/42	C5-6	53	Chest/abdominal discomfort	Central disc	Good	0	

No : number, MR : magnetic resonance, Chief complain : All patients had myelopathic symptoms, and listed here were the main cause for admission. Cx : complication. *Herkowitz's outcome scale¹⁷⁾(Excellent : Complete relief of pain and weakness, Good : Improvement in pain and weakness requiring analgesics without lifestyle restrictions, Fair : Improvement in pain and weakness requiring analgesics with lifestyle restrictions, Poor : No improvement over preoperative symptoms and signs). †Nurick's grade²⁴⁾(Grade 0 : Root signs & symptoms, no evidence of cord involvement, Grade 1 : Sign of cord involvement, normal gait, Grade 2 : Mild gait impairment, able to be employed, Grade 3 : Gait abnormality prevents employment, Grade 4 : Able to be ambulate only with assistance, Grade 5 : Chair bound or bedridden)

autogenous bone (13 cases) and AMSLUTM cage (Eurosurgical, Amsterdam, Netherlands) with Lubbock[®] (Transphyto S. A., Clermont-Ferrand, France) (7 cases), respectively.

Authors retrospectively studied the clinical and radiographic profiles and post operative results by using medical records, radiological findings, and telephone questionnaire. We distinguished soft cervical disc from hard disc by using simple x-ray, magnetic resonance image (MRI) and computerized tomography (CT). For the purpose of this study, myelopathy was defined as constellation of clinical presentation, such as walking difficulty, weakness of upper limb and hand, spasticity, hyperreflexia, pachy sensory loss, and autonomous

dysfunction (bladder, bowel, and sexual dysfunction).

The clinical outcomes were judged using two grading systems [Herkowitz's scale¹⁷⁾ and Nurick's grade²⁴⁾ (Table 1)]. We looked into correlation between prognosis and previous trauma history and symptom duration. For investigating correlation between prognosis and preoperative neurologic deficit, we categorized the whole patients into two groups by Nurick's grade; good (Group 1 : Nurick's grade 0-2) and bad (Group 2 : Nurick's grade 4-5) prognosis group. For the statistical analysis, Fisher's exact test was used to verify the correlation between two different groups. *P* value of less than 0.05 was regarded as being statistically significant.

Table 2. Clinical symptoms and neurologic signs in 26 patients with myelopathy caused by soft cervical disc herniation

Symptoms and signs	No. of Patient(%)
Walking difficulty	20 (77)
Spasticity	15 (58)
Chest/abdominal discomfort	15 (58)
Hand numbness	11 (42)
Radicular pain	9 (35)
Muscle atrophy	7 (26)
Spinothalamic deficits	7 (26)
Sphincter disturbance	5 (19)
Central cord syndrome	4 (15)

No : Number

Table 3. Comparison of Nurick's grading system between pre-operative and post-operative period in 26 patients with myelopathy caused by soft cervical disc herniation

	Post-op Nurick's grade						total
	0	1	2	3	4	5	
Pre-op	0	1					1
Nurick's	1	2	1				3
grade	2	5	3				8
	3	2	3	2			7
	4		1	2		1	4
	5			1	1	1	3
total	10	7	3	3	1	2	26

Refer to the table 1 for detailed description of Nurick's grade

Table 4. Correlation between pre-operative Nurick's grade²⁴⁾ and Herkowitz's outcome scale¹⁷⁾

Group	Nurick's grade	Excellent-good outcome
1	0-2 (n:12)	12 (100%)
2	4-5 (n:7)	1 (14%)

Refer to the table 1 for detailed description of Herkowitz's scale and Nurick's grade. Nurick's grade 3 was omitted owing to the potential ambiguity of result interpretation. $P=0.001$ Fisher's exact test**Table 5.** Correlation between symptom duration and Herkowitz's outcome scale¹⁷⁾

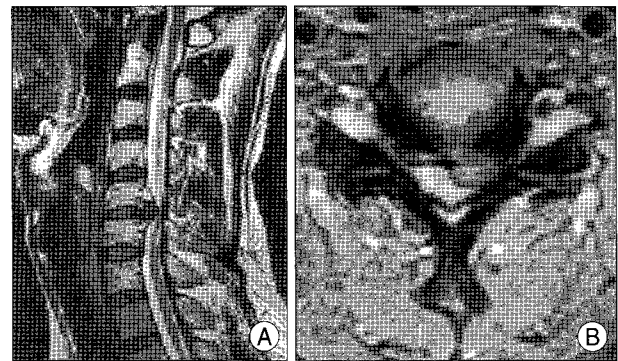
Group	Symptom duration (month)	Excellent-good outcome
1	≤ 2 (n:20)	18 (90%)
2	> 2 (n:6)	2 (33%)

 $P=0.019$ Fisher's exact test

RESULTS

Clinical and radiological findings

Table 1 shows the demographic data of this retrospective study. Mean age was 44.8 years (range 23-61 years) and male were outnumbered female (20:6). Length of follow up ranged from 7 months to 87 months (mean, 43.0 months). The most frequently involved level was C5-6 level and four patients exhibited more than 2 levels of involvement. Gait disturbance, spasticity and pain and discomfort were the most commonly complained symptoms and signs (Table 2). On the basis of the MR finding, the authors verified signal

**Fig. 1.** Preoperative magnetic resonance images of a 35-year-old man presenting with radiculopathy and partial Brown-Sequard syndrome. A : Sagittal T2-weighted image shows herniated disc at C5-6. B : Axial T2-weighted image shows cervical cord compression by huge ruptured paracentral disc.

change within the cord in 8 cases. Median disc herniation was seen in 16 cases.

Clinical outcome

According to the Herkowitz's scale (Table 1), excellent results were shown in 6 patients, good results in 13 patients, and fair results in 4 patients (excellent-good-fair in 88%). Table 3 represents change in Nurick's grade between pre- and post-op period. History of trauma did not significantly correlate with improvement of outcome ($p=1.000$, Fisher's exact test). Group 1 was excellent-good outcome cases (according to the Herkowitz's scale) among patients of trauma history (7/10) and group 2 is excellent-good outcome cases (according to the Herkowitz's scale) among patients without such history (13/16). There was a significant correlation between pre-operative Nurick's grade and Herkowitz's outcome (Table 4). Pre-operative good group (Nurick's grade 0-2) had better outcome than bad group (Nurick's grade 4-5). There was a significant correlation between symptom duration and outcome ($p=0.019$, Fisher's exact test) (Table 5). Group 1 (≤ 2 months) represents better outcome than group 2 (> 2 months).

Representative case

Case 1

A 35-year-old man suffered from radiculopathy of the upper limb for 2 weeks. Neurological examination showed partial Brown-Sequard syndrome that presenting as contralateral analgesia of pain and temperature, and ipsilateral motor paralysis (Grade 4). His condition was compatible with Nurick's grade 2. MR images (Fig. 1) showed paracentral ruptured disc at C5-6 level and anterior cervical discectomy and fusion with cage and autogenous bone was performed. He showed an improvement of myelopathic symptoms upto Nurick's grade one at 1 month postoperatively.

DISCUSSION

Soft cervical disc herniation accounts for 64 to 89% of ruptured cervical disc⁶. It exhibits a distinct predilection for males in the fourth decade of life^{2,8,15} and C5-6 and C6-7 level are the most frequently involved sites^{11,23}. However, herniation on multiple level is quite infrequently^{11,15}.

Myelopathy is a term implying something is wrong within the spinal cord itself. From the pathogenic point of view, it is different from the radiculopathy that is caused by isolated points of pressure on the individual nerve roots.

Cervical myelopathy can be caused by numerous diseases such as cervical spondylosis, soft cervical disc herniation, ossification of posterior longitudinal ligament (OPLL), tumor, infection (spondylitis), and bony architectural abnormalities (fracture, dislocation)^{10,20}. Among them, cervical spondylosis is the most common cause of myelopathy in patients of more than 55 years of age⁷. Cervical spondylotic myelopathy (CSM) develops in almost all patients with more than 30% narrowing of the cross-sectional area of the cervical spinal canal, while some patients with severe cord compression do not have myelopathy⁶⁻⁸. It is not yet known what percentage of soft cervical disc herniation is responsible for the cervical myelopathy. According to the present study, soft cervical disc herniation accounts for approximately 23% of cause for cervical myelopathy. Lateral or posterior disc herniations are common causes of radiculopathy, whereas midline disc herniations sometimes lead to myelopathy^{11,21}. Mostly, to produce a myelopathy, disc herniations have to be associated with a congenitally narrow canal or ligament hypertrophy which renders further compromise the spinal canal posteriorly^{12,21}. Far lateral herniated discs are rare, probably due to buttressing effect by the uncinat process.

Crandall et al.⁸ grouped the patients into 5 categories according to the predominant spinal cord syndrome. The *transverse lesion syndrome* apply to condition with neurological evidence of involvement of corticospinal and spinothalamic tracts, and involvement of posterior column in almost equal severity below the cervical level. The *motor system syndrome* apply to condition in which deficit is primarily of corticospinal tracts or anterior horn cells. In *central cord syndrome*, patients show motor and sensory deficit affecting the upper limbs more severely than the lower. The *Brown-Sequard syndrome* applied to condition where clinical picture is that of a unilateral cord lesion with ipsilateral corticospinal deficit and a contralateral analgesia below the level of the lesion. The *brachialgia and cord syndrome* denotes a predominating picture of upper limb pain and some associated long tract involvement, either motor, sensory or both. The transverse cord syndrome is the most frequent

Table 6. Comparison of surgical outcome of patients with cervical discogenic myelopathy and those with CSM

Series	Total	Better (%)	Unchanged (%)	Worse (%)
Boni, et al ³	29	51	47	2
Lunsford, et al ²²	37	50		50
Seifert & Stolke ²⁸	22	77	23	0
Saunders, et al ²⁷	40	57.5 (cure)		15
Chiles, et al ⁵	76	80	14	7
Present	26	88	8	4

This table illustrates the difference of surgical outcome between soft cervical disc herniation (as in present literature) and CSM (above cited literatures). All the patients in the above series had been undertaken the same surgical approach (anterior cervical discectomy and fusion)

and possibly represents an end-stage of the disease⁸.

Clinical manifestations of myelopathy are manifold, such as gait disturbance, spasticity, hand numbness, chest and abdominal discomfort, position and sensory disturbances, central cord syndrome, sphincter dysfunction, muscle atrophy, and so forth^{6,8,13,17,18,30}. The common neurologic findings of cervical myelopathy in the current study are listed on Table 2. It is reported that most prominently improved symptoms postoperatively are spasticity and pain⁸.

MR imaging is the most sensitive method for detection of nerve root or spinal cord compression by the herniated disc^{9,12}. Moreover, a compressed spinal cord may show areas of increased signal intensity on MR T2-weighted images, representing either edema or petechial hemorrhages that have not coalesced into a visually resolvable clot in the acute stage, and myelomalacia or gliosis in the chronic stage^{9,12,15,18,26,29}.

The authors compared surgical outcome of CSM in other literature with that of discogenic myelopathy, performed the same approach (Table 6). Surgical outcome of cervical discogenic myelopathy was better than that of spondylotic myelopathy^{3,5,22,27,28}. Spondylotic myelopathy has progressed to elicit slow degeneration, thus, direct compression of spinal cord for longer time can bring out higher rate of irreversible injury. Moreover, sudden interruption in the competent blood supply produced severe ischemia of the spinal cord due to ruptured soft disc and acute edematous cord. Because of the above mentioned reasons, discogenic myelopathy can be detected earlier. Ferguson and Kaplan¹⁴ recognized a group of acute presenting symptomatology and suggested them as vascular etiology. Criteria for inclusion in their study were the acute nature of the event, absence of obstruction on myelography, lack of pain, and failure to respond to surgery¹⁴. Vascular etiology predisposed an interruption in the competent supply of blood, via radicular spinal arteries to the anterior spinal arteries, and finally to the spinal cord. It has been proposed that compression by disc material to one of these radicular spinal arteries at some point of its course or in the anterior spinal axis itself can produce ischemia of

the spinal cord with zones of softening and necrosis, peculiar to the cervical myelopathy²⁶⁾. Angiography of the vertebral artery shows decreased filling of the radiculospinal arteries in cases of cervical myelopathy compared with controls²⁶⁾. The spinal cord is most subject to compression in the lower cervical region and thus, represents region of the greatest vascular vulnerability on an anatomic basis²⁵⁾.

Bucciero et al.⁴⁾ compared the recovery rate of myelopathy with that of radiculopathy after operation. Complete or most complete relief of preoperative symptomatology was observed in 95.6% of patients with radiculopathy and in 83.3% of those with myelopathy. In this study, successful relief of preoperative myelopathy was observed in 88% of patients with myelopathy.

Until recently, surgical methods for treating soft cervical disc herniation include posterolateral foraminotomy and anterior discectomy^{4,6,11,29)}. The posterolateral foraminotomy may be utilized in patients with radiculopathy due to lateral disc herniation, whereas the anterior discectomy is indicated for all types of disc herniation.

CONCLUSION

In this report, conventional anterior cervical discectomy and fusion yield 88% of favorable result to the patients with myelopathy from soft cervical disc herniation. Outcome of myelopathic symptoms was closely related to the short duration of clinical manifestation (≤ 2 months), severity of neurologic deficits (preoperative Nurick's grade). In the literature, surgical outcome of cervical discogenic myelopathy is better than that of cervical spondylotic myelopathy. Therefore, surgeon should strongly consider operation on soft cervical disc herniation presenting as myelopathy if the patients have short duration and good preoperative Nurick's grade.

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