

C5 Palsy Following Cervical Spine Decompression

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ABSTRACT **Background:** Cervical spinal surgery is considered safe and effective. One of the few specific complications of this procedure is C5 nerve root palsy. Expressed primarily by deltoid muscle and biceps brachii weakness, it is rare and has been related to nerve root traction or to ischemic spinal cord damage.

Objectives: To determine the clinical and epidemiological traits of C5 palsy. To determine whether C5 palsy occurs predominantly in one specific surgical approach compared to others.

Methods: A retrospective study of patients who underwent cervical spine surgery at our medical center during a consecutive 8-year period was conducted. The patient data were analyzed for demographics, diagnosis, and surgery type and approach, as well as for complications, with emphasis on the C5 nerve root palsy.

Results: The study group was comprised of 124 patients. Seven (5.6%) developed a C5 palsy following surgery. Interventions were either by anterior, by posterior or by a combined approach. Seven patients developed this complication. All of whom had myelopathy and were older males. A combined anteroposterior (5 patients) and posterior access (2 patients) were the only approaches that were associated with the C5 palsy. None of the patients who were operated via an anterior approach did develop this sequel.

Conclusions: The incidence of the C5 root palsy in our cohort reached 5.6%. Interventions performed through a combined anterior-posterior access in older myelopathic males, may carry the highest risk for this complication.

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Surgeries of the cervical spine represent a salient part of the spinal procedures, and are considered to be safe and efficacious for trauma as well as degenerative and malignant diseases. There are a few specific complications concerning cervical spine surgery. Among them: recurrent laryngeal nerve palsy, dysphagia, Horner's syndrome, pharyngeal or esophageal perforation and the C5 nerve root palsy [1]. The C5 palsy is not the most frequent or serious sequels of this intervention; however,

it is a burden to the patient due to a significant reduction in the strength of the deltoid or biceps brachii. The palsy may develop shortly or within days after surgery [2]. Most of the patients will recover weeks or months following surgery [3,4]. A correlation between muscle strength at presentation and time to recovery, which may last up to one year in severe cases, has been described. There may also be a permanent muscle weakness in up to 20% of the patients. [2].

C5 nerve root palsy is expressed by a deltoid muscle weakness with or without involvement of the biceps brachii. Its incidence and etiology may include root traction injury during expansion or part of the myelopathic process. It is not excluded that the pertinent etiology might be a combination of the two [5,6].

Earlier studies have shed a light on some of the risk factors for the development of C5 nerve root palsy, such as older age and male gender [2,4]. These factors might help physicians during the preoperative planning and assessment. Other factors include anatomical features detected at preoperative imaging, such as the anteroposterior diameter of the spinal canal at C4-C5 or the ipsilateral foramen diameter. These preoperative measurements have not been validated in large and well-designed prospective clinical studies [7-9].

We have established the frequency of this unaccountable complication of cervical spine surgeries as well as the related risk factors. Clarifying these aspects of C5 root palsy may allow more careful preoperative, intraoperative, and postoperative perspectives from the managing staff.

PATIENTS AND METHODS

The study was approved by our institutional review board. This retrospective study included all patients who underwent cervical spine surgery during an 8-year period. The patient data were analyzed for demographics, diagnostics, surgery type and approach, and for complications. Emphasis was put on the uncommon sequels related to this type of surgery, notably C5 nerve root palsy.

All approaches involved decompression. Anterior decompression occurred either through discectomy or corpectomy. Posterior decompression included laminectomy and lateral mass arthrodesis. In a combined anteroposterior approach the

decompression reached almost 360 degrees.

All myelopathic patients were operated routinely, with neurophysiologic monitoring.

Post-operative CT scan was performed in all patients who developed a C5 palsy to confirm the lack of evidence of residual or iatrogenic pressure.

RESULTS

In our department during the study period, 124 patients underwent cervical spine surgery. Table 1 summarizes the leading indications for surgery: Cervical spondyloitic myelopathy (86 patients) cervical radiculopathy (13 patients) and spinal cord compression due to trauma (11 patients), metastatic spinal cord disease (6 patients) and spondylodiscitis (2 patients).

Postoperatively, seven of the 124 patients (5.6%) had developed C5 root palsy. The mean age of the study group was 57.13 years for the normal deltoid strength group, while the patients who had C5 palsy were slightly older with a mean age of 66.43 ($P = 0.08$) [Table 2]. The odds ratio was 1.066 with 95% confidence interval of 0.99–1.136. Patients with C5 palsy were all males ($P = 0.09$).

Forty-four (36 %) of the procedures were conducted by an anterior approach, and none of these patients had a C5 palsy.

Thirty-five (28%) of surgeries were done through a posterior approach only, of whom two patients (5.7%) developed C5 palsy.

Most of the patients (45, 36%) with C5 palsy had undergone surgery through a combined anteroposterior approach. This was the most common approach employed ($P = 0.04$) [Table 3]. When comparing the posterior to a combined anteroposterior approach, the odds ratio was 2.06 with 95% Wald Confidence Interval of 0.376–11.328.

All seven patients who developed C5 palsy had undergone posterior arthrodesis that included C4–C5. None of the postoperative CT scans that were performed on patients diagnosed with C5 palsy showed neural pressure that needed to be revised.

In 18% of patients, surgery was located either above or below the C5 level. None developed C5 palsy. All seven who developed C5 palsy had decompression involving C5 [Figure 1]. This was either in a nearly 360 degrees fashion (5 patients who had an anterior-posterior approach) or a posterior laminectomy combined with arthrodesis (2 patients). No palsy has occurred in the additional 96 (82%) of patients who had decompression at the C5 level.

The most common indication for the primary spinal surgery was myelopathy, which encompassed 86 of the cases (68.5%). All seven patients with C5 palsy belonged to this group ($P = 0.9$). In contrast, none of the remaining indications for surgery, was associated with this sequel [Table 1].

Table 1. C5 nerve root palsy following cervical spine decompressive surgery: clinical features

Indication		Postoperative C5 palsy n (%/124)	Normal postoperative Strength n (%/124)	Total	P value
Degenerative spondylosis	Myelopathy	7 (5.6)	79 (64)	88	NS
	Radiculopathy	0	13 (10.4)	13	NS
	Revision stenosis	0	6 (4.8)	6	NS
Cord compression	Trauma	0	11 (8.8)	11	NS
	Tumor	0	6 (4.8)	6	NS
	Spondylodiscitis	0	2 (1.6)	2	NS
Total		7	117	124	

Table 2. C5 nerve root palsy following cervical spine decompressive surgery: demographic features

		Postoperative, C5 palsy n (%/124)	Normal postoperative deltoid strength n (%/124)	P value
n (%)		7 (5.6)	117 (94.4)	NS
Mean age, years		66.43y	57.13y	NS
Sex	Male	7	0	NS
	Female	0	117	NS

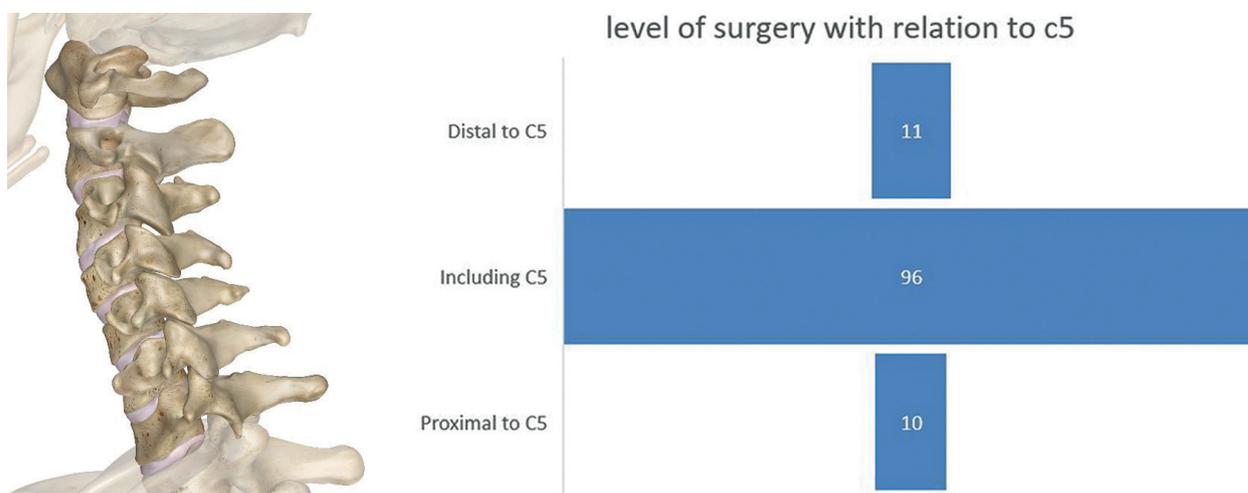
DISCUSSION

C5 root palsy is relatively rare following cervical spine surgeries. It appears as weakness of the deltoid and sometimes the biceps brachii muscles. A recent meta-analysis has further established the features of this condition, and its clinical associations [10].

The incidence of this sequel is variously reported to encompass 4.3% [11] to 15.7% [8]. Risk factors for this complication includes older age, male gender, previous foraminal stenosis at C4-5, posterior surgical approach [4,12] Etiology and pathogenesis have not been determined; however, common theory explains it with a nerve roots traction due to cord shift following laminectomy and sac expansion [2,4,12]. The occurrence rate of a C5 palsy in our study was 7 of 124 cervical spine surgeries (5.6%), which is near the minimal rate disclosed so far [6,8,12,13].

Table 3. C5 nerve root palsy following cervical spine decompressive surgery: surgical features

Surgical approach		C5 palsy n	Normal deltoid strength n	Total	P value
Anterior		0	44 (100)	44 (%/n)	NS
Posterior		2 (5.7)	33 (94.3)	35 (%/n)	NS
Ant. & Post.		5 (11)	40 (89)	45 (%/n)	0.04
Total	7	117	124		

Figure 1. Level of surgery with relation to C5 (number of patients)

We found older age and male gender to be associated with the incidence of C5 nerve root palsy. Age could be a confounder due to its strong association with cervical spinal stenosis. Yet, foraminal stenosis was excluded as a risk factor in all patients of our group who developed C5 palsy.

No significant difference between prior anterior and posterior approaches associated with C5 root palsy has been proven [6,8,13,14], although a tendency to lower incidence following anterior approach is reported [4,12]. This sequel was not found in our study in patients who underwent anterior approach surgery; however the number of participants is small and we did not exclude this complication [11,14-16]. When posterior access and the anterior-posterior combined approach were compared, the mixed approach was related to twice as much incidence of C5 palsy. Absence of that complication following an anterior approach, as well as the finding that all patients with C5 palsy had posterior arthrodesis, may raise the suspicion of direct root injury as a cause of C5 palsy. However, all patients in our series had a postoperative CT scan that excluded mechanical injury. In addition, only 2 of 35 patients who had undergone a posterior approach only, developed C5 palsy.

Postoperative C5 palsy has been related to a transient spinal cord injury [17]. The fact that all 7 patients who developed this complication in our group were myelopathic supports this assertion. Others have associated this complication with stretching of the nerve roots during cervical spine surgery [18-20]. This theory, however, is valid for those who are operated from anterior as well as posterior access [4]. Another correlation with C5 palsy that was mentioned is C4-5 foraminal stenosis. However, none of the 7 patients who were diagnosed with C5 palsy in our group had stenosis as determined by their neuroimaging studies.

CONCLUSIONS

The posterior surgical approach during cervical spinal surgery, either as part of a combined anteroposterior or as a solitary surgical approach, was found to be associated with C5 palsy. Other possible risk factors are preexistent cervical myelopathy, older age, and male gender. Pre-operative undetected spinal injury may be related to preexistent myelopathy and spinal stenosis could explain some of the findings, but should probably be further investigated.

The etiology for C5 palsy as a sequel of cervical spine surgery has remained a moot point. In our study, we nevertheless could not raise for this purpose the likelihood of more than one etiological factor.

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Capsule

Effectiveness of an Inactivated SARS-CoV-2 vaccine in Chile

Jara et al. used a prospective national cohort, including participants 16 years of age or older who were affiliated with the public national healthcare system, to assess the effectiveness of the inactivated severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) vaccine with regard to preventing coronavirus disease-2019 (COVID-19) and related hospitalization, admission to the intensive care unit (ICU), and death. The authors estimated hazard ratios using the extension of the Cox proportional-hazards model, accounting for time-varying vaccination status. They also estimated the change in the hazard ratio associated with partial immunization (≥ 14 days after receipt of the first dose and before receipt of the second dose) and full immunization (≥ 14 days after receipt of the second dose). Vaccine effectiveness was estimated with adjustment for individual

demographic and clinical characteristics. The study was conducted from 2 February to 1 May 2021. The cohort included approximately 10.2 million individuals. Among people who were fully immunized, the adjusted vaccine effectiveness was 65.9% (95% confidence interval [95%CI] 65.2–66.6) for the prevention of COVID-19 and 87.5% (95%CI 86.7–88.2) for the prevention of hospitalization, 90.3% (95%CI 89.1–91.4) for the prevention of ICU admission, and 86.3% (95%CI 84.5–87.9) for the prevention of COVID-19–related death. These results suggest that the inactivated SARS-CoV-2 vaccine effectively prevented COVID-19, including severe disease and death, a finding that is consistent with results of phase 2 trials of the vaccine.

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Capsule

Neutralizing antibody levels are highly predictive of immune protection from symptomatic SARS-CoV-2 infection

Khoury et al. analyzed the relationship between in vitro neutralization levels and the observed protection from severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) infection using data from seven current vaccines and from convalescent cohorts. They estimated the neutralization level for 50% protection against detectable SARS-CoV-2 infection to be 20.2% of the mean convalescent level (95% confidence interval [95%CI] 14.4–28.4%). The estimated neutralization level required for 50% protection from severe infection was significantly lower (3% of the mean convalescent level; 95%CI 0.7–13%, *P* = 0.0004). Modeling of the decay of the neutralization titer over the first 250 days after immunization

predicts that a significant loss in protection from SARS-CoV-2 infection will occur, although protection from severe disease should be largely retained. Neutralization titers against some SARS-CoV-2 variants of concern are reduced compared with the vaccine strain, and the model predicts the relationship between neutralization and efficacy against viral variants. The authors show that neutralization level is highly predictive of immune protection, and provide an evidence-based model of SARS-CoV-2 immune protection that will assist in developing vaccine strategies to control the future trajectory of the pandemic.

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