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Original Article

Quantitative measures of functional outcomes and quality of life in patients with C5 palsy

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Abstract

Background: It is generally understood that postoperative C5 palsy can occur with anterior or posterior decompression surgery, but functional measures of the palsy have not been well documented. This study aimed to investigate the incidence of C5 palsy in different surgical procedures, examine the correlations between muscle strength, upper extremity functional measures, and health-related quality of life, and to observe potential risk factors contributing to C5 palsy.

Methods: Our investigation involved a retrospective study design. A total of 364 patients who underwent decompression surgery were indicated within the selected exclusion criteria. Additionally, 12 C5 palsy patients were recruited. The relationships between the manual muscle test (MMT), the action research arm test (ARAT), the Jebsen test of hand function (JTHF), and the European quality of life-5 dimensions (EQ-5D) were studied, and univariate analyses were performed to search possible risk factors and recovery investigation.

Results: The data analyzed in the 12 cases and C5 palsy incidences (3.3%) were: 0.7% in anterior procedures ($n = 2$), 8.8% in posterior procedures ($n = 6$), and 36.4% in combined procedures ($n = 4$). Moderate-to-high correlations were observed between the ARAT, JTHF, EQ-5D visual analog scale scores, and MMT ($r = 0.636−0.899$). There were significant differences in patient age, etiology of cervical lesion, variable decompression procedures, and the number of decompression levels between the C5 palsy and non-C5 palsy groups. For female patients ($p = 0.018$) and number of decompression levels ($p = 0.028$), there were significant differences between the complete recovery and the incomplete recovery groups.

Conclusion: Patients undergoing combined anterior−posterior decompression surgery had the highest incidence of C5 palsy, and correlations between the ARAT, JTHF, EQ-5D visual analog scale clinical tools, and MMT scores supported these findings. Female status and lower decompression levels could also be predictive factors for complete recovery, although additional research is needed to substantiate these findings.

Keywords: cervical spine; C5 palsy; functional measures; quality of life; surgical decompression

1. Introduction

Postoperative C5 motor palsy may occur arising from anterior or posterior decompression surgery, but the pathogenesis and functional measures of the palsy remain unknown.[1,2] The published incidence of C5 palsy varies widely; for example, in the anterior cervical discectomy and fusion group, the range of incidence was 1.6−12.1%,[3−6] and 0−30.0% in the laminoplasty

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group.[7–10] Most studies have been limited by a small number of cases and dependence on specialized institutions. This study will investigate the incidence of C5 palsy after various surgical procedures.

Although controversy regarding the various mechanisms underlying postoperative C5 palsy still exists, the importance of the functional measures and quality of life regarding this issue have recently garnered attention. Objective functional measures of C5 palsy following cervical decompression surgery have not yet been fully established. However, most studies have used a manual muscle test (MMT) grade and the Japanese Orthopedic Association (JOA) score to present the severity and neurological recovery rate,[2,11,12] but both tools may not be specific to an upper extremity functional measure. Thus, we used two functional outcome evaluation tools: the action research arm test (ARAT),[13] and the Jebsen test of hand function (JTHF),[14] for upper extremity functional outcome evaluation. In addition to the importance of functional measures, we also emphasized the quality of life (QoL) investigation in the C5 palsy group. QoL assessed patients' success or achievements in life domains that are considered important to most people, including physical, social, and mental issues. Researching the QoL of C5 palsy patients was important because it helped the clinician to recognize these patients' level of satisfaction with the postoperative motor palsy event. This analysis also provided clinicians with information on dose adjustments for pain management, demand for psychological support, and motivation to rehabilitate. In this study, the European quality of life-5 dimensions (EQ-5D) was used as a self-rated assessment of health status of clinical outcomes.[15]

A previous study discussed the possible poor surgical outcome factors in patients with cervical myelopathy,[16] but it lacked a correlation between objective upper extremity functional measures and surgical factors analysis in postoperative C5 palsy. Therefore, it seems reasonable to survey these relationships with respect to this issue to clarify and prevent this major morbidity.

The two specific aims of the current study were: (1) to investigate the incidence of C5 palsy following cervical decompression surgery and identify differences based on these three surgical procedures; and (2) to analyze the correlation of functional measures and QoL related to MMT.

2. Methods

2.1. Study design

This was a retrospective study that analyzed the variant incidences of C5 palsy in all patients following cervical decompression surgery and their functional measures in order to clarify the possible risk factors for this major morbidity. The study was approved by the Institutional Review Board of Taipei Veterans General Hospital, and the patients gave informed consent before participation.

2.2. Recruitment and data collection

There were 401 patients who underwent cervical decompression surgery between January 2009 and September 2010 at Taipei Veterans General Hospital, Taipei, Taiwan. The surgical data bank was searched using surgical codes such as anterior cervical decompression, posterior cervical decompression, and combined anterior–posterior cervical decompression to enroll cases.

Exclusion criteria were: (1) evidence of spinal cord injury; (2) previous traumatic cervical spine injury or cervical spine fracture history; (3) spinal tumor or vascular malformation; and (4) evidence of spinal infection extending to the disks or spinal canal. A total of 37 patients were ineligible for the exclusion criteria. The remaining 364 patients with cervical disease underwent cervical decompression surgery (285 anterior, 68 posterior, 11 combined anterior–posterior) at the hospital. Their ages ranged from 19 years to 84 years, with a mean ± standard deviation (SD) of 55.9 ± 12.0 years, and included 224 men and 140 women. Various cervical lesions for surgical decompression are presented in Table 1.

Most studies generally used the inclusion criteria of C5 palsy that were a deterioration of the muscle strength of the deltoid or biceps brachii by at least one grade in a standard

Table 1
Patient characteristics and incidence of C5 palsy for different procedures.

Decompression procedures	Anterior approach	Posterior approach	Combined anterior–posterior approach	p
Age (y, mean ± SD)	54.3 ± 11.7	62.4 ± 11.7 *	58.7 ± 10.5	<0.001
Gender (M/F)	178/107	45/23	10/1	
	No. of palsy cases (%)	No. of palsy cases (%)	No. of palsy cases (%)	
Cervical lesion [a]				
CSM	1/108 (0.9%)	6/50 (12%)	3/6 (50%)	<0.001
CSR	1/46 (2.2%)	0/2 (0%)	0/1 (0%)	0.006
Disc herniation	0/106 (0%)	0/3 (0%)	0/2 (0%)	<0.001
OPLL	0/23 (0%)	0/13 (0%)	1/2 (50%)	0.16
CSA	0/2 (0%)	0/0 (0%)	0/0 (0%)	1.000
Total	2/285 (0.7%)	6/68 (8.8%)	4/11 (36.4%)	

*$p < 0.001$ by one way analysis of variance (ANOVA) between anterior approach and posterior approach procedure.
CSA = cervical spondylotic amyotrophy; CSM = cervical spondylotic myelopathy; CSR = cervical spondylotic radiculopathy; OPLL = ossification of posterior longitudinal ligament; SD = standard deviation.
[a] Fisher's exact test.

MMT, without aggravation of lower extremity function. In addition to meeting the previous inclusion criteria, we used stricter inclusion criteria of C5 palsy that the muscle strength of the affected extremity must be normal grade in a standard MMT before surgery for the purpose of eliminating the baseline variability. Charts were reviewed and the diagnosis of C5 palsy recorded in the charts confirmed. A total of 12 patients met the selection criteria. All participants were recruited from the neurosurgery inpatient ward via neurosurgeons or neurosurgery outpatient department follow-up group via a research assistant by telephone. All recruitments for each of the 12 patients occurred at an average of 4 months after surgery (range 1–6.5 months).

The assessment process consisted of the following steps. First, all patients meeting the study criteria were given a detailed explanation of the study, and signed informed consents before participation. Then, all participants received an initial screening by a rehabilitation physician to confirm their C5 palsy diagnosis and assess their current muscle strength. Next, an occupational therapist carried out the two upper extremity functional measures. A research assistant interviewed these patients with the Chinese version of the EQ-5D questionnaire for QoL assessment.[17] The assessment duration ranged from 30 minutes to 60 minutes, with a typical length of 45 minutes. The rehabilitation physician then proceeded, and the survey protocol included separate measures of physical symptoms, preoperative/intraoperative factors, surgical procedure, and overall post-C5 palsy treatment course from individual chart records. All patients had undergone conventional rehabilitation, consisting of 2 hours of daily therapy 3–4 times a week during the inpatient period.

2.3. Surgical techniques

Three types of surgical techniques have been previously described in detail, and include anterior cervical discectomy and fusion (ACDF),[18,19] posterior decompression surgery (laminoplasty),[20,21] and anterior cervical microdiscectomy combined with posterior decompression surgery.[22]

In this study, the ACDF area varied from 1–4 intervertebral disc levels. Spinal fusion was performed with an autologous iliac crest or fibula bone graft. Internal fixation devices such as a plate and screw system were used for fusion surgery of three or more levels.

In posterior decompression surgery, laminectomy levels varied from a single intervertebral disc level to five intervertebral disc levels. An iliac crest autograft, harvested from the right iliac crest site, or a fibula bone graft, was then applied after routine decortication. Construction devices such as a plate and lateral mass screw system were used for three or more levels.

The anterior approach combined with posterior laminectomy and fusion was usually indicated in cases with obvious cervical myelopathy or ossification of posterior longitudinal ligament at multiple levels. Owing to the complex procedures, the surgical duration was significantly increased. As in previous surgical procedures, autologous graft and construction devices were also used in this procedure.

2.4. Measurement tools

The ARAT[13,23] is an observational test used to assess upper extremity function and impairment. The test comprises 19 items grouped into subtests (grasp, grip, pinch, and gross arm movement), and uses a four-point quantitative scale (0 = no movement possible, 1 = movement partially performed, 2 = movement performed but abnormally, and 3 = movement performed normally). The maximum obtainable score is 57.

Three manual tasks adapted from the JTHF[14,24] were used to evaluate upper extremity dexterity: (1) picking up small common objects; (2) picking up large light objects; and (3) picking up large heavy objects. Patients were instructed to complete each task as fast as they could and the time to complete each task was thereafter analyzed.

The EQ-5D self-classifier assesses the five dimensions of mobility, self-care, usual activity, pain/discomfort, and anxiety/depression in three degrees (none, moderate, and extreme).[15] It can be used to generate a single index derived from valuations of the health state. The EQ-5D consists of a self-rated visual analog scale (VAS) that allows people to classify and rate their overall health status on the day of the survey.

2.5. Statistical analysis

Statistical analyses were conducted using the SPSS 17.0 software (SPSS Inc., Chicago, IL, USA). Quantitative data are presented as the mean ± SD. All potential risk factors and recovery investigation used in the univariate analysis were assessed between groups. Continuous variables were compared using one-way analysis of variance (ANOVA; Table 1), independent *t* test (Table 3), or Mann–Whitney *U* test (Table 5). Categorical variables were assessed using Chi-square test or Fisher's exact test. The relationship between the scores in the upper extremity subscale of the ARAT, JTHF, and in the C5 MMT were examined using nonparametric statistical method Spearman's correlation coefficient method. A multivariable analysis was determined using stepwise linear regressions, considering all variables with $p < 0.05$ to be candidate variables. An r value between 0 and 0.25 was considered to represent a low association, a value of between 0.25 and 0.5 represented a fair association, a value of between 0.5 and 0.75 represented a moderate association, and a value > 0.75 represented a high association.[25] A p value <0.05 was considered significant.

3. Results

Table 1 presents patients' characteristics, the number of cases of postoperative C5 palsy, and the percentage of C5 palsy cases among the total number of C5 palsy cases for each category by surgical procedure. The average age of patients in the anterior approach group was significantly less than in the posterior approach group ($p < 0.001$). The etiology of cervical lesions of operation was significantly different among the three groups as determined by Fisher's exact test as follows: cervical spondylotic myelopathy ($p < 0.001$); cervical spondylotic radiculopathy ($p = 0.006$); disc herniation

Table 2
Summary of demographic data from 12 patients with C5 palsy.

Case no.	Age (y)/sex	C5 palsy onset		MMT grade			Operative data			
		Pain (d)	Weak (d)	Preop	Onset	FU	Hb (g/L)	Blood loss (mL)	Level (n)	Period (min)
1	58/F	0.5	1	5	4	5	151	150	4	210
2	60/F	2	3	5	4	5	116	50	1	145
3	57/M	1	2	5	4	5	160	150	2	290
4	53/F	2	4	5	1	5	155	500	2	650
5	77/M	3	3	5	3	3	108	150	5	325
6	71/M	1	2	5	3	3	129	1400	3	180
7	65/M	3	3	5	1	2	118	200	4	185
8	81/M	2	3	5	2	2	123	250	4	465
9	58/M	1	1	5	0	2	133	200	3	165
10	62/M	1	2	5	0	2	142	650	5	470
11	51/M	1	1	5	1	1	157	500	5	440
12	80/M	2	5	5	2	1	143	700	4	230
Mean ± SD	64.4 ± 10.4	1.6 ± 0.8	2.5 ± 1.2	5.0	2.1 ± 1.5	3.0 ± 1.6	136 ± 18	408.3 ± 379.5	3.5 ± 1.3	312.9 ± 159.5

FU = follow-up; Hb = hemoglobin; MMT = manual muscle test; SD = standard deviation.

($p < 0.001$); ossification of posterior longitudinal ligament ($p = 0.16$). The incidence of C5 palsy was two of 285 cases (0.7%) in the anterior approach group, six of 68 cases (8.8%) in the posterior approach group, and four of 11 cases (36.4%) in the combined approach group.

The mean ± SD age of the 12 patients (9 men and 3 women) at the time of surgery was 64.4 ± 10.4 years (range 53−81 years; Table 2). The clinical demographic data were as follows: time to onset of pain, 1.6 ± 0.8 days; time to onset of muscle weakness, 2.5 ± 1.2 days; further detailed data are presented in Table 2.

The total score for the ARAT was 41.1 ± 21.4 points; further detailed subscales for ARAT are presented as follows: grasp movement (13.3 ± 7.0 points), grip movement (9.1 ± 4.8 points), pinch movement (13.8 ± 6.8 points), and gross movement (4.9 ± 3.7 points). The time taken to complete the JTHF task was as follows: picking up small objects (11.6 ± 3.0 seconds), picking up large light objects (11.6 ± 9.4 seconds), and picking up large heavy objects (11.7 ± 8.3 seconds). The average index and VAS score for EQ-5D were 0.617 ± 0.194 and 69.8 ± 12.9 points, respectively.

Table 3
Potential risk factors analysis for C5 palsy following decompression surgery.

Variable	Non-C5 palsy patients (n = 352)	C5 palsy patients (n = 12)	p
Age (y, mean ± SD)[a]	55.6 ± 12.0	64.4 ± 10.4	0.013
Gender (M/F)	224/128	9/3	0.549
Cervical lesion (%)			
CSM	154 (93.9%)	10 (6.1%)	0.007
CSR	48 (98.0%)	1 (2.0%)	1.0000
Disc herniation	111 (100%)	0 (0%)	0.021
OPLL	37 (97.4%)	1 (2.6%)	1.0000
CSA	2 (100%)	0 (0%)	1.0000
Decompression procedures			
Anterior approach	283 (99.3%)	2 (0.7%)	
Posterior approach	62 (91.2%)	6 (8.8%)	
Combined anterior-posterior approach	17 (81.0%)	4 (19.0%)	<0.001[b]
Hb (g/L)	132 ± 16	136 ± 18	0.397
Blood loss (mL)	308.9 ± 276.7	408.3 ± 379.5	0.227
Decompression levels (n)	2.9 ± 0.9	3.5 ± 1.3	0.026
Operation period (min)	280.8 ± 118.6	312.9 ± 159.5	0.362

CSA = cervical spondylotic amyotrophy; CSM = cervical spondylotic myelopathy; CSR = cervical spondylotic radiculopathy; Hb = hemoglobin; OPLL = ossification of posterior longitudinal ligament; SD = standard deviation.

[a] Independent t test.

[b] Indicates that p was calculated using the overall of all variables listed under the subheading.

Univariate analysis of potential risk factors studied for C5 palsy following decompression surgery showed statistically significant difference between the groups for the following variables: age, etiology of cervical lesion, variable decompression procedures, and the number of decompression levels (Table 3).

The correlation between the subscales of the ARAT and MMT at follow-up were moderate to high ($r = 0.636−0.730$ for pinch, grasp, and grip; $r = 0.803−0.899$ for total ARAT and gross movement; Table 4). The JTHF scores were highly correlated with MMT scores at follow-up ($r = 0.845−0.867$; Table 4), and the EQ-5D VAS score presented a moderate correlation with MMT scores at the follow-up. Correlation between EQ-5D index and MMT scores was not statistically significant ($p = 0.057$). However, in a stepwise linear regression model including all the previous mentioned parameters, only gross movement remained significantly associated with MMT scores ($p < 0.001$).

Table 5 presents demographic characteristics of patients with complete recovery and incomplete recovery. There were significant differences in female patients ($p = 0.018$) and the number of decompression levels ($p = 0.028$) between the complete recovery and incomplete recovery group. Age, time from surgery to pain onset, time from surgery to C5 palsy development, MMT at onset, variable decompression procedures, hemoglobin, blood loss amount, and operation period were not statistically significant.

4. Discussion

C5 palsy was found in 12 of the 364 patients who underwent cervical decompression surgery, and the overall incidence was 3.3%. The incidence of C5 palsy at our institute was as follows:

Table 4
Correlations between MMT grade and ARAT, JTHF, and EQ-5D.

	MMT grade at follow-up		Linear multiple regression
	Spearman's coefficient	*p*	*p*
ARAT			
Total score	0.803	0.002	0.682
Grasp	0.663	0.019	0.601
Grip	0.730	0.007	0.685
Pinch	0.636	0.026	0.775
Gross movement	0.899	<0.001	<0.001
JTHF			
Pick up small objects	0.845	0.001	0.710
Pick up large light objects	0.858	<0.001	0.430
Pick up large heavy objects	0.867	<0.001	0.867
EQ-5D			
EQ-5D index	0.562	0.057	
ED-5D VAS	0.635	0.026	0.411

ARAT = action research arm test; EQ-5D = European Quality of Life-5 Dimensions; JTHF = Jebsen test of hand function; MMT = manual muscle test; VAS = visual analog scale.

anterior cervical discectomy and fusion (0.7%), posterior surgery (8.8%), and combined anterior–posterior surgery (36.4%). Our study indicated a lower incidence of C5 palsy for the anterior surgery group than in previous studies (0.7% vs. 4.3%).[26] Greiner-Perth et al[27] described a C5 palsy incidence of 4.6% in the fusion of one or two levels group and 12.5% in the fusion of three or more levels group. Hashimoto et al[28] reported a C5 palsy incidence of 2.7% in the fusion of one or two levels group and 11.9% in the fusion of three or more levels group. These previous studies indicated that the incidence of C5 palsy tended to increase parallel to the number of levels fused. In the anterior surgery group, we found that two of 223 patients (2.7%) developed C5 palsy after the fusion of one or two levels, and none of the 62 patients (0%) developed palsy after the fusion of three or more levels. The percentage of the fusion of three or more levels in all anterior surgery groups was 27.8% in our study. By contrast, the percentage of fusion of three or more levels in all anterior surgery groups in the Greiner-Perth et al[27] and Hashimoto et al[28] studies was 46.3% and 63.6%, respectively. The lower percentage of multiple-level fusion procedures in the present study may explain the lower incidence of C5 palsy.

Table 5
Demographic characteristics of patients with complete recovery and incomplete recovery.

Variable	Complete recovery patients (n = 4)[a]	Incomplete recovery patients (n = 8)[b]	*p*
Age (y, mean ± SD)[c]	57 ± 2.9	68.1 ± 10.9	0.073
Gender (M/F)	1/3	8/0	0.018
Pain onset after surgery (d)	1.4 ± 0.8	1.8 ± 0.9	0.57
C5 palsy developed after surgery (d)	2.5 ± 1.3	2.5 ± 1.3	0.933
MMT at onset	3.3 ± 1.5	1.5 ± 1.2	0.073
MMT at F/U	5.0 ± 0	2.0 ± 0.8	0.004
Decompression procedures			
Anterior approach	2	0	
Posterior approach	1	5	
Combined anterior–posterior approach	1	3	0.188
Hb (g/L)	146 ± 20	132 ± 16	0.283
Blood loss (mL)	212.5 ± 197.4	506.3 ± 420.4	0.073
Decompression levels (n)	2.3 ± 1.3	4.1 ± 0.8	0.028
Operation period (min)	323.8 ± 225.4	307.5 ± 134.5	0.933

ARAT = action research arm test; EQ-5D = European Quality of Life-5 Dimensions; FU = follow-up; JTHF = Jebsen test of hand function; MMT = manual muscle test; SD = standard deviation; VAS = visual analog scale.
[a] Complete recovery indicates that the patient's manual muscle test grade is 5.
[b] Incomplete recovery indicates that the patient's manual muscle test grade is ≤4.
[c] Mann–Whitney *U* test.

The average age of patients and the cervical lesions of operation etiology were significantly different among the three groups in our study. This may be explained by the complexity of surgical decision-making in accordance with the patients' choice. Before surgery, we explained to the patients our previous surgical results of ACDF, posterior decompression surgery (laminoplasty), and combined surgery, including neurologic recovery, surgery-related complications, and postoperative neck immobilization with a cervical orthosis. In our experience, the anterior approach usually yielded better surgical outcomes and reduced frequency of postoperative neck pain due to injury to the nuchal muscle, so it was preferable to use the anterior approach in the general population. However, the disadvantage of ACDF is that it required a longer postoperative immobilization of the neck with a cervical orthosis, which interfered with its acceptance in the elderly group. This might contribute to the difference of the average age of patients between the anterior approach group and the posterior approach group.

With regard to the risk factors of C5 palsy following decompression surgery, Hasegawa et al,[29] in a study on 857 patients, observed the etiology of postoperative C5 palsy. In that study, 49 of 857 cases developed postoperative paralysis following decompression surgery and the overall incidence of infection was 5.7%. Risk factors identified in their study included the number of decompression levels, age, and etiology of cervical decompression. Older patients had a higher incidence of postoperative palsy, and the number of decompression levels ($p < 0.001$) was the strongest predictor for the occurrence of palsy. These findings of their multivariable analysis are consistent with results from our study.

With the increasing emphasis on the issue of postoperative C5 palsy, comprehensive functional measures have gained greater importance. MMT can reflect a patient's muscle strength, but does not correspond to actual functional capacity in daily activities. In addition, the JOA score consists of three categories: upper limb function JOA score; lower limb function JOA score; and sphincter function JOA score. The inclusion points of the lower limb function JOA score and sphincter function JOA score may not be specific to an upper extremity functional measure. Thus, the ARAT and the JTHF considered as arm-specific measures of activity limitations were used to present the postoperative C5 palsy upper extremity functional status. These tools have been widely used in clinical research for different conditions, including stroke, spinal cord injury, and rheumatoid arthritis.[14,30] However, this is the first study to use them in a postoperative C5 palsy investigation. In this study, the ARAT revealed a moderate-to-high correlation to MMT, and the JTHF showed a high correlation to MMT. Quantitative measures that revealed the problems of muscle strength correlated with current functional status can enable clinicians to make better choices regarding the level and type of rehabilitation needed.

Analysis of the possible factors contributing to the surgical outcome in patients with postoperative C5 palsy has become a major topic. Risk factors, including age at surgery, duration of symptoms, severity of myelopathy before surgery, and anteroposterior canal diameter, have been reported to affect surgical outcome.[16] Ikenaga et al[31] reported that preoperative muscle weakness and a low JOA score were factors predictive of poor recovery. Masaki et al[12] found that old age and hypermobility of vertebrae at the cord compression level indicated a poor neurologic recovery. In the present study, there were significant differences in female patients and the number of decompression levels between the complete recovery and incomplete recovery group. These findings may suggest a potential link between these possible factors and better recovery, and provide new perspectives for future research. The remaining factors investigated in our study demonstrated no significant difference with complete recovery after postoperative C5 palsy between the two groups, although some variables displayed some tendency. This result may be explained by the small sample size, which probably limited the yield of the statistical difference.

Some limitations of our study need to be addressed. First, the sample size was relatively small, which may limit the yield of statistical difference and the ability to generalize our findings to the C5 population. For example, although multiple variable analyses in our study ($n = 12$) revealed that only gross movement remained significantly associated with MMT scores, it was still necessary to include more patients to substantiate this finding. Second, this is the first study using upper extremity functional measurement tools in a C5 palsy investigation. The feasibility and efficacy of such new evaluation measures need to be extensively evaluated in future studies. A long-term study is needed to further explore the relationships between upper muscle strength, the ARAT, JTHF, JOA score, and QoL among individuals with C5 palsy, as well as to determine the functional measures that are suitable for this complex C5 palsy group.

In conclusion, our study demonstrated that a higher incidence of postoperative C5 palsy was observed when patients with cervical lesions underwent multilevel decompression surgery, particularly via the combined anterior–posterior approach. The ARAT and the JTHF for assessing arm-specific functional impairments had a close correlation to muscle strength. The concerns of potential risk factors and recovery investigation may provide a new springboard for developing strategies to minimize the postoperative C5 palsy risks in future studies.

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