Ossification of the posterior longitudinal ligament in the cervical spine: an 11-year comprehensive national epidemiology study

JAU-CHING WU, M.D.,1–3 LAURA LIU, M.D.,4 YU-CHUN CHEN, M.D., M.Sc.,2,5 WEN-CHENG HUANG, M.D., PH.D.,1,2 TZENG-JI CHEN, M.D., PH.D.,6 AND HENRICH CHENG, M.D., PH.D.1–3

1Department of Neurosurgery, Neurological Institute, Taipei Veterans General Hospital; 2School of Medicine, Institute of Pharmacology, and 4Institute of Hospital and Health Care Administration, National Yang-Ming University, Taipei; 3Department of Ophthalmology, Chang-Gung Memorial Hospital, and College of Medicine, Chang-Gung University, Taoyuan, Taiwan; and 5Department of Medical Informatics, Institute for Medical Biometry and Informatics, Heidelberg University, Heidelberg, Germany

Object. This study aimed to calculate the incidence and prevalence of ossification of the posterior longitudinal ligament (OPLL) in the cervical spine with its comorbid disability.

Methods. Using an 11-year nationwide database in Taiwan (National Health Insurance Research Database), this retrospective study cohort analyzed the incidences of cervical OPLL causing hospitalization. All patients admitted for the diagnosis of OPLL, regardless of surgery, were identified. Age- and sex-specific incidences, Poisson regression, and multivariate logistic regression analysis were conducted.

Results. Between 1997 and 2007 covering 241,800,725.8 person-years, 1651 patients were admitted for OPLL. The overall incidence of OPLL-related admission was 6.1 per 1 million person-years. Specifically, male sex and older age were associated with higher OPLL incidences (both p < 0.001). Among the 1651 OPLL patients, 542 (32.8%) received conservative management, 612 (37.1%) had anterior only surgery, 353 (21.4%) had posterior only surgery, and 144 (8.7%) had anterior and posterior surgery. Eighty-five patients were moderately to severely disabled (5.2% cumulative incidence rate). The incidences of disability varied by age, in a decreasing trend, except for the 60- to 69-year-old age group (p = 0.05). Patients who received posterior-only surgery were more likely to have disability.

Conclusions. In a large cohort of the Chinese population, the incidence of cervical OPLL-related admission is 6.1 per 1 million person-years, and the prevalence rate is 7.7 per 100,000 person-years. Higher incidences are observed in elderly and male patients, which implies the disease’s degenerative nature. After adjustments for demographics, the incidences and trends of OPLL-related comorbid disability are associated with age and surgical approaches. (DOI: 10.3171/2010.12.FOCUS10268)

Key Words • ossification of posterior longitudinal ligament • incidence • spinal cord injury • national health insurance

Ossification of the posterior longitudinal ligament is an uncommon disease that may cause cervical radiculopathy and myelopathy of varying severity. It is reported mostly in literature from Japan, where prevalence rates are extraordinarily high compared with other ethnic groups.4–6 The prevalence reportedly ranges from 1.9% to 4.3% among individuals older than 30 years in investigations conducted in Japan.8,12,14,15 Some epidemiological studies reported slightly lower or similar prevalence to that of the Japanese population among East Asians and definitely lower in the Caucasian population, suggesting genetic involvement.4,6 However, reported data are often institution-based, which implies some bias. A population-based epidemiological investigation has not been published in English-language literature. If the disease is genetically relevant, neighboring countries in East Asia with a close geographic and anthropological relationship to Japan could share similar epidemiological features.

The NHIRD, provided by the NHRI of Taiwan, is a national database containing 26 million administered insurants accumulated between January 1997 and December 2007. The extremely high coverage, more than 99% of the population, yields a unique system that finances health care for the entire population and offers unrestricted access to any health care provider of the patient’s choice. Therefore, the statistics gathered represent a sound epidemiological investigation of incidences of diseases and utilization of medical interventions because of universal coverage.
This study used the nationwide data to estimate, from a large population, the incidence of cervical OPLL and its comorbid disability. Age- and sex-specific incidences were also analyzed. To date, this is the largest cohort study to investigate such an issue, and it can provide a better depiction of the disease course.

**Methods**

**Database**

The NHIRD included all claims data from Taiwan's National Health Insurance program. This study was exempted from full review by the institutional review board because the NHIRD consisted of deidentified secondary data released to the public for research purposes.

**Study Sample**

In the entire 11 years between January 1, 1997, and December 31, 2007, all inpatient data from NHIRD were collected for analysis. The total enrollees consisted of 26,750,807 people, and the total observation span included 241,800,725.8 person-years.

**Identification of OPLL**

Diagnosis of every admission was recorded in the NHIRD using the International Classification of Disease, 9th Version (ICD-9). All hospitalizations discharged with the diagnostic code of OPLL of the cervical region (723.7) were identified. Accompanying surgical procedures coded with cervical laminectomy, laminoplasty, discectomy, corpectomy, and fusion (03.09, 03.09, 80.51, 80.99, and 81.02, respectively) were considered as receiving the surgery for OPLL during the specific admission. The surgical procedures were subsequently classified into anterior approach only, posterior approach only, or combined anterior and posterior procedures (front-and-back surgeries).

The incidences of hospitalization for cervical OPLL were identified as patients who underwent follow-up for more than 1 year and newly hospitalized with the aforementioned discharge code between January 1, 1998, and December 31, 2007. The incidence rates in the study were calculated by the incidence density.

**Disability**

The registry of patients with catastrophic illnesses (HV1997–2007) of the NHIRD was used to identify patients with cervical myelopathy or SCI causing moderate and severe disabilities. All newly diagnosed cervical myelopathy or SCI comorbid with OPLL were identified. By assumption, patients with severe neurological deficits such as paraplegia, tetraplegia, and incontinence were all included.

**Statistical Analysis**

All data were calculated using SPSS software for descriptive statistics and contingency tables (SPSS, Inc.). Poisson regression and multivariate logistic regression were used. A probability value of 0.05 was considered statistically significant.

**Results**

**Incidence and Prevalence**

During the study period, 1651 patients admitted for cervical OPLL were identified (1204 men [72.9%] and 447 women [27.1%]). There were 485 patients (29.4%) between 50 and 59 years old, 379 (23.0%) between 60 and 69 years old, 365 (22.1%) 70 years old or older, 359 (21.7%) between 40 and 49 years old, 52 (3.1%) between 30 and 39 years old, and only 11 (0.7%) younger than 30 years old. The overall incidence of cervical OPLL was 6.1 per 1 million person-years. There was an age-related increase in incidence at 0.2, 1.1, 8.7, 18.2, 22.9, and 22.8 for ages 20–29, 30–39, 40–49, 50–59, 60–69, and ≥ 70 years old, respectively. Higher incidences were also found in men than in women in every age group. The incidences of men and women were 0.3 versus 0.1, 1.6 versus 0.6, 11.3 versus 6.1, 25.2 versus 11.3, 35.2 versus 11.1, and 36.6 versus 7.9 for ages 20–29, 30–39, 40–49, 50–59, 60–69, and ≥ 70 years old, respectively (Table 1).

![Table 1: Age- and sex-specific incidence of cervical OPLL](image)

<table>
<thead>
<tr>
<th>Age Group (yrs)</th>
<th>Female (%)</th>
<th>Male (%)</th>
<th>All (%)</th>
<th>Female Rate (10^6)</th>
<th>Male Rate (10^6)</th>
<th>All Rate (10^6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20–29</td>
<td>3 (0.7)</td>
<td>8 (0.7)</td>
<td>11 (0.7)</td>
<td>0.1</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>30–39</td>
<td>15 (3.4)</td>
<td>37 (3.1)</td>
<td>52 (3.1)</td>
<td>0.6</td>
<td>1.6</td>
<td>1.1</td>
</tr>
<tr>
<td>40–49</td>
<td>124 (27.7)</td>
<td>235 (19.5)</td>
<td>359 (21.7)</td>
<td>6.1</td>
<td>11.3</td>
<td>8.7</td>
</tr>
<tr>
<td>50–59</td>
<td>150 (33.6)</td>
<td>335 (27.8)</td>
<td>485 (29.4)</td>
<td>11.3</td>
<td>25.2</td>
<td>18.2</td>
</tr>
<tr>
<td>60–69</td>
<td>94 (21.0)</td>
<td>285 (23.7)</td>
<td>379 (23.0)</td>
<td>11.1</td>
<td>35.2</td>
<td>22.9</td>
</tr>
<tr>
<td>≥70</td>
<td>61 (13.6)</td>
<td>304 (25.2)</td>
<td>365 (22.1)</td>
<td>7.9</td>
<td>36.6</td>
<td>22.8</td>
</tr>
<tr>
<td>All</td>
<td>447 (100.0)</td>
<td>1204 (100.0)</td>
<td>1651 (100.0)</td>
<td>3.3</td>
<td>9.0</td>
<td>6.1</td>
</tr>
</tbody>
</table>

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3.6, 21.6 versus 9.4, 28.0 versus 13.5, and 37.7 versus 8.2 per 100,000 person-years, respectively (Fig. 2; Table 2).

Incidence of Neurological Deficits

Eighty-five patients (5.2% of all OPLL cases) were moderately or severely disabled due to related cervical myelopathy or SCI (Table 3). The incidences of disability varied by age, in a decreasing trend, except for the 60-to 69-year-old group (p = 0.05, chi-square test for trend; Fig. 3). Although male patients with OPLL appeared to have higher risk of developing SCI-related disability, this trend did not reach statistical significance (p = 0.18, test for proportion).

Surgical Treatment

A total of 542 patients (32.8%) in the cohort were conservatively treated, while 1109 (67.2%) underwent surgical treatment. Of those who received surgery, 612 (55.2%) underwent an anterior-only approach, 353 (31.8%) underwent a posterior-only approach, and 144 (13.0%) underwent a combined anterior and posterior approach.

Incidence of Neurological Deficits by Surgical Approach

The incidence of disability varied with surgical approach. The majority of patients who had OPLL (67.2%) underwent surgery during their admission, and more than half (55.2%) underwent an anterior-only approach, whereas almost one-third (31.8%) had a posterior-only approach. A minority (13.0%) had the combined anterior and posterior approach. After adjustments for demographic features and comorbidities such as diabetes, hypertension, and cerebro- and cardiovascular diseases, patients with cervical OPLL who underwent posterior-only surgery were more likely to have related disability (adjusted OR 2.19, p = 0.01; Table 4). There were no other significant differences among the groups.

Discussion

The present report is, to date, the largest series of cervical OPLL in a span of a decade to investigate the incidence, prevalence, hospitalization, and surgical treatment of OPLL. All previously reported prevalence rates, varying from 0.1% to 4.6% in different ethnic groups including Caucasian and Japanese, have been calculated from institutional databases. Furthermore, most are radiographic prevalence rates, which should not be considered representative of endemic reality. Data from patients, whether symptomatic, who underwent imaging studies of the cervical spine for various reasons at certain institutions, inherently had selection bias. Therefore, data in the literature are overestimated when considering the epidemiological status of cervical OPLL. Comparisons of prevalence rates among these hospital-based studies are thus pointless since they have different inclusion cri-
teria of the sample populations. The selection bias from institution-based data becomes more prominent considering the rarity of the disease. In the current study, the incidence of cervical OPLL-related admissions, calculated from the nationwide retrospective cohort, is 6.1 per 1 million person-years. The differences in each age and sex category also provide a better understanding of the endemic nature and natural history of the disease.

Very few epidemiological investigations on OPLL come from authors outside Japan. Even in endemic regions of Japan, where there are reports, there is a paucity of cross-sectional epidemiological studies for the actual prevalence rate. Some literature report higher incidences of OPLL in middle-aged patients. In 1984, Tsuyama reported the highest incidence among patients 50–59 years old in Japan. In Korea, Kim et al. reported the highest prevalence rate of 1.36% in the age group of 50–59 years old from 11,774 patients who underwent radiographic examinations of the cervical spine. Aside from East Asian countries, Harsh et al. reported on 20 patients from North America with a mean age of 47.5 years old. For the first time, data from the present study clearly demonstrate that older age correlates with higher incidence and prevalence rates of cervical OPLL (Fig. 1). This fact also implies the degenerative nature of the disease.

Ossification of the posterior longitudinal ligament has been reported to be more common in male patients. In the literature, the male/female ratio ranges from 1.1 to 3.0 in different reports, including those from outside Japan. On the other hand, there are reports that state the opposite. For example, Hiramatsu and Nobechi reported that women were affected 3 times more than men. The discrepancy can again be attributed to the use of an institutional database rather than population-based data. The data in the current study also demonstrate clearly, for the first time, the sex-specific incidences and prevalence of cervical OPLL. Overall, men are almost 3 times more commonly affected than women, and the gap between sexes increases with age. In the male population, incidence and prevalence rates escalate drastically as age increases. Despite a similar increase in women, the actual numbers are smaller, and the increase does not change until they are older than 70 years (Fig. 2).

Cervical OPLL can cause severe adverse effects on spinal cord function. There is no practical treatment other than surgery. However, a large portion of patients with cervical OPLL remain asymptomatic for prolonged periods. Therefore, numerous reports address the best timing of surgery, as well as the choices of surgical approaches. In the current cohort, 67.2% of patients received surgical treatment, of whom more than half (55.2%) were

![Fig. 3. Age- and sex-specific percentages of cervical OPLL-related moderate to severe disability.](image-url)

**TABLE 4: Demographic factors, co-morbidities, cumulative incidence rates, and adjusted odds ratios of OPLL patient with disability, stratified by surgical approach**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conservative Treatment (542 patients)</th>
<th>Anterior-Only (612 patients)</th>
<th>Posterior-Only (353 patients)</th>
<th>Anterior + Posterior (144 patients)</th>
</tr>
</thead>
<tbody>
<tr>
<td>demographic factor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>female sex</td>
<td>136 (25.1)</td>
<td>199 (32.5)</td>
<td>80 (22.7)</td>
<td>32 (22.2)</td>
</tr>
<tr>
<td>mean age (± SD)</td>
<td>60.8 ± 13.7</td>
<td>57.4 ± 11.6</td>
<td>57.5 ± 11.1</td>
<td>58.2 ± 11.1</td>
</tr>
<tr>
<td>comorbidity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>diabetes</td>
<td>64 (11.8)</td>
<td>80 (13.1)</td>
<td>46 (13.0)</td>
<td>23 (16.0)</td>
</tr>
<tr>
<td>hypertension</td>
<td>107 (19.7)</td>
<td>115 (18.8)</td>
<td>62 (17.6)</td>
<td>26 (18.1)</td>
</tr>
<tr>
<td>cerebrovascular disease</td>
<td>31 (5.7)</td>
<td>16 (2.6)</td>
<td>4 (1.1)</td>
<td>5 (3.5)</td>
</tr>
<tr>
<td>heart diseases</td>
<td>39 (7.2)</td>
<td>28 (4.6)</td>
<td>17 (4.8)</td>
<td>6 (4.2)</td>
</tr>
<tr>
<td>disability (moderate to severe SCI)</td>
<td>no. of patients w/ disability 21</td>
<td>24</td>
<td>29</td>
<td>11</td>
</tr>
<tr>
<td>cumulative incidence rate of disability (%)</td>
<td>3.9</td>
<td>3.9</td>
<td>8.2</td>
<td>7.6</td>
</tr>
<tr>
<td>adjusted OR (95% CI)</td>
<td>reference</td>
<td>0.99 (0.54–1.81)</td>
<td>2.19 (1.17–3.77)†</td>
<td>1.93 (0.90–4.14)</td>
</tr>
</tbody>
</table>

* Unless indicated otherwise, values are presented as the number of patients with percentages in parentheses.
† Significant (p < 0.05) after adjustments for sex, age, and comorbidities.
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via an anterior-only approach, 31.8% were via a posterior-only approach, and 13.0% had a combined anterior and posterior approach. It has always been a classic debate regarding the best surgical approach for such patients with regard to fewer complications and better outcomes. Data in the current study show higher disability rates after posterior surgery. However, this finding should not be misinterpreted as posterior surgery posing more risk on patients. Due to lack of clinical parameters, the analysis is underpowered to compare options for surgical treatment. Nonetheless, it serves as a survey for disease outcomes in epidemiology.

This study also shows a trend of the decreasing risk of disability as the patient ages. This holds true with all age groups with the exception of the 60- to 69-year-old age group. There are still insufficient data to determine the timing of surgical intervention. However, the surge of risk in the 60- to 69-year-old age group implies a potential benefit of intervention in asymptomatic patients belonging to this age group or symptomatic patients reaching this age group. The best timing, as well as choice of surgical approach, requires confirmation in future studies. No conclusion can be made in the present report.

The current study has limitations. First, diagnoses in the national health insurance claims primarily serve administrative billing purposes, and as such, do not undergo verification for scientific purposes. Nonetheless, individuals with cervical OPLL are ascertained by hospitalization and surgical procedures in most cases, which are therefore reliable. Second, the disability outcome of the study is determined by the registry of patients with catastrophic illnesses of the NHIRD, which also serves billing and social welfare benefits, and thus, is under prudent internal monitor. The study individuals are also blinded to the investigator, and mild disability or minor SCI is not included. There is, therefore, a lack of differentiation of degrees of neurological outcome. Third, although demographic data and comorbidities, such as diabetes, hypertension, cerebrovascular disease, and diseases of the heart, have been included in the multivariate logistic regression analysis, personal habits such as smoking, body mass index, and the condition of the anatomical level of the disease are not available from the NHIRD. Additional large-scale studies with detailed clinical parameters will be helpful in further understanding the disease.

One critical caveat of this report is the source of the incidence. The data are collected from OPLL-related admissions, which inherently underestimated the actual value, due to possible exclusion of asymptomatic or mildly symptomatic patients. Furthermore, since the asymptomatic or mildly symptomatic patients who would not be hospitalized are not included in this database, the data presented in this paper are likely to underestimate the incidence and prevalence of OPLL of asymptomatic or mildly symptomatic patients. The advantages of this study are the nationwide database, which provides a large patient number on a rare disease, and the validity of diagnosis ascertained by admissions. On the other hand, because the hospitalization database of NHIRD used in this study does not include patients who underwent follow-up in the outpatient clinic, there is a bias toward identifying more symptomatic patients who require hospitalization. In addition, the surgical rate in this group is rather high compared with other published series, indicating that there are more symptomatic patients in this cohort leading to a higher rate of surgery. Interestingly, the study raises the importance of the rate of disability. The most symptomatic patients who are disabled from the OPLL are likely to be captured in the database with a high accuracy rate. The relative proportion of patients who are disabled from OPLL, in respect to the overall number of OPLL patients, cannot be determined by this method.

The natural history of cervical OPLL is critical, especially in the management of young or mildly symptomatic patients. However, very few reports address this issue due to the rarity of the disease. Compared with the incidence of cervical disc diseases receiving anterior cervical discectomy and fusion in Taiwan, 98 per 1 million person-years, also calculated by NHIRD, cervical OPLL is indeed an uncommon disease of the cervical spine in the Chinese population. The results of this study can be deemed as indirect evidence indicating the degenerative nature of cervical OPLL. This degenerative process more obviously affects males and the severity of its comorbid disability is related to age and surgical approach. These findings add to literature as a regional, nationwide overview.

Conclusions

In this large cohort of the Chinese population, the incidence of cervical OPLL is 6.1 per 1 million person-years, and its prevalence rate is 7.7 per 100,000 person-years. Higher incidences are observed in elderly and male patients, which implies the degenerative nature of the disease. After adjustment for demographics, the incidences and trends of OPLL-related comorbid disability are associated with age and surgical approaches.

Disclosure

This study was based partly on data from the NHRI database provided by the BNHI, Department of Health, and managed by NHRI in Taiwan. The interpretation and conclusions contained herein do not represent those of the BNHI, the Department of Health, or NHRI.

Author contributions to the study and manuscript preparation include the following. Conception and design: YC Chen, Wu, Liu. Acquisition of data: YC Chen. Analysis and interpretation of data: YC Chen, Wu. Drafting the article: YC Chen, Wu, Liu. Critically revising the article: Wu. Reviewed final version of the manuscript and approved it for submission: YC Chen, Wu. Statistical analysis: YC Chen. Administrative/technical/material support: YC Chen, Huang, TJ Chen, Cheng. Study supervision: Huang, Cheng.

References


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Address correspondence to: Yu-Chun Chen, M.D., M.Sc., Institute for Medical Biometry and Informatics, Department of Medical Informatics, Heidelberg University, Im Neuenheimer Feld 305, Heidelberg 69120, Germany. email: Yu-Chun.Chen@stud.uni-heidelberg.de.