Trauma-induced myelopathy in patients with ossification of the posterior longitudinal ligament

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Object. In these prospective and retrospective studies the authors evaluated trauma-induced myelopathy in patients with ossification of the posterior longitudinal ligament (OPLL) to determine the effectiveness of preventive surgery for this disease.

Methods. The authors studied 552 patients with cervical OPLL, including 184 with myelopathy at the time of initial consultation and 368 patients without myelopathy at that time. In the former group of 184 patients retrospective analysis was performed using an interview survey to ascertain the relationship between onset of myelopathy and trauma. In the latter group of 368 patients prospective examination was conducted by assessing radiographic findings and noting changes in clinical symptoms apparent during regular physical examination. The follow-up period ranged from 10 to 32 years (mean 19.6 years).

In the retrospective investigation, 24 patients (13%) identified cervical trauma as the trigger of their myelopathy. In the prospective investigation, 70% of patients did not develop myelopathy over a follow-up period greater than 20 years (determined using the Kaplan–Meier method). Of the 368 patients without myelopathy at the time of initial consultation, only six patients (2%) subsequently developed trauma-induced myelopathy. Types of ossification in patients who developed trauma-induced myelopathy were primarily a mixed type. All patients in whom stenosis affected 60% or greater of the spinal canal developed myelopathy regardless of a history of trauma.

Conclusions. Preventive surgery prior to onset of myelopathy is unnecessary in most patients with OPLL.

KEY WORDS • myelopathy • ossification of the posterior longitudinal ligament • trauma

Ossification of the posterior longitudinal ligament, a subtype of diffuse idiopathic skeletal hyperostosis, may contribute to the onset of and produce quadriplegia in older individuals. A number of studies of OPLL in the cervical spine have been performed since the publication of the autopsy report by Tsukimoto. Ossification of the posterior longitudinal ligament may contribute to development of myelopathy in elderly individuals. Observation of the natural course of the disease has revealed that the development of ossification does not always lead to myelopathy. It is difficult to predict the course of future neurological deterioration in patients with OPLL. Severe myelopathy can be induced by minor cervical trauma in patients with OPLL. Surgery-related results in patients with this condition are far from satisfactory. Some experts have recommended that preventive surgery be performed prior to the onset of myelopathy in patients with OPLL and potential spinal stenosis secondary to ossified ligaments. To justify the efficacy of preventive surgery in patients with potential spinal stenosis due to ossified ligaments, it should be demonstrated that trauma is a significant factor in the onset of myelopathy in cases of OPLL. In this study we reviewed data obtained in patients with OPLL treated in our clinic from 1967 by conducting retrospective and prospective investigations to assess the onset of trauma-induced myelopathy.

Clinical Material and Methods

Study Design

We used retrospective and prospective methods to examine patients with OPLL in an effort to assess the onset of cervical trauma-induced myelopathy. Patients in whom myelopathy had already developed by the time of initial consultation were included in the retrospective study in which we used an interview survey to ascertain the relationship between onset of myelopathy and trauma. Patients without myelopathy at the time of initial consultation were included in the prospective study (mean observation period 19.6 years) in which we noted radiographic findings and changes in clinical symptoms on regular physical examination twice a year. In all patients, we examined the relationships between ossification type and the presence/absence of trauma-induced myelopathy as well as the maximum degree of spinal canal stenosis caused by

Abbreviations used in this paper: CT = computerized tomography; MVA = motor vehicle accident; OPLL = ossification of the posterior longitudinal ligament.
Trauma-induced myelopathy in OPLL

the ossified ligament (Fig. 1) and the onset of myelopathy. Myelopathy was defined as disturbances in motor function associated with abnormal reflexes, muscle weakness, and sensory disturbance. Cervical trauma was determined when complaints such as cervical pain developed following whiplash injury and when medical treatment was required to treat symptoms such as cervical pain secondary to hyperflexion and hyperextension of the cervical spine after a fall.

Patient Population

Candidates in this study were 612 patients with cervical OPLL who had visited our clinic over a greater than 10-year period. A total of 552 patients were followed: 184 with and 368 without myelopathy at the time of initial consultation; the former group underwent surgery, and the latter was followed without surgery. In the 184 patients with myelopathy, age at presentation ranged from 39 to 75 years (mean 57 years); there were 123 men and 61 women. Based on criteria established by the Japanese Ministry of Public Health and Welfare,19 the ossification type at presentation was determined to be continuous in 50 (27%), segmental in 86 (47%), mixed in 46 (25%), and other in two patients (1%). Continuous-type OPLL represents continuous ossification over several vertebral bodies; segmental type, segmental ossification of one or more vertebral bodies; and mixed type, continuous-type ossification associated with segmental type. Other-type OPLL represents the ossification of intervertebral disc level.

In the group of 368 patients without OPLL at presentation, age ranged from 29 to 79 years (mean 59 years); there were 286 men and 82 women. Ossification type at presentation was continuous in 105 (29%), segmental in 155 (42%), mixed in 98 (27%), and other in seven patients (2%). Continuous-type OPLL was present in 37 (19%) of 194 patients, segmental in 102 (52%), mixed in 74 (38%), and other in two patients (1%). Continuous-type OPLL represents continuous ossification over several vertebral bodies; segmental type, segmental ossification of one or more vertebral bodies; and mixed type, continuous-type ossification associated with segmental type. Other-type OPLL represents the ossification of intervertebral disc level.

In our current investigation we found that in some patients (43%) developed trauma-induced myelopathy (Table 1). Characteristics observed in these six patients trauma-induced myelopathy and acute deterioration are presented in Table 2. In five of the six patients mixed-type OPLL was present. No myelopathic signs were detected in five of the six patients before trauma, and severe myelopathy (Nurick Grade 4 or 5) developed after trauma.

Ossification Type and Maximum Percentage of Stenosis

Ossification types in the 30 patients in whom trauma-induced myelopathy developed were determined to be the following: mixed in 20 (67%); segmental in nine (30%); and continuous in one patient (3%). The risk of trauma-induced myelopathy is significantly higher in patients with mixed-type OPLL than in those with segmental- or continuous-type OPLL (Table 3). In all of the 45 patients with 60% or greater maximum stenosis of the spinal canal, myelopathy developed regardless of a history of cervical trauma. Analysis of the remaining 507 patients with maximum percentage spinal canal stenosis less than 60% revealed no significant difference in diameter of the remaining spinal canal between the groups of patients with and without myelopathy (Table 4).

Results

Incidence of Trauma-Induced Myelopathy

Retrospective Study. In 24 (13%) of 184 patients who presented with myelopathy this condition had been triggered by cervical trauma: 13 suffered a fall and 11 were involved in MVAs. Fifty-two patients (28%) had a history of cervical trauma, and among these, 24 (46%) developed myelopathy due to trauma (Table 1).

Prospective Study. Of the 368 patients in whom no distinct myelopathy was present at the time of initial consultation, 70 (19%) developed myelopathy during the follow-up period. The Kaplan–Meier method was used to determine the percentage of patients who did not develop myelopathy: 79% at 10-year follow up and 70% at longer than 20-year follow up (Fig. 2). Of the 70 patients in whom myelopathy occurred, six (9%) developed trauma-induced myelopathy, and in all of these patients there was a history of involvement in MVAs. Of these 368 patients, 14 (4%) suffered cervical trauma. Of these 14 patients, six

### Table 1

<table>
<thead>
<tr>
<th>Factor</th>
<th>No. of Patients (%)</th>
</tr>
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<tbody>
<tr>
<td>Retrospective Study</td>
<td>Prospective Study</td>
</tr>
<tr>
<td>no. w/ history of cervical trauma</td>
<td>52 (28)</td>
</tr>
<tr>
<td>no. w/ trauma-induced myelopathy</td>
<td>24 (13)</td>
</tr>
<tr>
<td>risk of myelopathy after trauma</td>
<td>24 (46)</td>
</tr>
<tr>
<td>total no. of patients</td>
<td>184</td>
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</table>

### Discussion

In our current investigation we found that in some patients...
patients with OPLL, myelopathy clearly occurred in association with trauma. In one report the authors have suggested that some patients with cervical cord injury not accompanied by distinct bone injury may suffer OPLL. A different group has noted that surgery-related results in patients with trauma-induced myelopathy are inferior to those in patients with nontrauma-related myelopathy. As has been determined, results of treatment of trauma-associated myelopathy in patients with OPLL are far from satisfactory. Preventive surgery is often recommended prior to the onset of myelopathy in patients with OPLL and potential spinal stenosis due to ossified ligaments. There are no scientific data, however, to support the use of preventive surgery in patients with OPLL.

In the present study, follow-up prospective investigation was performed in individuals after explaining that they should avoid cervical trauma that might precipitate myelopathy. In this group, the frequency of cervical trauma decreased to 4%, compared with 28% in the retrospectively investigated patients. Almost no difference was noted in the incidence of myelopathy between retrospectively and prospectively studied patients who suffered trauma. A decrease in frequency of trauma-induced myelopathy in the prospective group may have been the result of efforts by patients to avoid trauma. Therefore, performing preventive surgery in patients in whom myelopathy has not developed is inappropriate. Informed consent concerning the possibility of developing trauma-induced myelopathy may be important for patients with OPLL without myelopathy at the time of initial consultation. Instruction on how to avoid trauma is given to the individuals in the prospective investigation led to a low frequency of trauma-induced myelopathy; in 70% of patients myelopathy did not develop during long-term follow up. All episodes of trauma in patients who did develop trauma-induced myelopathy in the prospective investigation, however, were secondary to MVAs. Because driving a car is an essential element for functioning in modern society, complete eradication of MVA-related trauma-induced myelopathy may be impossible, despite careful efforts to avoid trauma in daily life.

Of those patients in whom trauma-induced myelopathy occurred, a large number developed mixed-type ossification with significant mobility at sites of noncontinuous-type ossification. This suggests that dynamic factors are important in the development of myelopathy in patients with preexisting OPLL. Currently, the degree of OPLL-induced stenosis in the spinal canal can be evaluated not only by plain radiography but also by CT scan or magnetic resonance imaging. Epstein has recommended evaluation of this disease by CT scanning. In the future, evaluation based on the remaining area of spinal canal or volume may be necessary. A great number of researchers have used plain lateral radiography of the cervical spine to measure the diameter of the remaining spinal canal. In the present prospective study, CT evaluation was impossible because this study was begun in 1967. The maximum percentage of spinal canal stenosis was measured using plain lateral radiography, and in all cases in which 60% or more of the spinal canal was affected by stenosis, the patients developed myelopathy following cervical trauma. In patients in whom the maximum percentage of spinal canal stenosis was less than 60%, there was no significant difference in this maximum percentage of stenosis between those who developed trauma-induced myelopathy and those who did not. The reason for this may be as follows: even patients with segmental-type disease in whom there was a small maximum percentage of spinal canal stenosis may develop myelopathy; however, those with continuous-type disease in whom there is a large maximum percentage of spinal canal stenosis do not always develop trauma-induced myelopathy. For example, this is demonstrated when the cervical spine has limited mobility and little involvement of the dynamic factor. Preventive surgery in cases of OPLL should be limited to selected patients in whom mixed-type ossification and maximum (≥60%) spinal canal stenosis are present and whose lifestyle suggests that they may be at high risk of trauma secondary to MVAs.

### TABLE 2
Characteristics obtained in six patients with acute deterioration following trauma

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Type of OPLL</th>
<th>Maximum % Stenosis</th>
<th>Nurick Grade*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>65, M</td>
<td>mixed</td>
<td>65</td>
<td>0/4</td>
</tr>
<tr>
<td>2</td>
<td>59, M</td>
<td>mixed</td>
<td>60</td>
<td>0/5</td>
</tr>
<tr>
<td>3</td>
<td>62, M</td>
<td>mixed</td>
<td>58</td>
<td>0/4</td>
</tr>
<tr>
<td>4</td>
<td>72, M</td>
<td>mixed</td>
<td>56</td>
<td>0/4</td>
</tr>
<tr>
<td>5</td>
<td>68, F</td>
<td>mixed</td>
<td>52</td>
<td>1/4</td>
</tr>
<tr>
<td>6</td>
<td>76, M</td>
<td>continuous</td>
<td>68</td>
<td>0/5</td>
</tr>
</tbody>
</table>

* Nurick Grade: 0, no myelopathic sign; 4, myelopathy with gait disturbance; 5, bedridden condition.
TABLE 4
Maximum percentage of stenosis in patients with or without myelopathy*

<table>
<thead>
<tr>
<th></th>
<th>W/ Myelopathy (174 patients)</th>
<th>W/O Myelopathy (333 patients)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean maximum % of stenosis of spinal canal ± standard deviation</td>
<td>45 ± 19</td>
<td>41 ± 17</td>
<td>NS</td>
</tr>
</tbody>
</table>

* Calculation was performed for data obtained in 507 patients with less than 60% of the maximum percentage of spinal canal stenosis. Abbreviation: NS = not significant.

Conclusions

Analysis of current results obtained prospectively in patients instructed on how to avoid trauma revealed a low incidence of trauma-induced myelopathy; in long-term follow up, 70% of the patients in this group did not develop myelopathy. In conclusion, preventive surgery prior to onset of myelopathy is unnecessary in most patients with OPLL.

References


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175