

# Correlations between and Absolute Rotation Angle, Anterior Weight Bearing, Range of Flexion and Extension Motion in Cervical Herniated Nucleus Pulposus

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**Abstract.** [Purpose] We attempted to examine the range of motion (rotation, flexion and extension) of the neck and forward head posture in patients with a cervical herniated nucleus pulposus (C-HNP) and in normal persons through radiometry; and examined the correlations between the ranges of these motions and C-HNP. [Subjects] The study subjects were 15 patients with C-HNP at level 5 or 6 (C5-6, (males=5, females=10) and 15 normal persons (males=5, females=10). [Methods] We analyzed the degree of cervical lordosis of patients with C-HNP at C5-6 and normal adults and compared them using radiographs of their lateral views. We observed the absolute rotation angles (ARA), anterior weight bearings (AWB) and ranges of flexion and extension motion (RFEM). [Results] The results indicated that as ARA increased, AWB decreased and RFEM increased. In particular, we confirmed that as AWB increased, RFEM decreased. [Conclusion] This study identified a remarkably decreased range of cervical motion in patients with C-HNP compared to normal persons, along with misalignments of the cervical spine due to from increased forward head posture.

**Key words:** C-HNP, Forward head posture, Range of motion

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## INTRODUCTION

Because the cervical spine is not only much smaller than the dorsal and lumbar spine, but also has a wider range of motion and higher frequency of motion. Therefore the amount and frequency of impacts imposed on the cervical spine are higher than those imposed on the dorsal and lumbar spine; thus, cervical disc herniations occur more frequently than lumbar disc herniations<sup>1)</sup>. Because many persons with neck problems experience decreased range of flexion and extension<sup>2,3)</sup> and

poor head/neck posture, measuring these patients' head/neck posture and range of neck motion is an important part of evaluating them<sup>4)</sup>. Clinical factors that affect the cervical spine's motion include not only cervical spinal trauma, but also head or neck problems and pain in the muscles around the shoulder joint, mandible and teeth<sup>5)</sup>.

X-ray imaging is a basic and essential diagnostic examination method and an important screening test for neck problems. In particular, the cervical lordosis and alignment observed in simple lateral views reveal a lot of information<sup>6)</sup>. Accordingly, in

study we examine the range of cervical rotation, flexion and extension and the forward head posture's range of motion in patients with C-HNP; and to examine the correlations between these ranges of motion and C-HNP. These examinations have provided basic data for physical therapeutic approaches to patients with C-HNP.

## SUBJECTS AND METHODS

This study included 15 patients with C-HNP at C5-6 (males=5, females=10: bulging= 5, protrusion= 6, extrusion= 4) confirmed with magnetic resonance imaging by radiologists and neurosurgeons. The subjects had experienced cervical region pain and radiating of a pain, of duration is  $6.60 \pm 2.2$  weeks. These subjects were selected from patients who visited S Hospital in Daejeon, Korea. This study also included 15 normal adults 5 males, 10 females at the same hospital as a control group. The mean age of the group with C-HNP at C5-6 was,  $35.8 \pm 6.0$ , their mean height was  $166.1 \pm 7.8$  cm and their mean weight was  $65.5 \pm 6.7$  kg. The mean age of the control group was  $33.6 \pm 6.9$  years, their mean height was  $166.4 \pm 8.5$  cm and their mean weight was  $64.0 \pm 7.7$  kg. Because the groups did not statistically significantly differ ( $p>0.05$ ), it seems that there was no problem with intergroup homogeneity.

Patients with a history of surgical treatment of their cervical spine, a systemic disease (e.g., cancer patients) or rheumatoid disease, neck pain accompanying pressure fractures and nervous system problems found in comparative analyses of their cervical spine were excluded. The purpose of this study and the experiment's overall process was sufficiently explained to the subjects, who underwent a comparative analysis of their cervical spine, and their voluntary agreements were obtained.

This study analyzed the degree of cervical lordosis of patients with C-HNP at C5-6 and normal adults and compared them through radiographs of their lateral views. Absolute rotation angles (ARA)<sup>7)</sup>, to examine the degree of cervical lordosis, anterior weight bearings (AWB)<sup>7)</sup> to examine forward head posture, and ranges of flexion and extension motion (RFEM)<sup>8)</sup>, to examine the necks' flexion and extension angles were measured. ARA is the angle formed by the intersection of lines that extending from the posterior surface of the C2 and

C7 vertebrae's pyramids. AWB is the distance between a vertical line drawn from the protruding area of the posterior bottom plane of the C7 vertebra's pyramid and a horizontal line drawn from the protruding area of the posterior top plane of the C2 vertebra's pyramid. The RFEM is the sum of two angles. The first is formed by the intersection of a line that extends from the C2 pyramid's bottom plane with a line that extends from the C7 pyramid's top plane when the cervical spine is flexed. The other angle is formed by the intersection of a line that extends from the C2 pyramid's bottom plane with a line that extends from the C7 pyramid's top plane when the cervical spine is extended (Fig. 1).

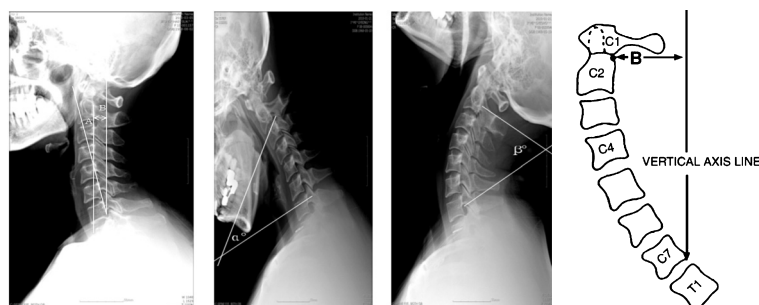
The same radiologist took the radiographs, at a distance of 1 m, and using X-ray equipment (DLD-150 RK, Dong-A company, Korea) and 14"×14" films after positioning the root of the subjects' noses and their external occipital protuberances to form a horizontal line while the subjects were standing with their eyes closed and the muscles around their neck, shoulder and humerus maximally relaxed in as comfortable and natural a posture as possible.

We analyzed the measurement data using the SPSS 12.0 KO (SPSS, Chicago, IL, USA) statistical program and presented the collected as with averages with standard deviations. The significance of the differences between the two groups' data using independent t-tests was tested and Pearson correlation coefficient analyses were conducted in order to assess the correlations between C-HNP at C5-6 and cervical lordosis was conducted. The statistical significance level of all the data was set to 0.05.

## RESULTS

We analyzed the sagittal planes of the C-HNP and control groups, on radiographs showed. The results indicate that the C-HNP group's ARA and RFEM were significantly lower than the control group's; and the C-HNP group's AWB was significantly lower than the control group's ( $p<0.05$ ) (Table 1). These findings indicate that the C-HNP group's range of neck flexion and extension were lower than the control group's, and that the C-HNP group's forward head posture's range of motion was higher than the control group's.

As for the correlations between ARA, AWB and RFEM in the C-HNP group, they indicate that as



**Fig 1.** A, ARA from the C2 through C7 vertebrae using the posterior tangent method for analysis of the angle of cervical lordosis is depicted<sup>7)</sup>. B, A measure of AWB is shown. The horizontal displacement of the posterior superior body corner of the C2 vertebra is compared to a vertical line originating at the posterior inferior body corner of the C7 vertebra<sup>7)</sup>. C, drawing showing the technique for measuring ranges of flexion and extension motions on plain lateral radiographs of the cervical spine: range of flexion and extension =  $\alpha^\circ + \beta^\circ$ .

ARA increased, AWB decreased ( $r=-0.80$ ) and RFEM increased ( $r=0.76$ ). In particular, AWB and RFEM showed negative correlations, showing that as AWB increased, RFEM decreased ( $r=-0.83$ ) (Table 2). Therefore, the results show that as the range of neck rotation increased, the range of the neck's flexion and extension also increased, but the forward head posture's range of motion decreased; and as the forward head posture's range of motion decreased, the neck's flexion and extension range increased.

## DISCUSSION

In the present study, we examined the angles of cervical rotation, flexion and extension and the forward head posture's range of motion in patients with C-HNP, and to examined the correlations between those angles, the range of motion and C-HNP.

A primary cause of disc damage is bending and torsion, which occur during compressive neck loading<sup>9)</sup>. Some clinicians believe that kyphosis of the sagittal cervical spine is the normal variant. However, we should consider cervical lordosis a primary curve because it forms at approximately the 10th week of fetal development<sup>10)</sup>. However, A forward head posture, where the head is placed anterior to the body, is a bad posture that generally appears in patients who have neck problems<sup>11)</sup>, and it is known that this posture reduces the cervical

**Table 1.** Comparison of ARA, AWB, RFEM in C<sub>5-6</sub> HNP and Control group

Category	C <sub>5-6</sub> HNP	Control
ARA*	13.91 ± 3.35	27.75 ± 3.84
AWB*	23.78 ± 4.55	10.92 ± 1.00
RFEM*	46.22 ± 12.03	74.28 ± 3.18

\*  $p<0.05$ . ARA: absolute rotation angle, AWB: anterior weight bearing, RFEM: range of flexion and extension motions.

**Table 2.** Correlation of the ARA, AWB, RFEM in C<sub>5-6</sub> HNP

Category	ARA	AWB	RFEM
ARA	1.00		
AWB	-0.80**	1.00	
RFEM	0.76**	-0.83**	1.00

\*\*  $p<0.01$ .

spine's curvature. Also, Researchers have also reported that patients with cervical spinal injuries are restricted in some motions such as bending, axial torsion and dynamic bending<sup>12-14)</sup>.

Evaluating the cervical spine's functions and measuring its flexion and extension motions in the sagittal plane are important for evaluating various diseases that accompany excessive motion or reduced mobility. Toward this end, physicians frequently use functional radiometry that uses radiographs of lateral views of the cervical spine<sup>15)</sup>.

In the present study, we study identified remarkably decreased ranges of cervical rotation, flexion and extension in patients with C-HNP compared to normal persons, along with misalignments of the cervical spine resulting from increased forward head posture. The results also shows that as the range of neck rotation increased, the ranges of cervical flexion and extension also increased, but that the forward head posture's range of motion decreased. As the forward head posture's range of motion decreased, the ranges of cervical flexion and extension increased. In normal cervical spinal curves, anterior and posterior stresses on the vertebral bodies are nearly uniform and minimal. In kyphotic areas, however, combined stresses change from tension to compression at the anterior vertebral margins and are very large compared to lordosis<sup>16)</sup>. In the present study, we showed that the cervical spine's misalignment, such as forward head posture, occurs because of these changes in pressure, which also change the ranges of cervical flexion, extension and rotation. Therefore, physical therapists' interventions for patients with C-HNP should consider careful interventional methods for forward head posture as a priority.

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