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Influence of minor trauma to the neck on the neurological outcome in patients with ossification of the posterior longitudinal ligament (OPLL) of the cervical spine

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The influence of minor trauma to the neck on the neurological outcome in patients with ossification of the posterior longitudinal ligament (OPLL) of the cervical spine was evaluated retrospectively. Out of 118 patients treated in our clinic for cervical OPLL between 1976 and 1992, 27 had sustained minor trauma to the cervical spine. Of these 27 patients, 13 developed myelopathy, seven showed deterioration of preexisting myelopathy, and no neurological change was observed in seven patients. Regarding the relationship between the diameter of the residual spinal canal and the neurological outcome in these 27 patients, 18 out of the 19 patients with a narrow residual spinal canal (< 10 mm) developed neurological deterioration, whereas that occurred in only two of the eight patients with a wider spinal canal (≥ 10 mm). Although the severity of myelopathy and the transverse area of the spinal cord measured from T1-weighted magnetic resonance images, in patients who had sustained minor trauma was not statistically different from patients without trauma, neurological recovery after surgical treatment was poorer in the former group than in the latter. These results indicate that even indirect minor trauma to the neck can cause irreversible changes in the spinal cord if there is marked stenosis of the cervical spinal canal; such patients who are at risk, must be educated, and should be told to avoid even minor injuries at any cost.

Keywords: ossification; posterior longitudinal ligament; trauma; neurological outcome; cervical spine injury

Introduction

The occurrence of cervical spinal cord injuries in Japan is high, and many of these patients are relatively old.[1] Although epidemiological data are not yet available, we are of the opinion that the high frequency of cervical spinal stenosis either because of a developmentally stenotic spinal canal or because of ossification of the posterior longitudinal ligament (OPLL) must be important. OPLL is designated as an intractable disease by the Ministry of Public Health and Welfare of Japan, and many of these patients in Japan have a serious compression myelopathy, which is sometimes further complicated by minor trauma to the spinal cord. Although the significance of minor trauma on the neurological outcome of such patients has been widely recognised in our clinic, it has not been well reported. We have investigated the development of neurological deterioration after such minor trauma and the influence of decompression surgery regarding neurological recovery.

Methods and subjects

We reviewed the clinical records and radiographs of 118 patients who had cervical OPLL and were treated in our clinic from 1976 and 1992. There were 76 males and 42 females. The age at first presentation ranged from 35 to 78 years with a mean of 58.0 years. The mean follow-up period was 5.5 years ranging from 2 to 15 years. Forty-seven patients were treated conservatively and 71 surgically; three patients who were initially treated conservatively had surgical treatment later. Patients with major neurological deterioration immediately following major trauma were excluded from our study.

As late adverse effects have been reported in patients undergoing multisegmental anterior interbody fusion,[2–4] laminoplastic posterior decompression has become the commonest surgical procedure for the treatment of patients with cervical OPLL, unless OPLL is localised to one or two segments (Figure 1). In the present series, 28 patients underwent anterior decom-

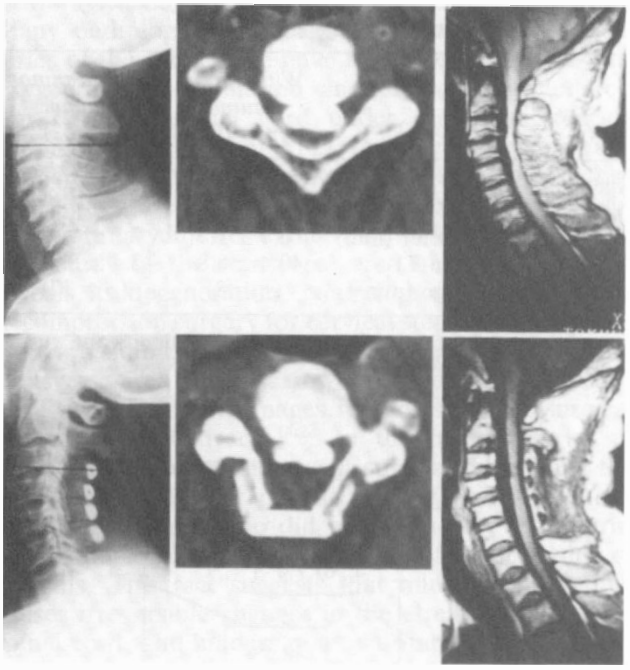

Figure 1 Illustrative case of a patient who presented with myelopathy due to OPLL and was subjected to laminoplastic posterior decompression using a hydroxyapatite interlaminar spacer (a, b, c: at presentation; d, e, f: after surgery; a, d: plain radiographs; b, e: CT; c, f: T1-weighted sagittal MR images)

pression and interbody fusion, and 43 were treated by posterior decompression procedures.

The neurological status was evaluated using the scoring system for cervical myelopathy established by the Japanese Orthopaedic Association (JOA score, Table 1). The recovery rate was calculated from the initial and the final JOA scores according to Hirabayashi's formula.[5] The residual anteroposterior diameter of the spinal canal (APD) which indicates the space available for the spinal cord, was measured on plain radiographs. In 25 patients who had been investigated by magnetic resonance (MR) imaging before surgical treatment, the transverse spinal cord area on the T1-weighted axial image was also measured.[6] The results obtained in patients who had sustained minor trauma and in those who had not, were compared.

Results

Twenty seven patients recalled episodes of minor neck trauma about 2 weeks previously, such as tumbling, slipping or jumping from small steps. Of the 27 patients, 13 developed myelopathy after the episode, seven experienced deterioration of pre-existing myelopathy, and one showed no change of pre-existing myelopathy. Six patients did not have, and did not develop myelopathy (Table 2). A fall on the level was the commonest cause of injury, followed by a traffic accident such as a 'whiplash'; or being struck by an object or a fall from a height of less than 2 m without suffering a direct injury to the neck (Table 3).

Table 1 Scoring system for cervical myelopathy established by the Japanese Orthopaedic Association in 1975

Motor function
Upper extremities
- Unable to feed oneself with chopsticks or spoon
- Can manage to feed oneself with spoon and/or fork, but not with chopsticks
- Feeds oneself with chopsticks but inadequately
- Feeds oneself with chopsticks but clumsily
- Normal

Lower extremities
- Unable to walk
- Unable to walk without cane or other kind of support on a level
- Walks independently on a level but needs support on stairs
- Walks independently but clumsily
- Normal

Sensory function
Upper extremities
- Apparent sensory loss
- Minimal sensory loss
- Normal

Lower extremities same as upper extremities

Trunk same as upper extremities

Bladder function
Urinary retention and/or incontinence
Sense of retention and/or dribbling and/or thin stream and/or incomplete incontinence
Urinary retardation and/or pollakiuria
Normal

Table 2 Neurological changes of the patients with cervical OPLL after minor trauma

Neurological changes	*Number of patients*
Developed myelopathy	13
Did not develop myelopathy	6
Deterioration of pre-existing myelopathy	7
No deterioration of pre-existing myelopathy	1
Total	27

Table 3 Causes of minor trauma

Causes of minor trauma	*Number of patients*
Fall on level	12
Traffic accident	6
Being struck by an object	5
Fall from a height (less than 2 m)	4
Total	27

Regarding the relationship between the residual AP diameter (APD) and neurological changes, deterioration of myelopathy after minor trauma was observed in 18 of 19 patients whose APD was less than 10 mm. On

the other hand, only two out of eight patients whose APD was 10 mm or more had neurological deterioration after minor trauma (Table 4). There was a statistically significant difference between these two groups (Fisher's exact probability test, $P < 0.01$).

Spontaneous neurological deterioration was also found in patients who had not suffered any kind of trauma, although such an occurrence was rare. Among those without trauma, 16 patients whose APD was less than 10 mm and who had been treated conservatively, five showed spontaneous neurological deterioration mainly due to progression of OPLL itself, whereas only two out of 34 patients whose APD was 10 mm or more, had neurological deterioration, (Fisher's exact probability test, $P < 0.05$).

Regarding patients who were treated surgically, there were no statistically significant differences in mean age, mean duration of illness, mean spinal cord area measured from T1-weighted axial images or mean JOA scores before surgery between patients ($n = 19$) who had suffered minor neck trauma and those ($n = 52$) who had not (Table 5). Neurological recovery after surgical treatment was poorer in the former group than in the latter (Figure 2). The JOA score of those two groups at follow-up more than 1 year after surgery was 11.7 ± 3.2 in patients who had had trauma, and 13.7 ± 2.7 in those without a history of trauma. The recovery rate was 42.0% in patients with trauma, and 61.7% in those without trauma. These differences in JOA scores and recovery rates were statistically significant ($P < 0.05$, unpaired t test).

Discussion

Ossification of the posterior longitudinal ligament (OPLL) in the thoracic and lumbar spine was first reported by Key in 1838.[7] Cervical myelopathy as a consequence of OPLL was reported by Tsukimoto in 1960,[8] and there has been an increasing number of reports on this condition. According to the authoritative paper by Tsuyama, the incidence of OPLL in eastern Asiatic subjects is about 2%, while that in white subjects is 0.16%.[9]

OPLL is categorised as an intractable disease by the Japanese government. The pathogenesis has not yet been elucidated, although it is regarded as a different pathological process from that of calcification of the ligamentum flavum; and genetic, metabolic and dietary factors of the patients as well as the local condition of the ligament have been investigated.[10–13] It is widely recognised that OPLL is a common cause of spinal canal stenosis, sometimes with myelopathy and/or radiculopathy. Considerable knowledge on the development of neurological deficits in relation to the configuration or shape of the ossified segments has been accumulated as a result of detailed autopsy studies and progressive radiological evaluations including MRI.[6,14] However, arterial occlusion or other causes of myelopathy have not yet been clearly appreciated.

The present study has demonstrated that cervical myelopathy developed or, if already present, deteriorated after minor neck trauma such as a fall on level ground in 16.9% of patients with OPLL, which is comparable to the incidence of 20.9% reported by Tsuyama.[9] It is not difficult to postulate that the narrowness of the space available for the spinal cord is a critical factor for neurological deterioration immediately after a neck injury since a reduction of sagittal spinal canal size contributes significantly to the severity of the neurological deficit after a spinal injury.[15] Neurological deterioration was delayed for several days after minor neck trauma in half of the patients in the present series. This delay may be similar to the delay of

Table 4 Relationship between residual spinal canal diameter and neurological changes in patients who suffered minor trauma

Residual antiposterior diameter of the spinal cord	*Development or deterioration of myelopathy*	*Unchanged*	*Total*
< 10 mm	18	1	19
⩾ 10 mm	2	6	8
Total	20	7	27

Table 5 Background of the patients with myelopathy due to OPLL who were treated surgically

	With minor trauma (n = 19)	*Without minor trauma (n = 52)*
Age (years)	57.9 ± 7.0	55.5 ± 10.0^{NS}
Duration of illness (months)	49.3 ± 42.5	44.6 ± 45.5^{NS}
Residual AP diameter (mm)	6.7 ± 1.7	7.2 ± 1.9^{NS}
Spinal cord area on T1-weighted MR image (mm^2)	40.4 ± 6.8 ($n = 8$)	42.4 ± 8.3^{NS} ($n = 17$)

Mean ± standard deviation; NS: not significant using unpaired t test

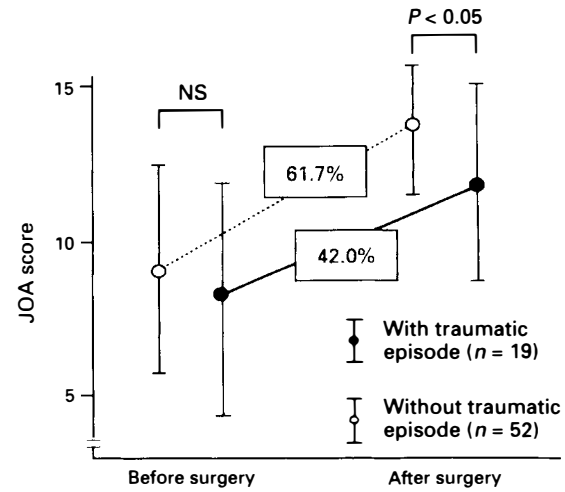

Figure 2 Linegraphs demonstrating the surgical outcome in patients who had suffered a minor trauma and those who had not. Recovery rates of both groups, which are shown in the rectangles, were significantly different (unpaired t test)

neurological deterioration after a spinal cord injury.[16,17] Many pathological processes secondary to direct injuries of the spinal cord have been postulated, such as oxygen radical formation and eicosanoids metabolism.[18–21] The spinal cord under markedly stenotic conditions (< 10 mm of APD) must be vulnerable even to indirect injuries to the neck, and secondary pathological processes may occur after clinically insignificant trivial primary injuries to the vulnerable spinal cord.

A study of the transverse area of the spinal cord reveals its degeneration. Neurological recovery after decompression surgery for cervical stenotic myelopathy shows a statistically significant correlation with the transverse area of the narrowest part of the spinal cord on T1-weighted MR images regardless of the surgical procedures employed.[6,14,22] In the present series in those patients who underwent surgical treatment, the area was not different in those who suffered minor neck trauma and those who did not; however, the neurological outcome was poorer in the former group of patients. This fact suggests that minor neck trauma causes irreversible changes in the already compressed spinal cord, and hinders potential improvement of the neurological symptoms after surgical decompression.

There appears to be general agreement in Japan that surgical treatment should not be employed for patients with a stenotic spinal canal if there are no neurological symptoms. Once symptoms of long-tract involvement develop, our practice is to operate, usually employing a laminoplastic procedure. For patients who develop myelopathy after minor neck trauma, we also undertake a surgical decompression not only to treat preexisting myelopathy, but also to prevent neurological deterioration by further trauma. Patients who have OPLL are strongly advised to avoid all such injuries.

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