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Clinical analysis of cervical radiculopathy causing deltoid paralysis

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Abstract In general, deltoid paralysis develops in patients with cervical disc herniation (CDH) or cervical spondylotic radiculopathy (CSR) at the level of C4/5, resulting in compression of the C5 nerve root. Therefore, little attention has been paid to CDH or CSR at other levels as the possible cause of deltoid paralysis. In addition, the surgical outcomes for deltoid paralysis have not been fully described. Fourteen patients with single-level CDH or CSR, who had undergone anterior cervical decompression and fusion for deltoid paralysis, were included in this study. The severity of deltoid paralysis was classified into five grades according to manual motor power test, and the severity of radiculopathy was recorded on a visual analog scale (zero to ten points). The degree of improvement in both the severity of deltoid paralysis and radiculopathy

following surgery was evaluated. Of 14 patients, one had C3/4 CDH, four had C4/5 CDH, three had C4/5 CSR, one had C5/6 CDH, and five had C5/6 CSR. Both deltoid paralysis and radiculopathy improved significantly with surgery (2.57 ± 0.51 grades vs 4.14 ± 0.66 , $P=0.001$, and 7.64 ± 1.65 points vs 3.21 ± 0.58 , $P=0.001$, respectively). In conclusion, the current study demonstrates that deltoid paralysis can develop due to CDH or CSR not only C4/5, but also at the levels of C3/4 and C5/6, and that surgical decompression significantly improves the degree of deltoid paralysis due to cervical radiculopathy.

Keywords Cervical disc herniation · Cervical spondylotic radiculopathy · Deltoid paralysis · Surgical decompression

Introduction

Because the deltoid muscle has almost complete motor innervation from the C5 nerve root, deltoid paralysis generally occurs in patients with cervical disc herniation (CDH) or cervical spondylotic radiculopathy (CSR) at the level of C4/5 [3, 14, 15, 16]. Cases in which deltoid paralysis occurs in CDH or CSR at other levels are, however, not rare, and yet to date little attention has been paid to CDH or CSR at other levels as a cause of deltoid paralysis. In addition, the clinical results of surgical decompression for deltoid paralysis have not been fully described in the literature.

In the current study, the authors retrospectively attempted to investigate the characteristics of cervical radiculopathy causing deltoid paralysis and to evaluate the surgical outcomes of anterior cervical decompression and fusion for treatment of deltoid paralysis due to cervical radiculopathy.

Materials and methods

Between 1998 and 2000, 18 patients underwent anterior cervical decompression and fusion for the treatment of deltoid paralysis due to CDH or CSR. Among them, the authors excluded four patients who underwent two-level anterior cervical decompression

Table 1 Muscle grading, based on the manual motor power test described by Klein and Garfin [4]

Muscle gradations	Description
5 – Normal	Complete range of motion against gravity with full resistance
4 – Good	Complete range of motion against gravity with some resistance
3 – Fair	Complete range of motion against gravity
2 – Poor	Complete range of motion with gravity eliminated
1 – Trace	Evidence of slight contractility; no joint motion
0 – Zero	No evidence of contractility

and fusion at the level of C4/5 and C5/6 from the current study. Finally, 14 patients with deltoid paralysis due to single-level CDH or CSR were selected for this study. There were 12 male and two female patients, with a mean age at the time of surgery of 51.6 years (range 32–64 years). All patients complained of radiating pain to scapula, shoulder or arm, with weakness of shoulder abduction. Neurologic examinations showed weakness of shoulder abduction due to deltoid paralysis in all 14 patients. The mean duration of deltoid paralysis was 7.7 weeks (range 1–28 weeks). However, there were no pathologic reflexes, long tract signs, or increased deep tendon reflexes in any of the patients.

The severity of deltoid paralysis was classified into five grades according to the manual motor power test described by Klein and Garfin (Table 1) [4], and the severity of radiculopathy was recorded on a visual analog scale with scores from 0 to 10 points; measurements were taken before surgery and postoperatively at 1, 3, 6, and 12 months, as well as at the last follow-up.

All patients were assessed using plain radiographs of the cervical spine including anteroposterior, lateral (neutral, flexion, and extension), and both oblique views. Radiographs were taken with a standard tube-distance of 1.8 m in order to evaluate evidence of instability and spondylotic changes, such as narrowing of disc space or foraminal osteophytes. Magnetic resonance imaging (MRI)

was undertaken using a 1.0-T unit (Siemens, Somatoplus, Germany) in all patients. The slice thickness used was 3 mm.

The main indication of surgical decompression was deltoid paralysis and radiating pain that were correlated with radiological findings. The same surgeon performed all surgeries and also evaluated medical records and clinical and radiological data. Patients with CDH were managed with anterior cervical discectomy and fusion using autogenous iliac bone graft. Patients with CSR were managed with anterior cervical discectomy, removal of the foraminal osteophytes, and fusion using autogenous iliac bone graft. A Philadelphia brace was put on all patients for 3 months.

They had adequate clinical and radiological follow-up for a minimum of 12 months following surgery, and the mean duration of follow-up was 16 months (range 12–28 months). The type (CDH or CSR) of cervical radiculopathy and location (central or paracentral) of CDH were determined based on plain radiographs, MR images, and operative findings.

The Wilcoxon signed rank test was used to evaluate the degree of improvement in the severity of deltoid paralysis and radiculopathy following surgery. A *P*-value of less than 0.05 was considered to be statistically significant.

Results

The clinical and radiological data are listed in Table 2. Of 14 patients, one had a C3/4 CDH, four had a C4/5 CDH, three had a C4/5 CSR, one had a C5/6 CDH, and five had a C5/6 CSR. Eight patients with CSR at the level of C4/5 or C5/6 showed narrowing of disc space and foraminal osteophytes at each lesion level (Fig. 1). Five patients with CDH at the level of C4/5 or C5/6 showed a paracentrally herniated soft disc fragment at each lesion level. Interestingly, in case 6, a large centrally herniated soft disc compressed the spinal cord at the level of C3/4, which resulted in deltoid paralysis, although myelopathic symptoms were not detected (Fig. 2). None of the patients demonstrated

Table 2 Clinical and radiologic data (CDH Cervical disc herniation, CSR cervical spondylotic radiculopathy)

Patient no.	Sex /Age (yrs)	Level of lesion	Type of lesion	Location of lesion	Duration of paralysis (weeks)	Preoperative paralysis ^a (grade)	Postoperative paralysis ^a (grade)	Preoperative radiculopathy ^b (points)	Postoperative radiculopathy ^b (points)
1	M / 32	C4/5	CDH	Paracentral	20	2	3	5	3
2	M / 35	C4/5	CDH	Paracentral	2	3	5	9	4
3	M / 62	C5/6	CSR		28	2	4	4	3
4	M / 63	C5/6	CSR		4	2	4	8	4
5	M / 59	C4/5	CDH	Paracentral	8	3	4	9	3
6	M / 51	C3/4	CDH	Central	4	3	5	9	3
7	M / 64	C5/6	CSR		4	3	4	8	3
8	M / 53	C4/5	CDH	Paracentral	4	3	4	8	2
9	M / 46	C5/6	CSR		1	2	4	9	3
10	M / 41	C4/5	CSR		4	2	4	8	4
11	M / 46	C4/5	CSR		4	3	5	8	3
12	M / 63	C4/5	CSR		12	3	4	9	3
13	M / 50	C5/6	CDH	Paracentral	1	3	5	7	4
14	M / 56	C5/6	CSR		12	2	3	7	3

^a The severity of deltoid paralysis is classified into five grades according to the muscle power test by Klein and Garfin [4]

^b The severity of radiculopathy is recorded on a visual analog scale with scores from 0 to 10 points

Fig. 1 A 46-year-old male patient with deltoid paralysis due to cervical spondylotic radiculopathy at the C5/6 level. **A** Lateral radiograph of the cervical spine showing narrowing of intervertebral disc space and posterior osteophytes of the C5/6 level (white arrow). **B** T2-weighted sagittal magnetic resonance (MR) image showing multiple disc degeneration but no disc herniation at the C5/6 level. **C** Last follow-up lateral radiograph of cervical spine showing evidence of complete union at the C5/6 level

any evidence of instability on flexion-extension lateral radiographs of the cervical spine. Solid fusion was achieved in all patients at the last follow-up, irrespective of the type of cervical radiculopathy.

The severity of deltoid paralysis, measured in terms of muscle power, was grade 2.57 ± 0.51 before surgery and grade 4.14 ± 0.66 at the last follow-up. The degree of improvement in the severity of deltoid paralysis was statistically significant ($P=0.001$). The severity of radiculopathy, measured on a visual analog scale, was 7.64 ± 1.65 before surgery and 3.21 ± 0.58 at the last follow-up. The degree of improvement in the severity of radiculopathy was statistically significant ($P=0.001$) (Table 3).

Discussion

There are several previously published studies reporting intersegmental connections, variations in motor distribution, or anomalies of the cervical nerve roots [6, 7, 8, 9, 11, 12, 13, 17]. Therefore, it is not always possible to accurately localize the level of cervical spinal root pathology on the basis of clinical signs and symptoms. Despite a popular belief that deltoid paralysis develops due to CDH or CSR at the C4/5 level, cases are sometimes en-

countered in which deltoid paralysis is caused by CDH or CSR at other levels.

Because it was uncertain as to which level was symptomatic for deltoid paralysis, we excluded four patients who had undergone two-level surgical decompressions from the current study. We therefore reported 14 cases of deltoid paralysis due to single-level CDH or CSR at the level of C3/4, C5/6 or C4/5. In all patients, single-level surgical decompression alone provided significant recovery in deltoid paralysis. Such a result provided evidence that the level of surgical decompression had been correct – a finding that is especially significant for patients with deltoid paralysis due to CDH or CSR of the C3/4 or C5/6 level. This study suggests that spinal surgeons keep the above findings in mind when determining the exact level of cervical spinal root pathology for deltoid paralysis due to CDH or CSR.

The pathogenesis of deltoid paralysis due to CDH or CSR at the level of C3/4 or C5/6 cannot be explained on the basis of this clinical study alone. On considering previous anatomic studies, however, the authors think that deltoid paralysis secondary to CDH or CSR at the C5/6 level is likely due to variations in motor distribution or anomalies of the cervical nerve roots [5, 6, 12]. In the case of deltoid paralysis secondary to CDH at the C3/4 level, we postulate that a large centrally herniated soft disc at the C3/4 level compressed anterior spinal cord, in turn causing deltoid paralysis to develop. Shinomiya et al. also reported dissociated motor loss of the deltoid muscle due to a cord lesion at the C3/4 level [15]. However, on considering the discrepancy between the spinal level of the C5 nerve root (C4/5 intervertebral neural foramen) and the spinal cord component of the C5 nerve root (more cranial than the C4/5 spinal level), we cannot exclude the

Fig. 2 A 51-year-old male patient with deltoid paralysis due to cervical disc herniation of the C3/4 level. **A** Lateral radiograph of the cervical spine showing no definite abnormal findings, apart from a relatively narrow canal of the cervical spine. **B, C** T2-weighted sagittal and T1-weighted axial MR images showing spinal cord compression by a large herniated soft disc at the C3/4 level with intramedullary high signal intensity. **D** Last follow-up lateral radiograph of cervical spine showing evidence of union at the C3/4 level

Table 3 Statistical analysis of degree of improvement in severity of deltoid paralysis and radiculopathy between before operation and last follow-up

	Before operation	Last follow-up	<i>P</i> -value*
Degree of deltoid paralysis	2.57±0.51	4.14±0.66	0.001
Degree of radiculopathy	7.64±1.65	3.21±0.58	0.001

**P*-value by the Wilcoxon signed-rank test

possibility of deltoid muscle dysfunction without long-tract sign of the spinal cord that was caused by compression of the anterior horn of the spinal cord at the C3/4 level.

Deltoid paralysis can be misinterpreted as a cervical disease even if radiological signs of cervical nerve root compression are present. Therefore, spine surgeons should

exclude the possibility of other disease, including brachial plexus neuritis, rotator cuff tears or anterior horn cell disease, all of which could improve by postoperative physical therapy.

The clinical results of surgical decompression for deltoid paralysis due to CDH or CSR have not been fully described in the literature [15]. In the current study, surgical decompression significantly improved the degree of deltoid paralysis, irrespective of type of cervical radiculopathy. We thought that a relatively short duration of deltoid paralysis might be attributed to satisfactory results of surgical outcomes in these patients, even though one patient had 28 weeks of deltoid paralysis. Therefore, such a result suggests that surgical decompression could be considered as a useful therapeutic option in cases of deltoid paralysis due to CDH or CSR.

As with any study, the current study may have two potential limitations. The first is that, because of the small

number of cases and various levels of lesion, we did not statistically analyze the differences in several radiographic parameters, such as canal diameter, body to canal ratio, size of herniated disc, or occupation ratio of disc to canal, that may affect the development of deltoid paralysis as compared with those of cervical radiculopathy without deltoid paralysis [1, 2, 10]. The second was that we did not perform electrophysiological examinations, which can provide objective evidence of the exact level for deltoid paralysis.

Conclusions

This study demonstrates that deltoid paralysis can develop due to CDH or CSR, not only at the level of C4/5 but also at C3/4 and C5/6, and that surgical decompression significantly improves the degree of deltoid paralysis due to cervical radiculopathy.

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