Article published online: 2022-09-20

ORIGINAL ARTICLE

Radiological study of C3–C4 level surgical cases of cervical spondylosis

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ABSTRACT

Objective: The purpose of this study was to elucidate the pathological characteristics of C3-C4 cervical spondylotic myelopathy (CSM) from the radiological study.

Materials and Methods: A total of 31 patients with single level anterior cervical discectomy and fusion (ACDF) at C3-C4 and 46 patients with single level ACDF at C5-C6 were included in this study. We selected C5-C6 level as a representative of the lower cervical level. The C3-C4 and C5-C6 levels were routinely examined to investigate the areas of the vertebral canal, subarachnoid space, and spinal cord in the cervical canal.

Results: The clinical study of C3-C4 ACDF patients showed that as for the C3-C4 area, the area of the cervical vertebral canal, the area of the subarachnoid space, and he transverse surface area of the spinal cord were all significantly smaller in C3-C4 ACDF patients than in C5-C6 ACDF patients. Moreover, as for the C5-C6 area, only the area of the subarachnoid space was significantly smaller in C5-C6 ACDF patients than in C3-C4 ACDF patients. Spondylotic changes predominated at both the C3-C4 and C5-C6 levels. However, in the C5-C6 ACDF patients, spondylotic changes tended to predominate only at the operation level at C5-C6.

Conclusions: Aging process develops from lower cervical to upper cervical level. Moreover, this static factor in conjunction with dynamic factor (instability) was the causative factors for the CSM in C3-C4 ACDF patients.

Key words: Anterior cervical discectomy and fusion, C3-C4 level, cervical spondylotic myelopathy, static factor

Introduction

Cervical spondylosis (CS) at the C3-C4 level (segment) usually presents with CS myelopathy (CSM) in older than younger patients.[1-4] In our previous study, greater segmental angulation and hypermobility at the C3-C4 segment were identified as potential contributors to the high incidence of pathology at the C3-C4 segment in elderly patients with CSM, and not only static factors but also dynamic factors may contribute to the development of CSM.[5] In the present study, we investigated the features of the static factor radiologically in both C3-C4 ACDF and lower cervical level anterior cervical discectomy and fusion (ACDF) patients.

Access this article online	
Quick Response Code:	Website: www.asianjns.org
	DOI: 10.4103/1793-5482.175624

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Materials and Methods

Between December 2007 and January 2013, 281 patients were surgically treated by ACDF in the Department of Neurosurgery, Southern TOHOKU General Hospital.

We selected C5-C6 level as a representative of the lower cervical level. A total of 31 CSM patients (20 men, 11 women) with single level ACDF at C3-C4 (group A) and 46 patients (36 men, 10 women), including 26 with CSM and 20 with radiculopathy, with single level ACDF at C5-C6 (group B)

How to cite this article: Tomii M, Mizuno J, Watanabe K. Radiological study of C3–C4 level surgical cases of cervical spondylosis. Asian J Neurosurg 2016;11:273-5.

in the Southern TOHOKU General Hospital, were included in this study. Preoperatively, cervical magnetic resonance imaging (MRI) and computed tomography (CT) were performed in the neutral position. The scanning plane was perpendicular to the cervical cord. Between four and five axial 4 mm contiguous cuts were obtained at C3-C4 and C5-C6 levels, centered on each disc, using a Signa EXCITE 1.5T (GE Health Care Milwaukee, WI) and SOMATOM Definition AS+ (SIEMENS Healthcare, Erlangen, Germany). The C3-C4 and C5-C6 nerve root canal levels (usually the level just above the upper border of the disc level) on T2-weighted axial images of MRI and bone window CT scans were routinely examined. The following parameters were measured from the scanned images using NIH image software. "Sb" is the area of the cervical vertebral canal, "Ss" is the area of the subarachnoid space, and "Sc" is the transverse surface area of the spinal cord [Figure 1].

Statistical analysis

Continuous variables are presented as means ± standard deviations with ranges. The Mann–Whitney U-test was used for evaluating intergroup differences. Differences were considered to be significant at a probability level of 95% (*P* (ve. 05). All statistical analyses were performed with a commercially available software program (IBM SPSS Statistics Version 19, Chicago, IL, USA).

Results

The mean age at the time of operation was 66.7 sr14.7 years (range: 34–89 years) in group A and 50.3 ou12.7 years (range: 31–76 years) in group B; the difference was significant ($P < 0.001$). In terms of the C3-C4 area in group A, Sb, Ss, and Sc were 2.11 ep0.44, 0.94 epi. 39, and 0.44 ep0.15 cm^2, respectively. In group B, Sb, Ss, and Sc were 2.74 epc. 80, 1.95 epc. 40, and 0.73 epc. 14 cm^2, respectively. In terms of the C5-C6 area in group A, Sb, Ss, and Sc were 2.26 epc. 45, 1.51 epc. 46, and 0.56 epc. 17 cm^2, respectively. In group B, Sb, Ss, and Sc were 2.20 epc. 49, 1.25 epc. 35, and 0.58 epc. 19 cm^2, respectively. As for the C3-C4 area, Sb, Ss, and Sc were all significantly smaller in group A than in group B ($P < 0.001$ for Sb, Ss, and Sc) and as for the C5-C6 area, the Ss was significantly smaller in group B than in group A, but Sb and Sc were not significantly different between the two groups ($P = 0.5611$ for Sb, 0.0109 for Ss, and 0.6959 for Sc). The details of the measurements of Sb, Ss, and Sc on axial T2-weighted MRI and CT in group A and B are summarized in Table 1.

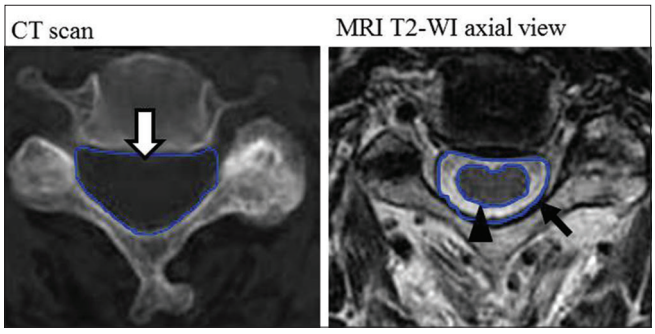

Figure 1: The open arrow (⇩) indicates the margin of the bony vertebral canal, and the closed arrow (⬇) indicates the subarachnoid space area. The arrow head (▼) points to the boundary of the cord area

Discussion

Degenerative changes develop in the cervical spine and its surrounding tissues as manifestations of the aging process. The level most loaded during cervical movement is the C5-C6 level.[6] As a result, at the first step of spondylosis, degenerative changes of discs and ligaments may develop at lower cervical levels in the younger group (<65 years), followed by osteophytes. As a consequence, the middle and/or lower cervical spine is already less mobile in the elderly group (65 years or older). Thus, this condition causes overloading at the upper cervical level during cervical movement,[6] leading to the development of degenerative spondylolisthesis[2] and comparatively greater mobility at this level.[1] Hypermobility at the C3-C4 segment, which still maintains mobility, compensates for decreased mobility at the lower segments. Cervical movement is dependent on the motion of the C3-C4 segment, which accounted for 39.8% of C2-C7 total motion of C3-C4 ACDF patients in our report.[5] The current study showed that in the C3-C4 ACDF patients, spondylotic changes predominated both at the C3-C4 level (upper cervical level) and at the C5-C6 level (lower cervical level), but in the C5-C6 ACDF patients, spondylotic changes tended to predominate only at the operation level mainly in the young. This feature supports the aging process in the cervical spine as stated above. Most C3-C4 ACDF patients were elderly. People develop lower cervical level spondylotic changes when young, and C3-C4 ACDF patients were asymptomatic with these changes. However, lower cervical level ACDF patients, such as C5-C6 ACDF patients, were symptomatic and presented with CS. As mentioned, C3-C4 spondylotic changes develop gradually for several decades after lower cervical level spondylotic changes develop. Thus, C3-C4 ACDF

Table 1: The details of Sb, Ss and Sc in group A and B

C3-C4 area of C3-C4 and C5-C6 ACDF patients			
C3-C4 area (cm^2)	C3-C4 ACDF patients (group A)	C5-C6 ACDF patients (group B)	*P*
Sb	2.11±0.44	2.74±0.80	<0.001
Ss	0.94±0.39	1.95±0.40	<0.001
Sc	0.44±0.15	0.73±0.14	<0.001
C5-C6 area of C3-C4 and C5-C6 ACDF patients			
C5-C6 area (cm^2)	C3-C4 ACDF patients (group A)	C5-C6 ACDF patients (group B)	*P*
Sb	2.26±0.45	2.20±0.49	0.5611
Ss	1.51±0.46	1.25±0.35	0.0109
Sc	0.56±0.17	0.58±0.19	0.6959

*Values are mean±SD. ACDF – Anterior cervical discectomy and fusion; SD – Standard deviation

patients presented with myelopathy when they are getting old. Cervical spinal canal diameter is a good indicator for detecting myelopathy.[7] We speculated the original cervical canal diameters at lower cervical levels of C3-C4 ACDF patients might be wider than those of C5-C6 ACDF patients, so that C3-C4 ACDF patients may have escaped CS due to lower CS changes when young.[5] Okamoto reported an investigation of surgical CSM cases and found that the old patients were more than 70 years old and had a sagittal diameter of the cervical canal that was stenotic but wider than that of patients in their fifties (50s) and sixties (60s),[8] supporting our hypothesis. In C3-C4 ACDF patients, lower cervical level spondylotic changes might have been asymptomatic when they were young, but they presented with CSM in their old age in conjunction with hypermobility at the C3-C4 level. In this study, radiological analysis was used to evaluate the static morphologic features that predispose patients to disorders at the C3-C4 segment. We should furthermore investigate radiological analysis in the normal group both the young and the old whether they show the similar aging process as ACDF patients.

Conclusions

Aging process develops from lower cervical to upper cervical level. Moreover, this static factor in conjunction with dynamic factor (instability) was the causative factors for the CSM in C3-C4 ACDF patients.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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