

# Life expectancy after cervical laminoplasty —Causes of the fatal prognosis at the early stage (within 5 years)—

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## Abstract:

**Introduction:** In more than 20 years' follow-up after cervical laminoplasty, some patients died at an early stage, within 5 years postoperatively. The details remain unclear. This study was conducted to elucidate the clinical features in patients who died at an early stage after cervical laminoplasty to determine possible preventive measures against early death after surgery.

**Methods:** A total of 74 patients who died with the follow-up period were included. The patients were divided into two groups: patients with a short survival period (S group, died  $\leq 5$  years after surgery) and patients with a long survival period (L group, died  $> 5$  years after surgery). Diseases, gender, age, causes of the death, general complications before surgery, and the pre- and postoperative JOA scores were compared between the two groups.

**Results:** Eleven patients (15%) died within 5 years after laminoplasty. The average age at death in the S group was 68.7 years which was considerably younger than that in the L group (80.2 years). The ratio of pneumonia was higher in the S group, compared to that in the L group. Postoperative JOA score in the S group was lower than that in the L group.

**Conclusions:** 11 patients out of 74 patients (15%) died within 5 years after laminoplasty. The average age at the death in the S group was much younger than that in the L group. The postoperative JOA score in the S group was lower than that in the L group. As pneumonia was more prevalent in the S group, it might be reasonable to give the information for the protection of pneumonia after cervical laminoplasty.

## Keywords:

cervical laminoplasty, cervical spondylosis, ossification of the posterior longitudinal ligament, life expectancy, cause of death, cervical spine, operative treatment

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## Introduction

Cervical laminoplasty has been indicated for treating the patients with cervical compressive myelopathy due to cervical spondylosis (CS) and ossification of the posterior longitudinal ligament (OPLL) since 1980's. In our recent study, we analyzed the surgical outcomes of more than 20 years' follow up after *en bloc* cervical laminoplasty and found that cervical laminoplasty is a safe procedure, because there were no patients who died due to surgical complications<sup>1)</sup>. The previous studies demonstrated that the average life expectancy from surgery to death was  $13.4 \pm 7.4$  years<sup>2)</sup>. There was no difference in the survival rate between the CS and OPLL patients. The most frequent cause of death was ma-

lignant tumor, followed by ischemic heart disease and cerebral infarction. However, there were some patients who died at the early stage in that follow up. As the average life expectancy was 13 years, it might be reasonable to judge the early death as the death within 5 years from surgery. In the clinical point of view, it is beneficial for spinal surgeons to know the detailed information of the early death after cervical laminoplasty when therapeutic strategy is considered for the patients with compressive myelopathy. This information might also be beneficial to consider the post-operative care. This study was conducted for detecting the clinical features in patients who died at the early stage, within 5 years, after cervical laminoplasty to seek the possible preventive measures against the early death.

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### Materials and Methods

Two hundred and sixteen patients underwent *en bloc* cervical laminoplasty for the treatment of cervical compressive myelopathy due to CS or OPLL between 1981 and 1994 at our university hospital. It was possible to follow 148 patients for more than 20 years. There were 68 surviving patients and 80 patients who had died by the time of their last follow-up. Demographic data of patients followed for more than 20 years after cervical laminoplasty are shown in Fig. 1. Clinical diagnosis was made by physical examination, plain radiography, CT, myelography, and MRI. This study was carried out using the data of patients with CS or OPLL only. Diseases such as rheumatoid arthritis, destructive spondyloarthropathy, spinal metastasis, and primary spinal tumors were strictly excluded. No patient in this study had a medical history of being treated for malignant tumors. *En bloc* laminoplasty, as proposed by Itoh and Tsuji<sup>3,4)</sup>, was utilized for the decompression of the spinal cord in all patients. The detail of this procedure was reported in previous papers<sup>2-4)</sup>.

Eighty patients who had died at the last follow up were subjected to this study. There were 44 patients with CS (31 males and 13 females) and 36 patients with OPLL (30 males and 6 females). Detailed information regarding the death was obtained from the medical record in our hospital or the family members of patients. It was unclear for the family members of 5 patients (2 males with CS and 3 males with OPLL) to declare the exact year of patients' death. These patients were excluded. One CS patient who committed suicide 1 year after surgery was also excluded. A total of 74 patients were subjected to this study.

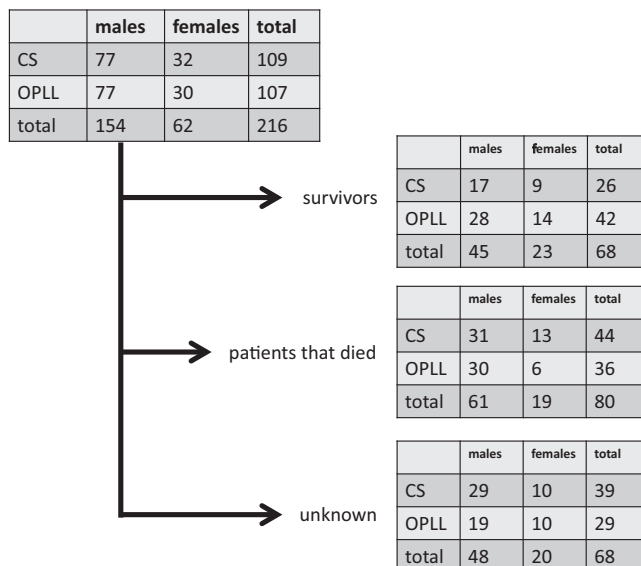
The patients were divided in to two groups; patients with short survival times (S group) and patients with long survive times (L group). The S group was the category of patients who died ≤5 years after surgery and the L group was that of patients who died >5 years after surgery. The following data was compared in the two groups. Those were diseases, gender, age, causes of the death, and general complications before surgery.

The neurological evaluation was graded using the scale devised by the Japanese Orthopaedic Association (JOA), called JOA score<sup>5)</sup>. The preoperative JOA score was compared between the S group and the L group. The rate of recovery, which indicates the degree of normalization after surgery, was calculated using the following formula:

$$(\text{postop. score} - \text{preop. score}) \times 100 / \{17 (\text{full score}) - \text{preop. score}\}$$

The postoperative score within 1 year after surgery was used for the analysis, because of the possible effect of the causes regarding the early death in the S group. The postoperative JOA score and recovery rate were also compared between the two groups.

Although we obtained data for respiratory function in all the patients before surgery, however we could not access data because the surgery was carried out more than 20 years



**Figure 1.** Demographic data of patients followed for more than 20 years after cervical laminoplasty. Results of 216 patients treated by cervical laminoplasty from 1981 to 1994. Sixty-eight patients died at the follow-up. CS: cervical spondylosis, OPLL: ossification of the posterior longitudinal ligament. The same figure was used in reference No. 2.

ago. Most of the medical sheets did not exist in the hospital.

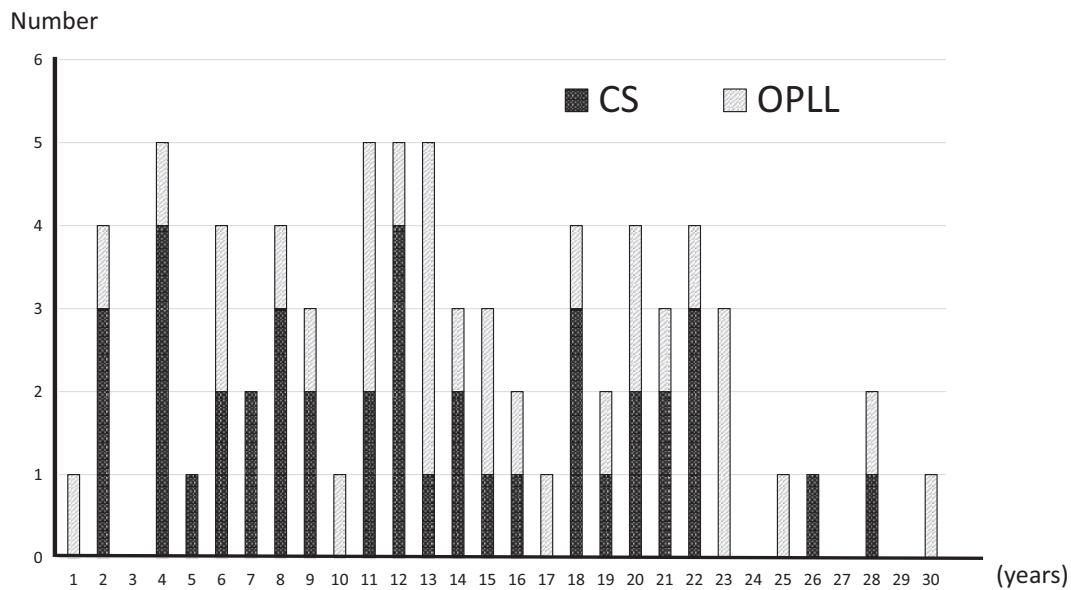
### Statistical analysis

Data were presented as the mean value ± standard deviation. Fisher's exact test was used for the analysis of the gender and disease distribution between the S and L groups. The same statistics were used for the analysis of incidence regarding the causes of the death. A *t*-test with Welch's correction was used for the statistical analysis of the difference in mean age, JOA score, and recovery rate between the S and L groups. StatMate software version 5.01 (Japan) was used for the analysis and p<0.05 was considered as statistically significant.

### Results

Fig. 2 showed the data of when patients died after surgery. Eleven patients (15%) died within 5 years after cervical laminoplasty. These patients were in the short survival time group (S group). The detailed demographic data were shown in Table 1. There were 8 males (5 CS and 3 OPLL) and 3 females (3 CS). The average age at operation in the S group was 65.6 ± 7.7 years and the age at death was 68.7 ± 7.3 years. The average period of survival was 3.1 ± 1.3 years in the S group. Sixty-three patients were included in the long survival time group (L group). Comparison of the demographic data showed that there were no statistical differences in gender, diseases of patients, and the age at operation (Table 2). However, the age at death in the S group was lesser than that in the L group (80.2 ± 7.2 years old).

As for the preoperative general complications, one patient



**Figure 2.** The period of death caused after cervical laminoplasty. CS: cervical spondylosis, OPLL: ossification of the posterior longitudinal ligament.

**Table 1.** Demographic Data of the Patients in the S Group.

No.	gender	disease	age at op.	age at the death	cause of the death	pre op. complication
1	male	OPLL	79	80	pneumonia	
2	male	CS	62	64	pneumonia	DM
3	male	CS	68	70	cerebral infarction	
4	male	CS	63	65	gastric cancer	HT
5	male	OPLL	63	65	pneumonia	
6	female	CS	62	66	brain tumor	
7	female	CS	67	71	unknown	
8	male	CS	65	69	lung cancer	HT
9	female	CS	78	82	natural death	HT
10	male	OPLL	64	68	ileus	
11	male	CS	51	56	pneumonia	

CS: cervical spondylosis  
 OPLL: ossification of the posterior longitudinal ligament  
 op.: operation  
 DM: diabetes mellitus  
 HT: hypertension  
 S group: short survival group

**Table 2.** Comparison of the Data between the S Group and the L Group.

	S group	L group	p value
Male/Female (n)	8/3	47/16	0.9
CS/OPLL (n)	8/3	33/30	0.21
age at operation (years)	65.6±7.7	64.7±8.5	0.74
age at death (years)	68.7±7.3	80.2±7.2	<0.001

(n): number  
 CS: cervical spondylosis  
 OPLL: ossification of the posterior longitudinal ligament  
 S group: short survival group  
 L group: long survival group

had non-insulin dependent diabetes mellitus and three patients had hypertension which was controlled by medication in the S group. No other remarkable general complications were found in the S group.

The causes of death were varied (Table 3). The characteristic finding was that the ratio of pneumonia sufferers was more in the S group than in the L group. Four patients (36%) in the S group died from pneumonia, whereas 6% in the L group died from pneumonia. There was a statistical difference in ileus between the two groups, but there was only 1 patient in the S group. Malignant tumor was the common lethal disease in both groups.

There was no difference in preoperative JOA score between the S and L groups. In contrast, postoperative JOA score in the S group was lower than that in the L group.

**Table 3.** Comparison of the Causes of the Death between the S Group and the L Group.

	S group (n=11)	L group (n=63)	p value
malignant tumor	3 (27%)	20 (32%)	0.83
ischemic heart disease	0	13 (21%)	0.14
natural death	1 (9%)	10 (16%)	0.61
pneumonia	4 (36%)	4 (6%)	0.015
cerebral infarction	1 (9%)	5 (8%)	0.91
ileus	1 (9%)	0	0.021
renal failure	0	1 (1.5%)	0.68
anaplastic anemia	0	1 (1.5%)	0.68
suffocation	0	1 (1.5%)	0.68
unknown	1 (9%)	8 (13%)	0.76

S group: short survival group

L group: long survival group

However, there was no statistical difference in the recovery rate between the two groups (Table 4).

## Discussion

This study showed that the average age at death in the S group was 68.7 years. This was much lesser than the average age of death in the L group. In recent public data published in 2013, the average life span in Japanese people was 80.21 years for males and 86.61 years for females. Thus, the average lifespan in the S group was also much lesser than that in the average Japanese people. It might be important for spine surgeons to know the exact reasons why the average age of death in the S group was so small, in order to consider the cautionary note before surgery. Also, it might be beneficial in the follow-up after cervical laminoplasty.

There were no remarkable general complications among patients in the S group. However, pneumonia was the most frequent cause of death in this group. The current data revealed that, regarding the cause of the death, the incidence of pneumonia in the S group was higher than that in the L group. These results indicate that we must pay attention to respiratory problems, such as pneumonia, in the follow up for the patients after cervical laminoplasty. Previous studies demonstrated that cervical myelopathy impaired respiratory function<sup>6-8)</sup>. Nomura et al reported that forced vital capacity%, peak flow rate, and maximum voluntary ventilation (MVV)% in patients with cervical myelopathy was smaller than those in normal controls<sup>6,7)</sup>. Toyoda et al found that expiratory flow was impaired in patients with cervical myelopathy<sup>8)</sup>. The patients with spinal cord injury had impaired pulmonary function and frequently suffered from pneumonia<sup>9)</sup>. Analysis of the three cohorts revealed that reduced respiratory function was the most important risk factor of pneumonia<sup>10)</sup>. Thus, it is speculated that the impaired respiratory function due to cervical myelopathy results in the fatal pneumonia at the early stage after cervical laminoplasty.

JOA score was established to evaluate neurological status

**Table 4.** Comparison of the JOA Score and Recovery Rate between the S Group and the L Group.

	S group	L group	p value
pre op. JOA score	8.1±3.4	7.8±3.4	0.75
post op. JOA score	11.2±4.1	13.0±2.2	0.035
Recovery rate (%)	39.5±29.4	54.0±25.4	0.09

op.: operation

S group: short survival group

L group: long survival group

in patients with cervical myelopathy<sup>5)</sup> and it is commonly used in clinical practice. This score includes the items for checking motor function of upper and lower extremities, sensory function of the whole body, and bladder function. In this study, postoperative JOA score in the S group was lower than that in the L group. This is an interesting result, because postoperative neurological status might be related to life expectancy. However, this JOA score system has no item to evaluate respiratory function. In our study, there was no data regarding the pre- and post-operative patients' respiratory function. Previous study showed that MVV% was significantly correlated with postoperative recovery of the JOA score<sup>7)</sup>. Unsatisfactory post-operative recovery, including impaired recovery of respiratory function, might be related to the early death in the S group. Although severity of neurological dysfunction is correlated with respiratory dysfunction<sup>11)</sup>, it is impossible to know the respiratory dysfunction only using JOA score. Respiratory dysfunction is caused by phrenic nerve insufficiency, weakness of respiratory muscles, and loss of intercostal tonus. Based on these dysfunctions, patients frequently have difficulty in deep breathing and experience cough. There was a case report describing diaphragmatic paralysis due to cervical spondylotic myelopathy<sup>12)</sup>. Some patients with respiratory dysfunction have severe sputum and suffer from aspiration pneumonia. Therefore, it might be beneficial to evaluate respiratory function before performing cervical laminoplasty. Breathing condition, ability to cough, the existence of severe sputum, and the level of diaphragm by X-P are the concrete checking points before surgery.

Cervical laminoplasty brings about the recovery of the neurological status in patients with cervical myelopathy. A previous study revealed that cervical laminoplasty improved respiratory function in elderly patients with cervical myelopathy<sup>13)</sup>. Thus, cervical laminoplasty might reduce the risk of postoperative pneumonia. However, we consider that surgery is not a direct protective measure for pneumonia. A new system to protect streptococcus pneumonia has been introduced in Japan since 2014. Vaccination against streptococcus pneumonia is recommended in elderly people every 5 years of age over 65 years old. The information regarding the vaccination should be given to the elderly patients who have cervical laminoplasty. Other protective measures, such as gargle, hand-washing, tooth brushing, and cessation of smoking, are strictly advised to the patients before surgery

and at the follow-up after surgery.

This study has several limitations. Firstly, this is a retrospective study with case series. We were not able to obtain any data from 68 patients who did not follow-up. Secondly, the responsible levels of cervical myelopathy were unclear. Most of them had multilevel spinal cord compression due to CS or OPLL. Thirdly, the data of pre- and post-operative respiratory functions were not evaluated in this study. This data is useful for the important message regarding the prevention of pneumonia. However, this data could not be accessed because the operation was performed more than 20 years ago. Fourthly, the causes of death were based on the medical sheets and answers to questions from family members of the patients. The real cause of death was partly unclear. In addition, the cause of pneumonia was unclear. If pneumonia was caused by streptococcus, vaccination might be effective for prevention.

In conclusion, 11 out of 74 patients (15%) died within 5 years after laminoplasty. The average age of patients at the time of death in the short survival time group was 68.7 years, which was much lesser than that in the long survival time group. The postoperative JOA score in the S group was lower than that in the L group. The ratio of pneumonia occurrence was greater in the short survival time group, compared to that in the long survival time group. It might be reasonable to give the information for the protection from pneumonia after cervical laminoplasty.

**Conflicts of Interest:** The authors declare no conflicts of interest.

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