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Cervical segmental motion induced by shoulder abduction assessed by magnetic resonance imaging

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Introduction

Patients sometimes present with neck pain caused by repetitive upper extremity movements. One explanation for this may be that shoulder movement induces secondary movement of the cervical spine because of attachment of muscles from the scapula to the cervical vertebrae.[1,2] In the Mulligan Concept it has been reported that cervical spine dysfunction may be managed by cervical rotation mobilization at the dysfunctional motion segment with concomitant active shoulder movements.[3,4,5]

Two studies have investigated the effect of shoulder movement on 3D motion of the thoracic spine.[6,7] but to date there have been no in vivo studies reporting the influence of shoulder movement on cervical segmental motion.

If cervical segmental motion is induced by shoulder movement it is possible that this movement may be caused by passive tension or active contraction of the axio-scapula muscles. Therefore in this study the effect of two conditions was assessed, passive and active shoulder elevation.

The purpose of this study was to measure cervical segmental rotation using magnetic resonance imaging (MRI), under the two conditions with the right shoulder in progressively greater range of abduction.

Materials and Methods

Participants

22 asymptomatic subjects (12 males, mean age 24, range 20-32), without history of significant cervical spine or shoulder girdle disorders were included. Subjects were screened for abnormality using MRI of the cervical region and provided written informed consent prior to data collection.

Materials, Measurements & Procedures

Kinematic MRI of the cervical spine was performed with the subject supine and the coil set to allow normal motion of the upper limb. Range of segmental cervical rotation was assessed from the T1 axial images at the level of each cervical vertebra; from the occiput to Th1 with the shoulder in 0, 30, 60, 90, and 120 degrees abduction.

With the axial image on the monitor, absolute rotation of each vertebra (alignment angle), were calculated for the occiput and each vertebra as far as Th1. The sagittal plane (vertical image frame) was used as a reference (Figure 1A-D). Right rotation values were defined as negative values, and left rotation values were defined as positive. The difference in vertebral rotation between the passive and active condition (with and without isometric muscle contraction) was termed the rotation angle (Figure 2).

In each right upper limb position, 0, 30, 60, 90, and 120 degrees shoulder abduction, two conditions were applied. Firstly no muscle contraction with the arm relaxed and supported and secondly isometric shoulder abduction with a standardized 2kg adduction force applied at the wrist (Figure 3).

Intra-observer and inter-observer reliability of measurements were calculated and results were analysed using two-way ANOVA for unbalanced data. A one-way ANOVA was used to determine the influence of shoulder position on the alignment angles for each vertebra. A series of paired T-test was used to determine the influence of muscle contraction on vertebral rotation. Significance was attributed to P values less than 0.05.

Results

The intertester- and intratester-ICC of the measurements were 0.96, and 0.95, respectively.

Passively positioning the shoulder in greater range of abduction had no influence on alignment angles ($P>0.05$). In contrast, during isometric contraction at each shoulder position up to 90 degrees abduction, alignment angles from C2 to Th1 increased significantly when compared to the passive condition ($P<0.05$)(Figure 4A-E). Furthermore at 120 degrees shoulder abduction, significant increases in the alignment angles occurred only from C5 to Th1 ($P<0.05$).

Figure 5 shows the rotation angles for each vertebra. At each shoulder position up to 90 degrees abduction, each cervical vertebra tended to rotate to the left, with the largest rotation angle being 5.2° (SD=3.7), which occurred at C6 vertebra at 0 degrees arm abduction. In contrast, the pattern of rotation changed at 120 degrees abduction, with C1 and C2 vertebra rotating slightly to the right. C2 rotated the most, with an average of 0.6° (SD=2.4) right rotation. In contrast the levels below C2 rotated to the left with the greatest movement observed at C6 with range similar to those shown at shoulder positions below 90 degrees abduction.

Discussions

The original article has been submitted to SPINE in 2008.

The results of this study show that cervical vertebral rotation occurred to a greater degree in the presence of isometric shoulder abduction rather than when the arm was relaxed, irrespective of the shoulder position. These results suggest that muscle contraction induced cervical rotation rather than passive tension on soft tissues.

It has been suggested that trapezius and other axio-scapular muscle contraction during shoulder abduction might influence cervical rotation. Although, like upper trapezius, levator scapulae is an extensor and lateral flexor of the cervical spine, levator scapulae rotates the neck ipsilaterally in contrast to upper trapezius which rotates contralaterally.9 Based on the anatomy and biomechanics8of the levator scapulae, if this muscle is active during resisted shoulder abduction, this may induce rotation of the upper cervical region differently to the lower region. This may explain the differences in the direction and magnitude of cervical rotation at 120 degrees abduction and ranges below this.

Figure 5 indicates that with increasing range of shoulder abduction, and therefore scapula upward rotation, the less the cervical vertebrae rotated. As a result of scapula upward rotation, the length of trapezius is relatively shortened compared with the increasing length of levator scapulae.10 Relative changes in muscle length, magnitude of muscle contraction, and changing vectors of force produced by muscle contraction around the scapula and spine may result in altered patterns of cervical vertebral rotation. Of course, it is recognised that other muscles than these may also affect the spine during abduction.

The greatest range of cervical rotation occurred at C6 and gradually decreased above and below this level. This may be explained by the relative greater flexibility of the C5/6 motion segment compared to all other levels apart from C1/2.11 In addition the subjects in our study were lying supine during measurement, which may have inadvertently fixed the thoracic spine limiting movement.

To identify the true functions of the muscles that attach to the spine and their effects on vertebral rotation, further research, for example using electromyography and MRI, is required. In addition further research is required to investigate cervical vertebral rotation in patients with neck pain and pathology.

CONCLUSION

- **Passive shoulder abduction has no influence on cervical vertebral rotation.**
- **Isometric shoulder abduction up to 90 degrees induces left rotation throughout the cervical spine, with the largest movement occurring at C6.**
- **A contrasting pattern of upper and lower cervical rotation occurs under the influence of isometric abduction contraction at 120 degrees abduction.**

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The original article has been submitted to SPINE in 2008.

FIGURES

Figure 1.

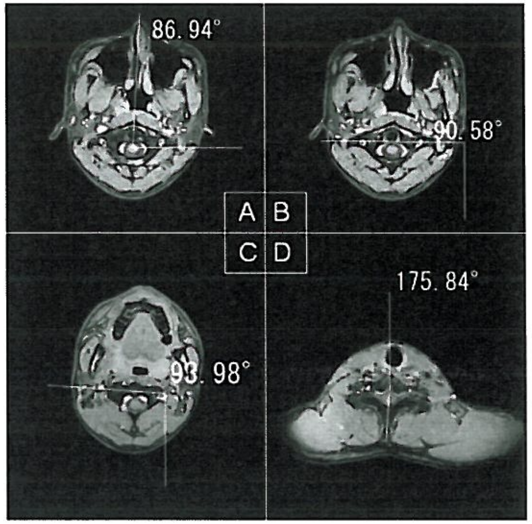
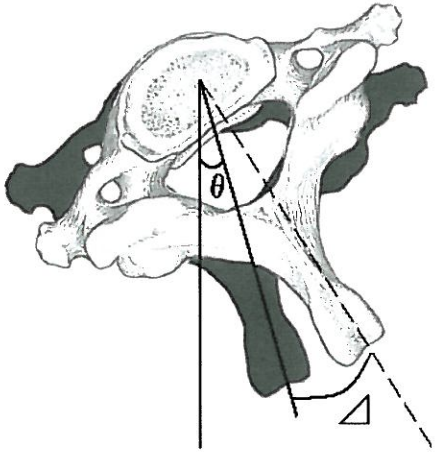


Figure 2. Alignment angle and Rotation angle



This schematic shows the change in vertebral position under muscle contraction. The dark vertebra shows the starting position without muscle contraction, and the lighter one the same vertebra during isometric muscle contraction. θ represents the alignment angle, and ⊿ represents the rotation angle.

Figure 3.

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Figure 4 :'A' to 'E' show the alignment angles for each shoulder position from zero to 120 degrees abduction, respectively. A positive value in the vertical axis indicates left rotation. The yellow bars show the conditions with contraction and the bars painted blue indicate the conditions without contraction.

*There was a statistically significant difference in alignment angles between the active and passive condition (P<0.05).

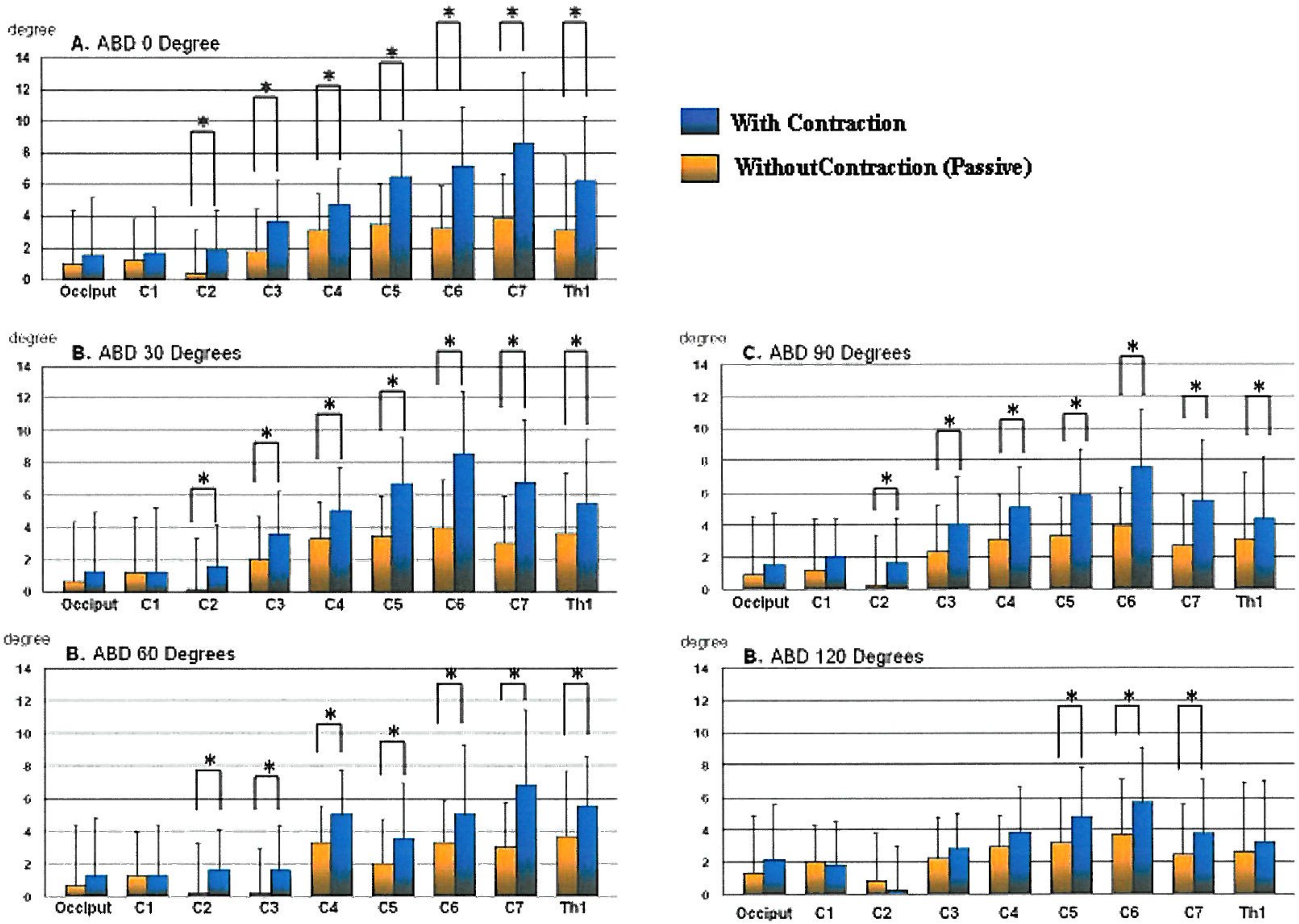

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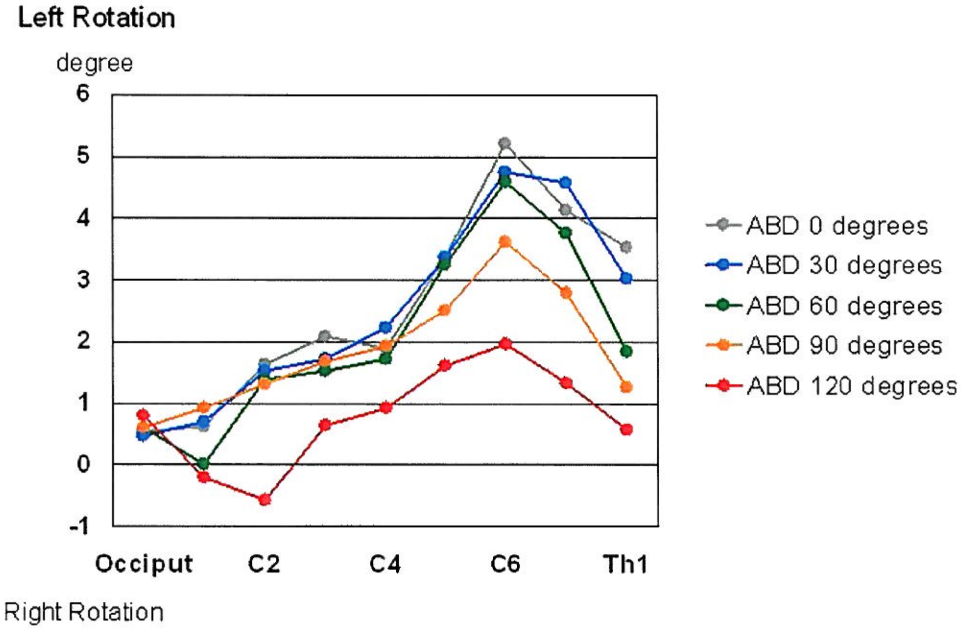
Figure 5: The rotation angles for each vertebra and each arm position. The vertical axis shows degree of rotation, positive values indicating left rotation. The horizontal axis shows each vertebra.



P.S.

Thank you for seeing my poster. It would be great to study something new with you for the evidence-based manual therapy.

Sincerely yours,
Hiroshi Takasaki
高崎　博司

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