

# C5 Palsy After Cervical Laminectomy

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## ABSTRACT

**AIM:** A common complication of cervical laminectomy and fusion with instrumentation is the development of postoperative C5 nerve palsy.

The aim of this study was to review the clinical outcome of surgery after cervical laminectomy for cervical spondylotic myelopathy (CSM), and to analyse the role of posterior shift of the spinal cord on the C5 palsy.

**MATERIAL and METHODS:** The patient population included all patients with CSM who underwent cervical laminectomy and fusion between 2008 and 2015. The demographic, clinical and radiological results of the patients were retrospectively reviewed.

**RESULTS:** From a total of 75 cases with CSM who underwent cervical laminectomy and fusion using lateral mass screw fixation, C5 palsy developed in 8 (10.7%) cases. Recovery was seen within six months in 7 cases but 1 case with bilateral C5 palsy only improved unilaterally. Postoperative posterior shift of spinal cord (PSSC) was measured as  $3.6 \pm 1.6$  mm and  $5.2 \pm 1.8$  mm in cases without and with C5 palsy, respectively ( $p < 0.05$ ).

**CONCLUSIONS:** It was concluded that there is an increased posterior shift of the spinal cord in cases with C5 palsy, when compared to those without C5 palsy.

**KEY WORDS:** Cervical spondylotic myelopathy, laminectomy, laminoplasty, C5 palsy

## INTRODUCTION

Cervical laminectomy and laminoplasty are well-defined surgical options in the treatment of cervical spondylotic myelopathy (20,21,35). Both techniques may be associated with a variety of complications.

C5 palsy is a well-known complication of posterior cervical decompression. Postoperative C5 palsy has been reported in 1.4-9.6% of cases after cervical laminoplasty, and in 4.8-18.4% of cases after cervical laminectomy (9). There are many hypotheses to explain this complication, including posterior shift of the spinal cord, persistent foraminal stenosis, insufficient C5 foraminotomy, and spinal cord hyperperfusion due to acute spinal cord decompression.

The aim of this study was to compare postoperative MR images in cases with and without C5 palsy, to reveal the signal changes in T2W MR images, and posterior shift of the spinal cord (PSSC) after posterior decompressive cervical spine surgery.

## MATERIAL and METHODS

The patient population included all patients with cervical spondylotic myelopathy who underwent cervical laminectomy and posterior stabilization between 2008 and 2015. The demographic, clinical and radiological aspects of all patients were reviewed retrospectively. Clinical states were evaluated using the Japanese Orthopedic Association (JOA) scale. Preoperative and postoperative MR images were retrospectively evaluated to determine PSSC. The PSSC was measured on the mid-sagittal views of T2-weighted MR images. The distance between the posterior wall of the vertebral body or intervertebral disc to the center of the spinal cord at the site of maximum compression was measured, and the difference between the postoperative and preoperative values was accepted as PSSC.

The patient population was categorized as patients with or without C5 palsy. Both JOA scores, postoperative signal changes in postoperative T2W MR images, and PSSC findings were measured in cases with and without C5 palsy.

Postoperative C5 palsy was described as deterioration of muscle strength with one or more grades of manual muscle testing on the deltoid and the biceps after surgery without any weakening of other neurological symptoms.

### Surgical Procedure

All cases underwent surgery in the prone position in a Mayfield head holder. The head was positioned in slight flexion. The number of lamina to be removed was determined based on preoperative MR and CT image findings. In order to minimize the risk of spinal cord injury due to posterior shift of the spinal cord, a hemilaminectomy in the levels above and below of the compression site was also performed.

After paravertebral muscle dissection, the lateral mass screw holes were prepared. The laminectomy was performed using either a high-speed drill or ultrasonic bone scalpel. In cases of foraminal stenosis, a foraminotomy was added. After laminectomy, rods were fixated to the screws, and otogenous bone grafts were placed over facet joints.

### Statistical Analysis

A value of  $p < 0.05$  was considered statistically significant. Logistic regression analysis was performed with SPSS software ver. 16.0 (SPSS Inc., Chicago, IL, USA). The same parameters were compared twice by the same person and the median was adopted.

## RESULTS

A total of 75 cases underwent cervical laminectomy and posterior stabilization using lateral mass screw fixation. The patients were 55 males and 20 females with a mean age of  $56.4 \pm 11.9$  years. Five-level laminectomy and posterior stabilization was applied to 14 (18.7%) cases, three-level to 32 (42.3%) cases, four-level to 20 (26.7%) cases, and two-level to 9 (12%) cases (Figure 1A,B; 2A,B).

Postoperative C5 palsy occurred in 8 (10.7%) cases (age:  $64 \pm 6.5$  years, 7 male, 1 female). C5 palsy occurred on postoperative day 1 in 7 cases, and on day 5 in 1 case. The C5 palsy was bilateral in 2 cases, and unilateral in 6 cases. Revision surgery for C5 nerve foraminotomy was applied to 2 cases with painful C5 palsy. The mean preoperative and postoperative JOA scores were found to be  $13.5 \pm 3.5$  and  $15.4 \pm 2.8$ , respectively. The mean preoperative and postoperative JOA scores of cases with C5 palsy were found to be  $11.4 \pm 2.5$  and  $12.8 \pm 3.2$ , respectively. A statistically significant change was determined in the JOA scores in the comparison of cases with and without C5 palsy ( $p < 0.05$ ).

There were no new signal changes on the T2W MR images of the cases with C5 palsy. Mean PSSC was measured as  $5.2 \pm 1.8$  mm and  $3.6 \pm 1.6$  mm in cases with and without C5 palsy, respectively. A statistically significant change was determined in the comparison of PSSC in cases with and without C5 palsy ( $p < 0.05$ ).



**Figure 1:** Postoperative without C5 palsy case sample; preoperative (A) and postoperative (B) magnetic resonance imaging sagittal T2-weighted images after treatment by multilevel laminectomy and instrumentation.

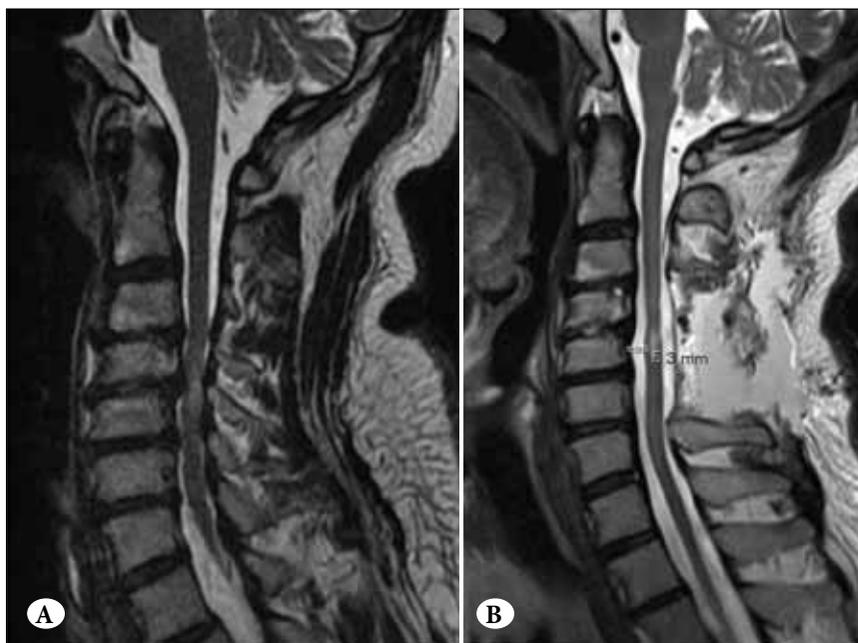
The mean follow-up period was  $36.4 \pm 3.6$  months. Complete recovery within 6 months was observed in 6 cases with C5 palsy, but 1 case with bilateral C5 palsy only improved unilaterally (Table 1-2).

## DISCUSSION

This study confirmed that there is no additional signal change on the MR images of cases with postoperative C5

palsy. However, there was an increased PSSC in cases with C5 palsy, when compared to the cases without postoperative C5 palsy.

There are a variety of anterior, posterior and combined methods to decompress and stabilize the cervical spine in cervical spondylotic myelopathy. Each approach has its pros and cons. Currently, laminoplasty or laminectomy



**Figure 2:** Postoperative with C5 palsy case sample; preoperative (A) and postoperative (B) magnetic resonance imaging sagittal T2-weighted images after treatment by multilevel laminectomy and instrumentation.

**Table 1:** Demographic and Clinical Data of Patients of C5 Palsy Group

No	Age-Sex	Level of Laminectomy & Stabilization	Palsy Side	Onset (Post Op. Day)	Treatment	Recovery (mo)
1	72 M	C3-4-5-6	R	1	Medical - Rehabilitation	5
2	64 M	C3-4-5-6	R	1	Foraminotomy	1
3	59 M	C3-4-5-6	L	1	Medical - Rehabilitation	2
4	63 M	C4-5-6	R	1	Medical - Rehabilitation	6
5	57 F	C4-5-6	B	1	Medical - Rehabilitation	6
6	66 M	C4-5-6	L	1	Foraminotomy	1
7	58 M	C3-4-5-6	R	5	Medical - Rehabilitation	6
8	58 M	C4-5-6	B	1	Medical - Rehabilitation	5

**Table 2:** Comparison of JoA Scores and Posterior Shift of Two Groups

	Without C5 palsy group	With C5 palsy group	P value
Preoperative JoA Score	$13.5 \pm 3.5$	$11.4 \pm 2.5$	$P < 0.05$
Postoperative JoA Score	$15.4 \pm 2.8$	$12.8 \pm 3.2$	$P < 0.05$
Posterior shift of spinal cord	$3.6 \pm 1.6$ mm	$5.2 \pm 1.8$ mm	$P < 0.05$

with or without fusion is the treatment choice in many cases. Although both procedures are associated with a good postoperative outcome, there is a risk of C5 palsy.

The first cases of postoperative C5 palsy in literature were reported by Stoops and King (30), and Scoville (26) in 1961.

C5 palsy has been reported to occur in 6.7% to 30% of reported series in meta-analyses. It may develop after all cervical procedures, including laminoplasty, corpectomy, laminectomy, and combined surgeries. However, the rate of C5 palsy is higher after laminectomy and fusion (18,24).

C5 palsy has been reported at the rate of 2.3-9.6%, 1.4-8.9%, 5.1%, 8.4%, and 4.8-18.4% after open-door laminoplasty, after double-door laminoplasty, after cervical corpectomy, after cervical corpectomy and fusion, and after laminectomy and fusion, respectively (10,18,32,35).

Kaneyama et al. (13) compared open door laminoplasty and double-door laminoplasty, and reported a higher rate of C5 palsy after open door laminoplasty.

In the current study, postoperative C5 palsy occurred in 8 (10.7%) of 75 cases, who underwent laminectomy and fusion.

The risk factors for postoperative C5 palsy have been reported to be male gender, the corpectomy level, type of laminoplasty, the presence of ossified posterior longitudinal ligament, age, and the laminectomy level (13,18).

Many hypotheses have been proposed to explain C5 palsy (5,20,21). Intraoperative injury is one of the first hypotheses. According to Tamiya et al. (31), C5 palsy may occur as a result of direct injury or thermal damage to the C5 nerve root. Hirabayashi et al. (8,9), and Iwamoto et al.(12), reported that in cases in which the C5 nerve is injured directly, C5 palsy is seen in the early postoperative period. In the current series, in spite of no direct injury, C5 palsy was seen on postoperative day 1 in 7 cases and in 1 case on the 5<sup>th</sup> postoperative day.

The role of reperfusion after decompression is another hypothesis (23,25). According to Chiba et al. (4), and Hasegawa et al. (6), C5 palsy may occur due to local reperfusion-induced grey matter damage. This type of injury may be seen on postoperative T2-weighted MR images (14). Seichi (27) did not find any relationship between C5 palsy and signal changes on T2-weighted MR images.

Furthermore, the presence of anterior compression, as seen in OPLL, is another etiological factor. In these cases, the spinal cord may shift 1-1.5 mm toward the posterior after

laminectomy or laminoplasty. In such a situation, a tethering effect-related C5 palsy may occur (2,17,20,33,34,36). According to Baba et al(1), C4 and C5 nerve roots shift an average of 3.6 mm toward the posterior after double door laminoplasty. However, it is of note that the role of spinal cord shift has not been accepted by other authors (7,28,29). The current study supports the effect of PSSC on C5 palsy. In this series PSSC was found to be  $3.6\pm 2.2$  mm, and  $5.2\pm 1.8$  mm in cases without and with C5 palsy ( $p<0.05$ ).

C5 foraminal stenosis may also increase the risk of C5 palsy. In a study of 1858 cervical laminoplasty cases, Imagama et al. (11), showed that the C5 foramen was smaller than the other foramina, although there was no difference in C5 foraminal diameter in the cases with and without C5 palsy.

The treatment of C5 palsy is still controversial. Although many authors have reported that prophylactic C5 foraminotomy decreased the risk of C5 palsy in cases with C5 foraminal stenosis (3,15,16,19), the effect of this procedure remains a matter of debate (16,31). In the current series, prophylactic foraminotomy was not applied. Similarly, the role of revision surgery is controversial. In the current study, only 2 cases with painful C5 palsy underwent revision surgery for additional foraminotomy. Both cases improved. However, C5 palsy occurred after one day in one of the cases. All cases, except one, improved within 3 months after surgery. The C5 palsy of 1 case with bilateral C5 palsy only improved on one side.

## CONCLUSIONS

There are currently many hypotheses to explain postoperative C5 palsy. The tethering effect hypothesis is one of the most popular theories. The results of this study confirmed statistically significant PSSC in cases with C5 palsy, when compared to those without C5 palsy.

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