Clinical Analysis of Spinal Cord Injury With or Without Cervical Ossification of the Posterior Longitudinal Ligament, Spondylosis, and Canal Stenosis in Elderly Head Injury Patients

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Abstract

Patients with degenerative diseases of the cervical spine, such as ossification of the posterior longitudinal ligament, spondylosis, and canal stenosis, sometimes present with acute spinal cord injury caused by minor trauma. However, the relative risk of cervical cord injury with these diseases is unknown. The clinical and radiological features of 94 elderly patients with head injury, 57 men and 37 women aged from 65 to 98 years (mean 76.6 years), were retrospectively analyzed to assess the association of spinal cord injury with degenerative cervical diseases. Degenerative cervical diseases were present in 25 patients, and spinal cord injury was more common in the patients with degenerative diseases (11/25 patients) than in the patients without such diseases (3/69 patients; relative risk = 10.2). The incidence of degenerative cervical diseases seems to be increasing in Japan because life expectancy has increased and the elderly are a rapidly growing part of the population. A fall while walking or cycling is a common mechanism of head injury and/or cervical cord injury in the elderly. To decrease the occurrence of cervical myelopathy, prevention by increasing social awareness and avoiding traffic accidents and falls is important.

Key words: head injury, spinal cord injury, ossification of the posterior longitudinal ligament, spondylosis, canal stenosis

Introduction

Ossification of the posterior longitudinal ligament (OPLL), spondylosis, and canal stenosis are common degenerative diseases of the cervical spine, particularly in the elderly. Severe myelopathy can be induced by minor trauma in patients with these diseases,^{3-5,8-11,14)} but the relative risk of spinal cord injury associated with such conditions is still unknown.

The present study reviewed the clinical and radiological features of elderly patients with head injury and analyzed the neurological status and findings of radiography, computed tomography (CT), and magnetic resonance (MR) imaging to determine the relative risk of spinal cord injury associated with degenerative cervical diseases in elderly patients with

head injury, and assess the relationship between the severity of trauma and the onset of spinal cord injury.

Materials and Methods

A total of 101 patients aged 65 years or older with head injury were treated at our institution between October 2006 and March 2008. However, 7 patients had poor quality radiological data. Therefore, 57 men and 37 women, aged from 65 to 98 years (mean 76.6 years) were analyzed. The causes of head injury included falls to level ground (46 patients), falls from height (28 patients), traffic accidents (19 patients), and banging the head on a wall (1 patient).

Radiography (anteroposterior and lateral views) of the cervical spine was performed in all patients on admission. Axial CT scans were also obtained at 3-mm intervals for all suspicious areas identified on radiography or for the lower cervical spine if not

Fig. 1 Representative case of a 68-year-old woman who became tetraplegic after falling to the ground while walking. **A:** Radiograph demonstrating bone scar formations at C3, C4, and C5 vertebral bodies. **B:** Computed tomography scan at C3 demonstrating spinal canal stenosis, and a sagittal diameter of the spinal canal of 10 mm. **C:** T₂-weighted magnetic resonance image revealing spinal cord compression from the C3 to C6-7 intervertebral levels due to disk herniation (arrows) and canal stenosis, and intramedullary hyperintensity at the C4-5 intervertebral level.

adequately visualized by radiography. Degenerative changes of the cervical spine were evaluated on radiographs and CT scans. Axial and sagittal T₁- and T₂-weighted MR imaging of the cervical spine was performed in patients with neurological deficits.

Degenerative diseases of the cervical spine were defined as OPLL, spondylosis, and canal stenosis. Cervical spondylosis was defined as obliteration of the subarachnoid space resulting from compression due to disk herniation and/or bone scar formation identified on sagittal T₂-weighted MR images (Fig. 1). Cervical canal stenosis was limited to the condition without OPLL and spondylosis. The sagittal diameter of the spinal canal was measured on lateral radiographs and bone window CT scans of the cervical spine, with the inherent size of the spinal canal measured from the posterior aspect of the vertebral body to the anterior surface of the lamina at the mid-vertebral body level. Cervical canal stenosis was defined as a diameter ≤ 16 mm at C1, ≤ 13 mm at C2, or ≤ 12 mm at C3–C7. If spinal cord compression was found, intramedullary signal changes were

mainly assessed on the T₂-weighted images, and spinal cord injury was defined as the presence of hyperintense changes.

Results

Degenerative cervical diseases were detected in 25 patients (Group 1), including 11 patients with cervical OPLL, 10 patients with cervical spondylosis, and 4 patients with cervical canal stenosis (Table 1). There were no significant differences in sex, age, initial Glasgow Coma Scale score, and mortality between these patients and the other 69 patients without such diseases (Group 2). Spinal cord injuries occurred in 14 patients (Table 2). The neurological state (Frankel grade) was grade A in 2 patients, grade C in 8 patients, and grade D in 4 patients. One patient had mild gait disturbance before head injury as a result of cervical myelopathy. Spinal cord injuries were significantly more common in Group 1 (11/25 patients) than in Group 2 (3/69 patients) by the χ^2 test (relative risk = 10.2, $p < 0.01$) (Table 1). Degenerative cervical diseases were present in 11 of the 14 patients (78.6%) with spinal cord injury.

To examine the relationship between the severity of trauma and spinal cord injury, the injury severity score (ISS)²⁾ was calculated for each patient. The mean ISS of Group 1 with spinal cord injury was 20.6 ± 5.9 (range 16–34) and that of Group 1 without spinal cord injury was 23.0 ± 10.0 (range 5–42), showing no significant difference ($p = 0.496$). The mean ISS of Group 2 with spinal cord injury was 41.7 ± 28.9 (range 25–75) and that of Group 2 without spinal cord injury was 21.9 ± 10.0 (range 1–50), showing no significant difference ($p = 0.358$).

Discussion

Our series of patients with degenerative cervical diseases showed a 10.2 times higher risk of spinal cord injury compared to patients without these diseases.

Several studies of OPLL in the cervical region have reported the incidence of OPLL as 2–3.5% in Japan.^{12,16,17} Fifteen of 231 cases of cervical spinal injuries (6.5%) were associated with cervical OPLL.³⁾ The incidence of OPLL was estimated as 26% to 38% among patients who sustained acute cervical cord injury without fracture or dislocation of the spinal column.^{5,9)} In our series, 6 of 14 cases of cervical spinal injuries were associated with cervical OPLL. The frequency of OPLL was 50.0% among patients sustaining acute cervical cord injury without fracture or dislocation. There was a marked difference in the incidence of OPLL between our series and previous reports, presumably because our institu-

Table 1 Demographic and admission data of the patients

Factor	No. of patients (%)		Total	p Value*
	Group 1	Group 2		
No. of patients	25	69	94	
OPLL	11 (44.0)	0	11	
spondylosis	10 (40.0)	0	10	
canal stenosis	4 (16.0)	0	4	
Sex				
male	17 (68.0)	40 (58.0)	57	0.379
female	8 (32.0)	29 (42.0)	37	
Age, mean $\pm$ SD (yrs)	74.6 $\pm$ 6.4	77.3 $\pm$ 8.9	76.6 $\pm$ 8.3	0.121
Initial GCS score				
15–9	21 (84.0)	51 (73.9)	72	0.456
$\leq$ 8	4 (16.0)	18 (26.1)	22	
Spinal cord injury				
present	11 (44.0)	3 (4.3)	14	< 0.01**
with fracture and dislocation	3 (12.0)	1 (1.4)	4	
without fracture and dislocation	8 (32.0)	2 (2.9)	10	
absent	14 (56.0)	66 (95.7)	80	
Mortality	5 (20.0)	16 (23.2)	21	0.962

*Chi-square test or student's *t*-test. **Present vs. absent. Group 1: patients with degenerative cervical diseases, Group 2: patients without degenerative cervical diseases. OPLL: ossification of the posterior longitudinal ligament, SD: standard deviation.

Table 2 Characteristics of 14 patients sustaining spinal cord injury

Case No.	Age (yrs)	Sex	Type of degenerative cervical spine disease	Level	Fracture/dislocation	Frankel grade	Surgical treatment
1	85	M	OPLL	C2–C5	none	A	none
2	82	M	OPLL	C2–T2	none	C	none
3	74	M	OPLL	C3–C7	none	C	none
4	72	M	OPLL	C4–C6	fracture of C5 and C6 vertebral bodies	C	none
5	69	M	OPLL	C3–C7	none	D	laminoplasty
6	67	F	OPLL	C3–C4, C7–T1	none	C	laminoplasty
7	74	M	spondylosis	C5–6, C6–7	none	C	anterior decompression and fusion
8	68	F	spondylosis	C3–4, C4–5	none	D	laminoplasty
9	67	M	spondylosis	C5–6, C6–7	anterior dislocation at C5	A	anterior decompression and fusion
10	75	M	canal stenosis	C4–C6	posterior dislocation at C3, fracture of C3 and C5 vertebral bodies	C	none
11	72	F	canal stenosis	C3–C7	none	D	laminoplasty
12	85	M	none		none	C	none
13	74	F	none		none	D	none
14	69	M	none		anterior dislocation at C6, fracture of C7 vertebral body	C	anterior fusion

OPLL: ossification of the posterior longitudinal ligament.

tion handles severe cases and all our patients were elderly. These findings suggest that elderly patients with head injury and cervical myelopathy are more likely to have degenerative cervical diseases, so that careful management is more important in such patients than in younger patients.

The relationship between the severity of trauma and the occurrence of spinal cord injury is unclear. ISS is an anatomical scoring system that provides an overall score for patients with multiple injuries, and is an established score for assessing trauma severity.²⁾ Each injury is assigned an abbreviated in-

Table 3 Abbreviated injury scale components

Score	Description
1	minor injury
2	moderate injury
3	serious injury
4	severe injury
5	critical injury
6	virtually unsurvivable injury

jury scale (AIS) score and is allocated to one of six body regions: head, face, chest, abdomen, extremities including the pelvis, and external.¹⁾ Injuries are ranked on a scale of 1 to 6, with 1 minor, 5 severe, and 6 unsurvivable injury (Table 3). Only the highest AIS score in each body region is used. The squares of the scores of the three most severely injured body regions are added together to produce the ISS score. The ISS score has values from 0 to 75. If an injury is assigned an AIS of 6 (unsurvivable injury), the ISS score is automatically assigned to 75. Examination of the ISS for patients in the present study found no significant difference between the group with spinal cord injury and the group without cord injury, which indicates that the severity of trauma was not relevant to the occurrence of spinal cord injury.

In Japan, a training program called Japan Advanced Trauma Evaluation and Care (JATEC) is now widely accepted for physicians involved in the management of acute trauma patients, and has become the standard for initial assessment and treatment in trauma centers like Advanced Trauma Life Support in the United States. The guidelines are based on the National Emergency X-Radiography Utilization Study and the Canadian C-Spine (cervical-spine) Rule for discontinuation of cervical spine immobilization.^{6,15)} According to the JATEC guidelines, if patients have neurological deficits and/or altered level of consciousness, it is mandatory to obtain lateral, anterior-posterior, and open mouth odontoid radiographs with supplementary CT scans for suspicious areas. Although it is important to avoid unnecessary radiography for more efficient treatment, the prevalence of degenerative cervical spine disease is high in Japan, so careful management of patients with head injury is required, particularly in elderly patients.

The elderly population (defined as persons aged 65 years or older) is rapidly growing in Japan. The 2005 census showed that there were nearly 27 million people aged 65 years or older in Japan, constituting 20.1% of the total population. Projections indicate that this age group will account for more than 30% of the Japanese population by the year 2025. As

the elderly population continues to grow, the prevalence of elderly patients with head injury will probably continue to increase. According to the Japan Neurotrauma Data Bank, traffic accidents are less common, and falls while walking or cycling are more common as the mechanism of head injury in the elderly population compared with the nonelderly population.^{7,13)} Accordingly, patients with spinal cord injury seem likely to increase and the prognosis will be worse. Providing information concerning the risk of trauma-induced myelopathy may be important for patients with OPLL without myelopathy at the initial consultation.¹⁰⁾ The frequency of cervical trauma decreased by 24% as a result of efforts by patients to avoid trauma. In the present study, 14 of 25 patients with degenerative cervical diseases were asymptomatic. To decrease the occurrence of cervical myelopathy, medical professionals should explain that such patients have a high risk of spinal cord injury and so should avoid cervical trauma that might precipitate myelopathy. In addition, social measures to reduce traffic accidents or falls are important, and cervical spine screening of the elderly population, by medical check-up for example, may also help to detect individuals with an increased risk of cervical myelopathy.

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Commentary

In this study, Nakae and colleagues tackle the extremely important and previously unanswered question of what added risk do degenerative changes of the cervical spine in the elderly (age >65 years) carry in head trauma. In particular, is there an increased relative risk of spinal cord injury in patients with asymptomatic or mildly symptomatic cervical diseases such as stenosis, spondylosis, and ossification of the posterior longitudinal ligament (OPLL).

To answer this question, the authors reviewed the medical records and radiographs of 94 elderly patients (age 65–98) with head trauma over a 1.5 year period. The overwhelming most frequent cause of trauma in this age group was falls from standing. Degenerative cervical disease was detected in 25 patients. 11 patients had OPLL, 10 had cervical spondylosis, and 4 had stenosis. Spinal cord injury (SCI) occurred in 11 of these patients (11/25), whereas SCI occurred in just 3 of the 69 patients without degenerative disease of the cervical spine. This represents a statistically significant increase in relative risk of SCI in patients with degenerative changes of the cervical spine of 10.2 ($p < 0.01$). Interestingly examination of injury severity score (ISS) between the two groups and between those with or without SCI within each group was not statistically different.

The authors of this study have nicely demonstrated that degenerative changes of the cervical spine carries with it a 10 fold increase in risk of SCI associated with head trauma in the elderly. Hopefully this information can be used to help better counsel patients and their families so that appropriate precautions can be taken. Larger, multicenter studies and evaluation of trauma databanks are necessary to truly assess the impact of SCI associated with head trauma in the elderly.

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