



Original Article

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Epidemiology of C5 Palsy after Cervical Spine Surgery: A 21-Center Study

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Objective: C5 palsy is a severe complication after cervical spine surgery, the pathophysiology of which remains unclear. This multicenter study investigated the incidence of C5 palsy following cervical spine surgery in Korea.

Methods: We conducted a retrospective multicenter study involving 21 centers from the Korean Cervical Spine Study Group. The inclusion criteria were cervical spine surgery patients between 2012 and 2016, excluding cases of neck surgery. In patients with C5 palsy, the operative methods, disease category, onset time of C5 palsy, recovery time, C5 manual muscle testing (MMT) grade, and post-C5 palsy management were analyzed.

Results: We collected 15,097 cervical spine surgery cases from 21 centers. C5 palsy occurred in 88 cases (0.58%). C5 palsy was more common in male patients ($p = 0.019$) and after posterior approach procedures ($p < 0.001$). C5 palsy usually occurred within 3 days after surgery (77 of 88, 87.5%) and most C5 palsy patients recovered within 6 months (51 of 88, 57.95%). Thirty C5 palsy patients (34.09%) had motor weakness, with an MMT grade ≤ 2 . Only four C5 palsy patients (4.5%) did not recover during follow-up. Posterior cervical foraminotomy was performed in 7 cases (7.95%), and steroids were used in 56 cases (63.63%). Twenty-six cases (29.55%) underwent close observation only.

Conclusion: The overall incidence of C5 palsy was relatively low (0.58%). C5 palsy was more common after posterior cervical surgery and in male patients. C5 palsy usually developed within 3 days after surgery, and more than half of patients with C5 palsy recovered within 6 months.

Keywords: C5 palsy, Cervical spine surgery, Epidemiology



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INTRODUCTION

Postoperative C5 palsy is a well-known complication after cervical decompression surgery. C5 palsy usually involves deltoid weakness, but it can affect the supraspinatus, infraspinatus, subscapularis, biceps brachii, brachialis, brachioradialis, teres minor, serratus anterior, levator scapulae, rhomboid minor, and rhomboid major. Usually, patients with C5 palsy show an inability to abduct the shoulder.

Numerous epidemiological studies have investigated C5 palsy after cervical decompression surgery. A recent meta-analysis showed that the incidence was 6.3%,¹ in a total of 61 studies containing 721 patients with C5 palsy among a total of 11,481 patients. The incidence of C5 palsy among the studies varied between 1% and 29%. C5 palsy may present immediately after surgery or up to 2 months postoperatively, and its prognosis is usually good.²⁻⁶

Some studies have suggested that the pathophysiology of C5 palsy may involve inadvertent injury to the nerve root during surgery, nerve root traction caused by spinal cord shifting, spinal cord ischemia resulting from decreased blood supply, and reperfusion injury of the spinal cord. However, the pathophysiology of C5 palsy remains unclear.⁷

The goal of this study was to investigate the incidence, patients' characteristics, and outcomes of C5 palsy in a large multicenter retrospective review of cervical spine surgery cases in Korea. This study has the largest number of cases of cervical spine surgery related to C5 palsy, to the best of our knowledge, and more data about C5 palsy will be available after this preliminary retrospective study.

Table 1. Postoperative C5 palsy and operative methods of cervical spine surgery

| Type of surgery | No. of cases | No. of cases of C5 palsy (%) |
|--------------------|--------------|------------------------------|
| ACDF | 7,952 | 24 (0.30) |
| ACCF | 610 | 5 (0.82) |
| Laminoplasty | 3,343 | 25 (0.75) |
| Laminectomy/Fusion | 2,935 | 33 (1.12) |
| 360° Fusion | 257 | 1 (0.39) |
| Total | 15,097 | 88 (0.58) |

ACDF, anterior cervical discectomy and fusion; ACCF, anterior cervical corpectomy and fusion.

MATERIALS AND METHODS

We conducted a retrospective multicenter study involving 21 centers from the Korean Cervical Spine Study Group. The inclusion criteria were patients who underwent cervical spine surgery between 2012 and 2016. Cases of neck surgery, such as interventions for a neck mass, tracheostomy, or pain, were excluded. We obtained patients' characteristics and information on complications including C5 palsy, diagnosis, and type of surgery. In patients with C5 palsy, the operative methods, disease category, onset time of C5 palsy, recovery time of C5 palsy, C5 manual muscle testing (MMT) grade, and post-C5 palsy management were investigated.

RESULTS

We collected 15,097 cervical spine surgery cases from 21 centers. Male patients were predominant in this study population (10,029 vs. 5,068). Among all cases of cervical spine surgery, 11,153 were performed for degenerative disease, 2,163 for trauma, 1,041 for a tumor, 157 for an infection, and 203 for congenital disease. There were 8,562 anterior approach procedures, 6,278 posterior approach procedures, and 257 anteriorposterior procedures. The patients' mean age was 55.06 ± 13.17 years.

C5 palsy patients accounted for 88 of all cervical surgery cases (0.58%). The prevalence of C5 palsy was ranged from 0% to 2.61% at 21 centers. There were 69 male patients. The mean age of patients with C5 palsy was 60.86 ± 11.78 years. There were 30

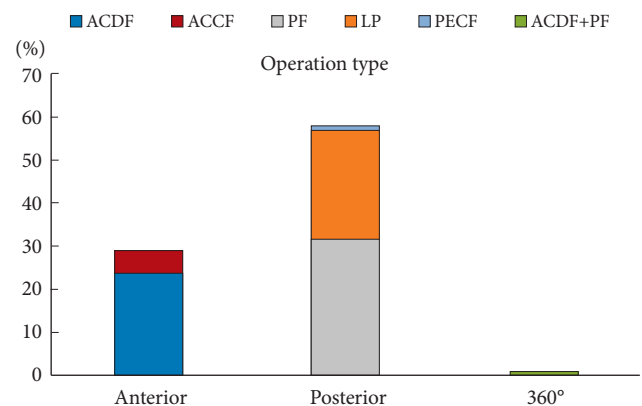


Fig. 1. Distribution of C5 palsy cases according to the type of cervical surgery. ACDF, anterior cervical discectomy and fusion; ACCF, anterior cervical corpectomy and fusion; PF, posterior fusion; LP, laminoplasty; PECE, posterior endoscopic cervical foraminotomy.

Table 2. Outcomes after C5 palsy in terms of the MMT grade

| MMT at C5 palsy onset | No. of cases of C5 palsy (%) | MMT at C5 palsy recovery | No. of cases of C5 palsy (%) |
|-----------------------|------------------------------|--------------------------|------------------------------|
| 0 | 2 (2.27) | 0 | - |
| 1 | 7 (7.95) | 1 | 2 (2.27) |
| 2 | 21 (23.86) | 2 | 2 (2.27) |
| 3 | 33 (37.5) | 3 | 12 (13.64) |
| 4 | 25 (28.41) | 4 | 42 (47.73) |
| 5 | - | 5 | 24 (27.27) |
| | - | Death | 1 (1.14) |
| | - | F/U loss | 5 (5.68) |
| Total | 88 (100) | - | 88 (100) |

MMT, manual muscle testing; F/U, follow-up.

anterior approach procedures, 57 posterior approach procedure, and 1 anterior-posterior procedure. In particular, C5 palsy occurred after anterior cervical corpectomy and fusion (5 of 620, 0.82%), laminoplasty (25 of 3,343, 0.75%), and laminectomy and fusion (33 of 2,935, 1.12%). C5 palsy was more common in male patients ($p=0.019$) and after posterior surgery ($p<0.001$), but age did not show a statistically significant relationship (Table 1, Fig. 1).

C5 palsy usually occurred within 3 days after surgery (77 of 88, 87.5%) and more than half of the C5 palsy patients recovered within 6 months (51 of 88, 57.95%). Thirty C5 palsy patients (34.09%) had motor weakness, with an MMT grade of 2 or lower. Only four C5 palsy patients (4.5%) did not recover during the follow-up period (Table 2).

After the onset of C5 palsy, posterior cervical foraminotomy was performed in 7 cases (7.95%), and steroids were used in 56 cases (63.63%). Twenty-six cases (29.55%) underwent close observation, without any intervention.

DISCUSSION

The prevalence of C5 palsy after cervical decompression surgery in our retrospective review was 88 among 15,097 cases (0.58%). This is much lower than has been observed in other studies.⁷⁻¹¹ However, a recent multicenter retrospective study found that C5 palsy occurred in 59 patients among 13,946 cases (0.41%).¹² This low incidence rate may have been due to recall bias, as a limitation of a retrospective study, but we suggest that improvements in surgical techniques, intraoperative neuro-monitoring systems, and the high quality of the microscope contributed to the lower incidence of C5 palsy after cervical decom-

pression surgery.¹³

In our results, C5 palsy was more common in male patients ($p=0.019$) and after posterior surgery ($p<0.001$). The surgical approach may affect the incidence of C5 palsy. A study comparing anterior and posterior surgery found a higher incidence of C5 palsy after the posterior approach.¹⁴ A meta-analysis of 79 studies showed the same results as ours, finding that C5 palsy was more common in posterior cervical surgery than in anterior surgery, and more frequent in male patients than in female patients (5.2% vs. 22%).¹⁰ After posterior decompression, the extensive reduction of the spinal cord may affect the C5 nerve root, causing it to kink in the cervical foramen. However, we are unsure why the anterior approach can also cause C5 palsy. One possibility is that the change of height between the cervical vertebral bodies may worsen foraminal stenosis. Further study would be necessary to prove this theory. Another study showed that older age was the strongest predictor of C5 palsy, but our results did not show a statistically significant relationship with age.¹¹

There is some controversy regarding prophylactic cervical foraminotomy to prevent C5 palsy after cervical decompression surgery. Komagata et al.¹⁵ reported that postoperatively, C5 palsy occurred in 0.6% of patients who received prophylactic cervical foraminotomy and in 4.0% of patients in the control group. Another study showed that prophylactic cervical foraminotomy reduced the incidence of C5 palsy compared with the control group (1.7% vs. 7.0%) through a 2-year prospective study, without adversely affecting cervical alignment, stability, hinge site, neurological recovery, and axial pain.¹⁶ However, a recent retrospective study reported that prophylactic bilateral C4/5 foraminotomies did not eliminate the occurrence of C5 palsy.¹⁷ We could not determine how many C5 palsy patients had received prophylactic cervical foraminotomy, but after the onset of C5 palsy, posterior cervical foraminotomy was performed in 7 cases (7.95%).

Intraoperative detection of C5 palsy using intraoperative neurophysiological monitoring (IONM) has been attempted. Specifically, transcranial electrically-stimulated muscle-evoked potentials (TcE-MsEPs) are expected to detect C5 palsy during surgery, but controversy remains whether TcE-MsEPs can in fact do so. Some studies have shown positive results of IONM,^{18,19} but others did not.^{20,21}

In our study, C5 palsy usually occurred within 3 days after surgery (87.5%). Similarly, in another study, among 52 C5 palsy cases, 31 patients (60%) had C5 palsy after surgery and the others within 7 days.¹¹ Furthermore, most of our C5 palsy patients

with an MMT grade of 2 or lower (30 patients) recovered to an MMT grade of 3 or higher, with the exception of 4 patients. In other studies, improvements were usually seen at the last follow-up.¹¹

This was a retrospective study, and therefore had several limitations. We cannot be sure that we collected all C5 palsy patients from all cervical decompression surgery cases. Some institutions did not carefully track cases of mild C5 palsy, with an MMT grade of 3 or higher, because their experience was that C5 palsy usually improves with time. Therefore, we cannot absolutely exclude the possibility that the incidence in our multicenter study was somewhat underestimated compared to previous studies.

Many studies have analyzed risk factors for C5 palsy after cervical decompression surgery, but have generally been limited to populations of 10–20 C5 palsy patients.^{7,22-24} However, in this multicenter study, we collected data on 88 C5 palsy patients, forming the cornerstone of our planned future study to analyze risk factors for C5 palsy.

CONCLUSION

The overall incidence of C5 palsy was relatively low (0.58%) in this study, and C5 palsy was more common after posterior cervical surgery and in male patients. C5 palsy usually developed within 3 days after surgery, and more than half of patients with C5 palsy recovered within 6 months. This data could serve as important information for preparing and counseling patients who need cervical spine surgery. However, a further prospective study is necessary to assess the risk factors and proper management of postoperative C5 palsy.

CONFLICT OF INTEREST

The authors have nothing to disclose.

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