Original Article

Outcome of late surgical treatment in patients with incomplete paraplegia due to spinal degenerative diseases

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Study design: Retrospective analysis.

Objective: To assess the outcome of late surgical intervention in patients with incomplete paraplegia due to spinal degenerative diseases.

Setting: Three men and four women with cervical or thoracic spinal degenerative diseases, who preoperatively were unable to walk for more than 6 months in Mie prefecture, Japan.

Methods: Review of clinical records and questionnaire survey regarding the walking ability of patients 2 years after surgery.

Results: All seven patients were unable to walk postoperatively.

Conclusion: A late surgical intervention may not lead to functional recovery in patients with spinal degenerative disease who were unable to walk for at least 6 months.

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Keywords: paraplegia; spinal degenerative diseases; surgery; gait

Introduction

If the spinal cord is compressed for a long time, it suffers irreversible changes, and even after surgery, the possibility of a neurological recovery is reduced.¹ Therefore, patients who become paraplegic due to spinal diseases should undergo decompression of the spinal cord as soon as possible. However, very few studies^{2,3} have investigated whether patients who are operated on late after becoming paraplegic can walk again. Therefore, we retrospectively investigated whether patients with cervical or thoracic spinal degenerative diseases, who had undergone surgery after at least 6 months of incomplete paraplegia, were able to walk after surgery.

Materials and methods

We reviewed the clinical records of three men and four women with cervical or thoracic spinal degenerative diseases, who had undergone surgery in our clinic, from July 1993 to September 2001, because they had been unable to walk for more than 6 months. Their age at the time of surgery ranged from 53 to 78 years (mean, 69.7 years). The diagnosis was cervical spondylotic myelopathy in five patients, ossification of the posterior longitudinal ligament (OPLL) in the cervical spine in one and thoracic spinal canal stenosis in the remaining

patient. The duration of the disease from the onset of neurological symptoms to surgery ranged from 10 months to 6 years (mean, 3 years 1 month) and the duration of incomplete paraplegia ranged from 6 months to 2 years (mean, 11.0 months). The postoperative follow-up period ranged from 2 to 9 years (mean, 3.5 years).

Six patients reported they had not been operated on soon after the onset of symptoms because although surgery had been recommended by an orthopaedic surgeon, the patient himself/herself and his/her family members had rejected it. The remaining patient reported that they had not consulted an orthopaedic surgeon, so surgery had not been recommended. When these patients visited our clinic, they gave their informed consent regarding surgery.

As for the patients' preoperative ability to perform activities of daily living (ADL), all the patients were able to adopt a sitting position, unable to stand up, and needed complete help to be transferred to a wheelchair. Muscle strength of both lower extremities at the time they were not able to walk was around Grade 3 (strength greater than gravity) in all the patients as demonstrated by a manual muscle test (Table 1), but it had decreased to Grade 2 (strength less than gravity) immediately before surgery in all the patients. All these patients also experienced vesico-rectal disturbances, such as pollakisuria, dysuria or constipation, but did not have any other serious organic disease. None of the

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Table 1 Grading system by manual muscle test

Grade	Muscle action
Grade 0 (zero)	Total paralysis
Grade 1 (trace)	Visual or palpable contraction
Grade 2 (poor)	Active movement, gravity eliminated
Grade 3 (fair)	Active movement against gravity
Grade 4 (good)	Active movement against resistance
Grade 5 (normal)	Active movement against full resistance

Table 2 Evaluation of severity of myelopathy using JOA scoring system

- (1) Upper extremity function
 - (0) Cannot eat with chopsticks or spoon
 - (1) Can eat with spoon, but not with chopsticks
 - (2) Can eat with chopsticks, but inadequately
 - (3) Can eat with chopsticks, but awkwardly
 - (4) Normal
- (2) Lowest extremity function
 - (0) Cannot walk
 - (1) Needs cane or aid on flat ground
 - (2) Needs cane or aid on stairs
 - (3) Can walk without cane or aid, but slowly
 - (4) Normal
- (3) Sensory disturbance
 - (A) Upper extremity
 - (0) Apparent sensory loss
 - (1) Minimal sensory loss
 - (2) Normal
 - (B) Lower extremity
 - (0) Apparent sensory loss
 - (1) Minimal sensory loss
 - (2) Normal
 - (C) Trunk
 - (0) Apparent sensory loss
 - (1) Minimal sensory loss
 - (2) Normal
- (4) Bladder function
 - (0) Complete retention
 - (1) Severe disturbance
 - (2) Mild disturbance
 - (3) Normal

patients had dementia or any other mental disease, not even depression. One spinal surgeon operated on all seven patients; he performed cervical laminoplasty for cervical spondylotic myelopathy, and posterior decompression and fusion for thoracic spinal canal stenosis. Postoperative magnetic resonance imaging (MRI) findings revealed that satisfactory decompression of the spinal cord had been achieved in the seven patients. Muscle strength training was started the day of surgery or on the next day. Training in the rehabilitation room was started 1 week after surgery.

We investigated the number of patients who were able to walk 2 years after surgery, the severity of myelopathy

and preoperative intramedullary signal intensity changes on MRI.

The severity of myelopathy in patients with cervical spondylotic myelopathy and cervical ossification of the posterior longitudinal ligament was evaluated using the JOA scoring system (Table 2) for cervical disease (maximum 17 points) to assess upper limb function, lower limb function, sensory disturbance and bladder function. The severity of myelopathy in a patient with thoracic spinal canal stenosis was evaluated using the JOA scoring system () for cervical disease (maximum 11 points), excluding evaluation of upper limb function. Postoperative recovery rate was determined 1 year after surgery according to the formula described by Hirabayashi *et al* as follows: Recovery rate = (postoperative JOA score – preoperative JOA score) × 100/(full score – preoperative JOA score). For this evaluation, two observers (coauthors) other than the surgeon evaluated pre- and postoperative JOA scores, and the mean value was then calculated to determine the improvement rate. The rate of consistency of the improvement rate achieved by two observers was 92.8%, and interjudge reliability was very good.

Preoperative intramedullary signal intensity changes on MRI were divided into three patterns: no intramedullary signal changes, signal changes only on T2-weighted images and signal changes on both T1- and T2-weighted images. For this evaluation, two independent radiologists evaluated preoperative intramedullary signal intensity changes, and the rate of consistency of the improvement rate achieved by these two observers was 100%, and interjudge reliability was excellent.

Results

None of the seven patients was able to walk after surgery; all data are summarized in Table 3. Motor paralysis and vesico-rectal disturbance scarcely improved in any of the seven patients. In two (Cases 1 and 5) patients, some degree of sensory improvement was observed, and one patient (Case 2) experienced increased spasticity and recurring pain of the lower extremities.

The preoperative JOA score was 4.7 ± 2.4 (mean $\pm$ SD, range 2–8), the postoperative JOA score was 5.0 ± 2.3 (range 2–8) and the postoperative improvement rate was 3.0 ± 3.7 % (range 0–8.3).

Regarding preoperative intramedullary signal intensity changes on MRI, there were two patients with no intramedullary signal changes, one patient with signal changes only on T2-weighted images and four patients with signal changes on both T1- and T2-weighted images.

Discussion

Recently, there have been lots of clinical studies on patients with cervical or thoracic myelopathy. However, no study has reported that patients with spinal degenerative disease resulting in complete or incomplete

Table 3 Summarized data

Case	Age at operation (years)	Diagnosis	Duration of disease	Period of gait impossibility	Possibility to walk after surgery	Preop JOA score	Postop JOA score	Recovery rate	Preoperative intramedullary signal intensity changes
1	77	Cervical spondylotic myelopathy	27	8	No	5	6	8.3	Signal changes on both T1- and T2-weighted images
2	63	Cervical spondylotic myelopathy	72	14	No	6	6	0	No intramedullary signal changes
3	53	Cervical spondylotic myelopathy	15	6	No	3	3	0	Signal changes on both T1- and T2-weighted images
4	70	Cervical spondylotic myelopathy	54	7	No	8	8	0	Signal changes on both T1- and T2-weighted images
5	78	Cervical spondylotic myelopathy	60	24	No	2	3	6.7	Signal changes on both T1- and T2-weighted images
6	74	Cervical OPLL	21	11	No	7	7	0	Signal changes only on T2-weighted images
7	73	Thoracic spinal canal stenosis	10	7	No	2*	2*	0	No intramedullary signal changes

*Maximum 11 points excluding evaluation of upper limb function

paraplegia for a long period of time were able to walk again after surgery.

It was reported that conservative treatment for mild or moderate cervical spinal myelopathy was effective,^{4,5} and Sampath *et al*⁶ reported that surgically treated patients appeared to have better outcomes, when conservative and surgical treatments were compared in a prospective, multicentre and nonrandomized investigation. Regarding surgical treatment, both multilevel anterior decompression by corpectomy and posterior decompression by laminoplasty have led to significant neurologic recovery and pain reduction in the majority of patients.^{7,8} Anterior decompression and fusion have been used to treat patients with one-level lesion without spinal canal stenosis, and laminoplasty has been used for patients with more than two-level fusions or spinal canal stenosis; whereas surgical treatments following both the anterior and posterior approaches have been used for patients with severe cervical kyphosis. In the present study, all seven patients had severe myelopathy and multilevel lesion without severe cervical kyphosis; therefore, laminoplasty or posterior decompression and fusion was selected for all seven patients.

Recently, attempts have been made to predict postoperative results in patients with cervical spondylotic myelopathy on the basis of the patient's background factors and MRI findings.⁹⁻¹² The following factors have been reported to influence postoperative results: duration of the disease, severity of myelopathy, intramedullary signal intensity changes on MRI and cross-sectional area of the spinal cord.

In case of spinal degenerative disease, which is of a long evolution, the spinal cord is compressed for a long time, blood circulation within the spinal cord is chronically disturbed and myelopathy progresses gradually. Some studies^{13,14} have reported that in patients with a spinal degenerative disease, the shorter the duration of the disease is, the more likely the postoperative results are to be excellent. However, the duration of disease is estimated based on information obtained from the patients, and therefore it is often uncertain.

In the present study, the JOA score of every patient was 8 or less than 8, and it was considered that all patients had severe myelopathy. Tanaka *et al*¹⁰ showed that the severity of myelopathy, as assessed using the JOA scoring system, influenced the outcome of the operation; on the other hand, Yamazaki *et al*¹² reported that the JOA score was not a reliable predictor, and this controversy still remains.

Regarding intramedullary signal intensity changes, Suri *et al*¹⁵ showed that the presence of intramedullary signal changes on T1- as well as T2-weighted sequences on MRI in patients with cervical spondylotic myelopathy indicated a poor prognosis. Morio *et al*¹⁶ reported that low-signal intensity changes on T1-weighted sequences indicated a poor prognosis. They speculated that high-signal intensity changes on T2-weighted images indicated a broad spectrum of compressive myelomalacic pathologies and reflected a broad spectrum of spinal cord recuperative potentials. In the

present study, there were only four of seven patients with signal changes on both T1- and T2-weighted images; therefore, it was considered that intramedullary signal intensity changes were not a reliable predictor.

Regarding the cross-sectional area of the spinal cord, computer analysis is needed to measure it, and this is time consuming. Yamazaki *et al*¹² reported that the cross-sectional area was the only predictor of excellent recovery in young patients, but it was not a good predictor in older patients.

From this study, we concluded that a late surgical intervention might not result in functional recovery in patients with a spinal degenerative disease and unable to walk for at least 6 months. Moreover, being unable to walk for 6 months or longer is a predictor of a poor surgical outcome. Surgical intervention must be performed as early as possible before changes in the spinal cord become irreversible.

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