Cervical myelopathy in elderly patients: clinical results and MRI findings before and after decompression surgery

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We examined 173 patients with cervical myelopathy of various causes. Seventy-seven patients underwent anterior decompression and fusion at not more than two levels, while 96 underwent posterior decompression by an expansive laminoplasty. Patients were followed up for between one and $4\frac{1}{2}$ years and the outcome was assessed both from a functional and a radiological point of view. The functional assessment used was according to the Japanese Orthopaedic Association (JOA) score (the higher the better), and the imaging outcome was assessed by a midline sagittal MRI assigned to three categories either for restoration of cord morphology, improvement or unchanged. Patients were divided into two groups: those 65 years old and older (50 patients), and those younger than 65 years old (123 patients). The data allowed the following conclusions to be reached: Older patients were likely to have more levels, and higher levels affected and as a result were more likely to require a posterior operation. The recovery rate after an anterior operation was the same as that after a posterior operation. The pre- and post-operative JOA scores were higher in younger patients who tended to have milder disease with fewer levels affected. Younger patients had better morphological restoration. The recovery was likely to be better if the postoperative morphology was better. The morphology postoperatively was likely to be better if there had been less compression preoperatively. If the morphology was restored the disease duration was likely to have been less. The patients did better if the cord morphology was restored to normal, and this was easier to achieve in younger patients who had fewer levels involved and had less cord distortion preoperatively.

Keywords: cervical myelopathy; magnetic resonance imaging; elderly patients; decompression surgery

Introduction

Recently, the proportion of those who are of old age in the general population in Japan is rapidly increasing and is expected to reach about 25% by the year 2020. This aging of the population is becoming an important social problem. With respect to cervical myelopathy, elderly patients have many problems with many various complications and their condition is often severe.^{1–4} We should therefore try to prevent myelopathy becoming severe in such patients. Here we report our investigation into the surgical results for cervical myelopathy in elderly patients according to their age, in order to improve their management of severe cervical myelopathy. These detailed retrospective studies will allow a more accurate operative indication and also improve preventative measures. We have examined both the morphological changes that

occurred in the cervical spinal cord on MRI and the clinical results before and after decompression surgery in the old-aged patients with cervical myelopathy.

Patients and methods

We have investigated the correlation between the preoperative and postoperative MRI and the operative results in 173 patients with cervical myelopathy who underwent decompression surgery since 1986. Anterior decompression with interbody fusion was performed for 77 patients whose condition was limited to only one or two levels. Posterior surgery was performed for 96 patients who had either a narrow spinal canal or three more levels of focus. The method of posterior surgery was expansive laminoplasty using sagittal splitting of the spinous processes.

For analysis, the patients were divided into two groups by age with those 65 years old and older in the Old Group, and those less than 65 years old in the Young Group. The Old Group consisted of 50 patients and the Young Group of 123 patients. The average age was 72.3 ± 5.2 years old (range 65–85 years) in the

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Table 1 JOA score: Severity of the cervical myelopathy was assessed by the Japanese Orthopaedic Association (JOA) score (range: 0–17 point)

<i>Motor dysfunction of the upper extremity</i>
Score
0=Unable to feed oneself
1=Unable to handle chopsticks, able to eat with a spoon
2=Handle chopsticks with slight difficulty
3=None
<i>Motor dysfunction of the lower extremity</i>
Score
0=Unable to walk
1=Walk on flat floor with walking aid
2=Up and/or down stairs with hand rail
3=None
<i>Sensory deficit</i>
A. The upper extremity
Score
0=Severe sensory loss or pain
1=Mild sensory loss
2=None
B. The lower extremity; same as A
C. The trunk; same as A
<i>Sphincter dysfunction</i>
Score
0=Unable to void
1=Marked difficulty in micturition (retention, strangury)
2=Difficulty in micturition (pollakisuria, hesitation)
3=None

$$\text{Recovery rate} = \frac{\text{postop.score} - \text{preop.score}}{17 - \text{preop.score}} \times 100\%$$

Five degrees evaluations were determined by recovery rate; Excellent; more than 75%, Good; < 75%, ≤ 50%, Fair; < 50%, ≤ 25%, Poor; 25% >, ≥ 1%, Worse; 0% ≥

Old Group, and 52.7 ± 7.7 years old (range 32–64 years) in the Young Group. The clinical results were evaluated according to the Japanese Orthopaedic Association (JOA) score (range: 0–17 points as described in Table 1) after a mean follow-up period of 1.5 years (follow-up period ranged from 1 to 4.5 years). The recovery rate was calculated by their pre- and postoperative JOA score as shown in Table 1. The morphological changes in the spinal cord after the operation were examined by midline sagittal T1-weighted MRI and classified into three groups: as full restoration, improvement, or unchanged; according to the degree of recovery in the cord deformity (Figure 1). The statistical analysis was done using the computer soft of STAX.

Results (Table 2)

X-P findings:

In the Old Group, the most frequent underlying causative condition was cervical spondylosis (70%), followed by ossification in the posterior longitudinal ligament(OPLL) (22%), and disc herniation (8%). While in the Young Group, three conditions were equally most frequent (disc herniation; 37%, spondylosis; 32%, OPLL, 31%). The A-P diameter of the vertebral foramen at C5 was 11.7 ± 1.3 mm in the Old Group and 12.3 ± 1.5 mm in the Young Group ($P < 0.01$).

Clinical results

The pre- and post-operative JOA scores of the Young Group were significantly higher than in the Old Group

Post-Op. MRI EVALUATION

Figure 1 Postoperative MRI evaluation. The morphological changes in the spinal cord after the operation were evaluated by midline sagittal T1-weighted MRI and classified into three groups as being full restoration, improvement, or unchanged; according to the degree of recovery in the cord deformity. A: before op. B: after op

Table 2 The two groups compared by age

Factors	Young	Old	Total	P value
Condition				< 0.01
spondylosis	39 (32%)	35 (70%)	74	
d.herniation	46 (37%)	4 (8%)	50	
OPLL	38 (31%)	11 (22%)	49	
Disease duration (month)	24 ± 35	57 ± 65	34 ± 48	< 0.01
A-P diameter of vertebral foramen at C5 (mm)	12.4 ± 1.5	11.7 ± 1.3	12.1 ± 1.5	< 0.01
op. method				< 0.01
ant. surg.	71 (58%)	6 (12%)	77	
post. surg.	52 (42%)	44 (88%)	96	
JOA score (point)				< 0.01
preoperation	9.5 ± 3.0	7.3 ± 2.6	8.8 ± 3.0	
postoperation	14.0 ± 2.4	12.3 ± 1.9	13.5 ± 2.4	
Disease severity				< 0.01
less than 5 points (pt.)	11 (9%)	13 (26%)	24	
more than 6 points (pt.)	112 (91%)	37 (74%)	149	
Recovery rate	62 ± 26%	52 ± 18%	59 ± 24%	< 0.01
Five degrees evaluation				< 0.05
excellent	44 (36%)	7 (14%)	51	
good	44 (36%)	21 (42%)	65	
fair	28 (23%)	21 (42%)	49	
poor	4 (3%)	1 (2%)	5	
worse	3 (2%)	0	1	
Preoperative MRI				< 0.01
Class 1	12 (10%)	0	12	
Class 2	38 (31%)	7 (14%)	45	
Class 3	73 (59%)	43 (86%)	116	
Postoperative MRI findings				< 0.01
restoration	64 (52%)	10 (20%)	74	
improvement	46 (37%)	35 (70%)	81	
unchanged	13 (11%)	5 (10%)	18	

($P < 0.01$). There were 13 severe disabled patients (26%) in the Old Group who could not walk, or who had a JOA score of less than 5 points, and only 11 such patients (9%) in the Young Group ($P < 0.01$). As an example, a 75 year-old man in the Old Group had severe heart failure and a JOA score of only 2 points. He died at 2 months after posterior surgery. Such a patient has many operation risk factors. He could not move his upper or lower extremities and was bedridden before the operation. However, after the operation he could feed himself, and was satisfied with the operative result. He was not evaluated in this study, because follow-up was for less than 1 year. The overall mean recovery rate by JOA score was $59 \pm 24\%$. The mean recovery rate in the Old Group was $52 \pm 18\%$, and in the Young Group was $62 \pm 26\%$ ($P < 0.01$). The subjective clinical evaluation was excellent in 36%, good in 36%, fair in 23%, poor in 3%, and worse in only 2% in the Young Group. While in the Old Group, it was excellent in only 14%, good in 42%, fair in 42%, poor in 2%, and worse in none. In the Old Group, there were less excellent than in the Young Group ($P < 0.05$). However, the clinical result in the Old Group was excellent or good in 56%, and some recovery was seen in a total of 98%. There was no

significant difference in these recovery rates between anterior surgery ($61 \pm 27\%$) and posterior surgery ($58 \pm 22\%$).

Preoperative MRI findings

The preoperative MRIs were also classified into four groups according to the degree of the compressed deformity in the cervical cord.⁵ Class 0: no compression, Class 1: cord compressed slightly, Class 2: cord width decreased by less than one third, Class 3: cord width decreased at least one third. Eighty-six percent were in class 3 in the Old Group, while 59% were in class 3 in the Young Group. The preoperative MRIs of the Old Group showed significantly more severe compression deformities than did those of the Young Group. The average number of intervertebral levels involved in the spinal cord anterior compression was 2.8 ± 1.0 in the Old Group, according to the T1 weighted MRI, and was 2.2 ± 0.9 in the Young Group ($P < 0.01$). Spinal cord posterior compression was seen in 39 patients (78%) in the Old Group and in 42 patients (34%) in the Young Group ($P < 0.01$). The most frequently involved levels were C4/5 and C5/6 in the Young Group, and C3/4, C4/5 and C5/6 in the Old Group. The C3/4 or C4/5 levels were more frequent in

the Old Group (C3/4; $P<0.01$, C4/5; $P<0.05$) than in the Young Group (Table 3). Therefore, those in the Old Group were more likely to undergo posterior surgery than those in the Young Group ($P<0.01$).

Table 3 Correlation between age and the level of cord compression on MRI

Level		Cord compression		
		(+)	(-)	
C2/3	young	2 (2%)	121	$P<0.01$
	old	5 (10%)	45	
C3/4	young	52 (42%)	71	
	old	40 (80%)	10	
C4/5	young	85 (69%)	38	$P<0.05$
	old	43 (86%)	7	
C5/6	young	99 (81%)	24	
	old	42 (84%)	8	
C6/7	young	39 (32%)	84	
	old	14 (28%)	36	

Postoperative MRI findings and clinical results

On the postoperative midline T1 weighted sagittal MRI in the Young Group, morphological full restoration was seen in 64 patients (52%), improvement in 46 patients (37%), and unchanged in 13 patients (11%). While in the Old Group, restoration was seen in only 10 patients (20%), improvement in 35 (70%), and unchanged in 5 (10%), with significantly more full restoration in the Young Group than in the Old Group ($P<0.01$). Comparing pre- and postoperative MRI findings, full restoration was seen in the majority of those (92%) in class 1, in 60% of those in class 2, and in only 32% of those in class 3. The restoration was significantly correlated with preoperative cord compression ($P<0.01$). The mean recovery rate calculated by JOA score was $68\pm24\%$ in the restoration group. This was significantly higher than $54\pm21\%$ in the improvement group, or $40\pm22\%$ in the unchanged group ($P<0.05$). We next investigated to see if there was any correlation between the disease duration and

80-year-old male

spondylosis

disease duration : 4 months.

before op.

6 months.

JOA score 7→15

recovery rate: 75%

Figure 2 80-year-old male. MRI findings at 6 months after operation showed full restoration. His disease duration was only 4 months. JOA score was 15 points after operation. Recovery rate was 75%

77-year-old male

OPLL

disease duration : 10 years.

before op.

6 months.

JOA score 5→9

recovery rate: 29%

Figure 3 77-year-old male. MRI findings at 6 months after operation showed that the spinal cord was not restored because of a longer disease duration of 10 years. JOA score was 9 points after operation. Recovery rate was only 29%

the postoperative MRI. The disease duration had been 16 ± 23 months in the restoration group, 44 ± 57 months in the improvement group, and 60 ± 54 months in the unchanged group. The duration had been significantly shorter for the restoration group than for the other two groups ($P < 0.01$) (Figures 2 and 3). The average disease duration was 24 ± 35 months for the Young Group, and 57 ± 68 months for the Old Group ($P < 0.01$).

Discussion

Lees⁶ reported the natural history of 44 patients with more than 10 years' follow-up. He described cervical spondylosis with myelopathy as a condition in which there are long periods without new or worsening symptoms. Exacerbations can occur at long or shorter intervals over many years. From the reports on the natural course of cervical myelopathy in Japan, improvement occurred in 23%, no change in 27%,

and deterioration in 50% after 5 years' follow-up of 30 patients by Kawai.⁷ Takada⁸ reported that improvement occurred in 28%, no change in 24%, and deterioration occurred in 48% of 29 patients after an average of 5.7 years' follow-up. Tuchiya⁹ reported that 25 patients (56%) were no change or deterioration after 3.5 years follow-up, and that those who had severe paralysis at onset were those who progressed, while the patients with slight paralysis at onset were those who later recovered. Over all reports,⁷⁻¹⁰ there was improvement in 35% (22–45%), no change in 35% (24–44%), and deterioration in 30% (22–48%). Japanese cervical myelopathy has tended to progress more frequently to become severe than in other countries. Because, developmental spinal canal stenosis is seen more frequently in oriental people.

On the characteristics of cervical myelopathy in the elderly, Machida³ reported that a rapid progression of symptoms was seen in old-aged patients who had instability at relatively high cervical spine levels

as well as at C3/4 and C4/5. He described dynamic factors affecting the normal natural course which were strongly correlated with the disease severity. From our observations of involved levels, the C3/4 or C4/5 levels were more frequently involved in old-aged patients than in younger patients (Table 3). Yamamoto¹¹ of our hospital studied the histometric quantitative analysis of the neurons and the arteries in 40 spinal cords, with aging. He reported that γ -motoneurons decreased, but α -motoneurons remained intact at the cervical level with aging. And, in the spinal cord, atherosclerosis of arteries scarcely occurred with aging. Kawamura¹² and others have reported that both α -motoneuron and γ -motoneuron have decreased in number at the lumbar level with aging. These reports suggest that the upper extremity function in old-aged people was kept intact more so than the lower extremity function, and that blood supply was better in the cervical spinal cord than in the brain. Therefore, operative recovery could also be expected in old-aged patients after compression myelopathy. Our results confirmed this expectation. Also our results are useful to decide on the surgical treatment between anterior and posterior decompressions. Surgical intervention should be recommended for old-aged patients with severe myelopathy. From our studies, the clinical symptoms evaluated by the JOA score was severer in the old-aged patients than those in the young-aged patients. We considered that the disease severity in the old-aged patients was caused by the longer disease duration, the higher affected intervertebral levels, a larger number of affected levels, and severer spinal cord compression. Developmental spinal canal stenosis was seen more frequently in old-aged patients than in young-aged patients. The young-aged patients most frequently presented disc herniation. Since development of MRI, the diagnosis of compression myelopathy has been accurate and many authors^{5,13,14} have reported that the disease severity was correlated with the degree of spinal cord deformity on MRI findings. The clinical results were quite sufficient for those whose cord deformity was restored, according to postoperative MRI.^{5,13,14} The frequency of achieving restoration in the cord was higher for a short disease duration and slight MRI cord compression. When we began treatment for old-aged patients with myelopathy, the disease severity and their general health complications were the leading problems for the management of the disease. However, other problems in old-aged patients must also be discussed. Old-aged patients have many various complications. In our recent studies, 91% of 67 old-aged patients had complications, with a recovery rate of 43%, compared to a recovery rate of 72% for old-aged patients with no complication. When old-aged patients have severe myelopathy and are unable to walk, they have great anxiety over their prognosis especially over becoming bedridden and over the operative results.

However, the techniques for anesthesia and post-operative intensive care unit have become highly developed. Now, an operation on an old-aged patient with complications can be performed relatively safely. Long-term bed rest should be avoided to prevent new complications such as senile psychoses. When we undergo expansive laminoplasty using sagittal splitting of the spinous process, the patients can sit up in bed wearing a cervical orthosis at 3 days after the operation, and they can walk at 1 week after the operation. Early moving from the bed and early rehabilitation are most important in old-aged patients. Therefore, we should choose stable operative methods that can best assure these outcomes.

The 75-year-old patient described earlier begged us for help so that he did not remain bedridden till death. His words are the hope of all elderly patients. We cannot neglect such patients and need improved management for them. We should therefore try to prevent myelopathy becoming severe in the elderly by performing decompression surgery as soon as possible after the onset of progressive myelopathy. In Japan, chest x-ray examination, routine blood test, liver function test, ECG, and urine test are regulated at 35-year-old and more than 40-year-old by law, while, neurological examinations are not. Neurological screening could help to identify patients earlier, and appropriate timely treatment could be given to prevent trauma, and progression to severe myelopathy. Prevention of the progression of this disease may now be possible. This fact must become more widely recognized.

Conclusions

From comparing the differences in the pre- and post-operative MRI findings and clinical results between the two groups one of old aged patients 65 years old and older and the other of the younger patients, we concluded that pre- and post-operative disease in elderly patients was significantly severer than in young-aged patients. The spinal cord compression in the elderly on MRI was severer than was seen in the young-aged patients. And, the affected levels of the spinal cord in the old-aged patients were higher and more in number than in the young-aged patients. From our follow-up studies, the frequency of achieving cord restoration, on MRI, in the elderly was significantly lower than that in young patients. The most significant factor affecting the clinical results was the disease duration prior to the operation, as well as the required degree of operative cord compression.

We conclude that it is most important to discover patients with only slight symptoms at the early stages of the disease, it is also important to prevent the disease progression using adequate management. Accordingly, decompression surgery is necessary as soon as possible after the onset of progressive myelopathy in the elderly.

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