



# Investigation of Gender-Related Changes of Craniocervical Region Variables on MRI in Adults with Reduced Cervical Lordosis Angle

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## Abstract

**Aim:** In the present study, the aim has been to evaluate the variables related to the craniocervical region on magnetic resonance imaging (MRI) of individuals with reduced cervical lordosis angle and to reveal the differences between genders.

**Material and Method:** Totally, 9 variables have been measured on the cervical vertebrae images of 120 individuals. The variables measured are as follows: Dens height (DH), dens anteroposterior distance (APDD), dens apical ligament length (LALD), foramen magnum sagittal diameter (SDFM), spinal canal anteroposterior diameter (APCSD), retropharyngeal space length (LRS), dens anteroposterior distance (ASDD), total cervical vertebrae length (TCVL) and dens angle (DA). Statistical analyses of the variables were performed with Minitab® 21.2 (64-bit) and R program.

**Results:** The study's results were as follows, men and women, respectively: DH: 31.5±2.8, 30.1±2.6, ASDD: 36.1, 34.2, TCVL: 116.2±7.2, 107.7±6.1. According to the analysis, the differences in DH, ASDD and TCVL variables between men and women were found to be statistically significant.

**Conclusion:** The study, which used MRI of the cervical region, found that gender was effective in the variables on the craniocervical region in individuals with reduced cervical lordosis angle and morphometric data related to the population were obtained.

**Keywords:** Gender, cervical vertebrae, lordosis, morphology, magnetic resonance imaging

## INTRODUCTION

The craniocervical junction, formed by the atlantooccipital and atlantoaxial joints, is the complex transition zone between the cervical vertebrae and the skull and includes the neurovascular structures from the skull base to the second cervical vertebrae (1). Approximately one-third of all pathologies of the cervical spine are encountered at the craniocervical junction, which is rich in structure and function and can be caused by aging, degeneration or trauma (2). As the craniocervical junction contains many vital structures that are in close relationship with each other, the neurological system and musculoskeletal system are affected in pathologic conditions involving this region (3). A decrease in the cervical lordosis angle is popularly known as neck flattening and radiographs constitute the first step in the evaluation (2,3). Nevertheless, computed

tomography and magnetic resonance imaging (MRI) can be used for detailed evaluations such as the degree and level of lordosis and its effect on surrounding structures (4,5). A lordotic angle of 20-35 degrees between C2-C7 vertebrae is considered physiologic. This angle may decrease due to pathologies in the muscle, intervertebral disc, bone tissue or adjacent segments, head position, injuries or accidents (6). Furthermore, a recent study reported that age and gender also play a role in the reduction of the lordosis angle (6,7). Thus, it is important to consider age and gender in diagnostic and therapeutic approaches and to prevent complications in surgery and to know the anatomical features of the region well (8). The purpose of this study has been to evaluate the variables related to the craniocervical region in adult individuals with decreased cervical lordosis angle and to present the differences between genders to the literature.

## CITATION

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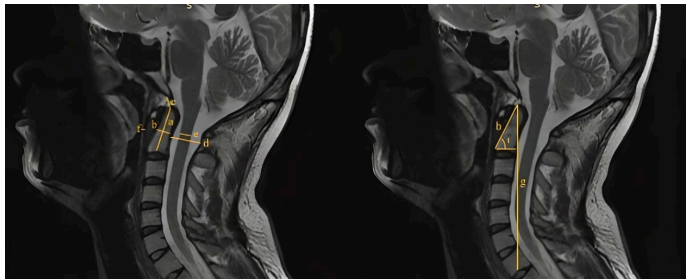
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## MATERIAL AND METHOD

Research has been started with the approval decision numbered 2023/230 from the Clinical Research Ethics Committee. In the study, MRI (1.5 Tesla MRI Device (Siemens-Magneton Symphony, Erlangen, Germany) of 120 individuals (60 women, 60 men) aged 25-55 years with reduced cervical lordosis angle randomly selected from the Picture Archiving and Communication Systems (PACS) archive of Bolu Abant Izzet Baysal University Training and Research Hospital has been used. The images taken from the system in Dicom format have been transferred to a personal workstation Radiant Dicom Viewer (RDV) program. After the determination of decreased cervical lordosis angle has been made by an orthopedic and traumatology specialist, the following parameters were measured. The following variables have been measured: Dens height (DH), anteroposterior distance of dens (APDD), length of apical ligament of dens (LALD), sagittal diameter of foramen magnum (SDFM), anteroposterior diameter of spinal canal (APCSD), length of retropharyngeal space (LRS), anteroposterior distance of dens (ASDD), total cervical vertebrae length (TCVL) and dens angle (DA). The demonstration of the measured variables is given in Figure 1.



**Figure 1.** Demonstrations of the variables; a- DH, b- APDD, c- LALD, d- SDFM, e- APCSD, f- LRS, h- ASDD, g- TCVL, i- DA; DH: dens height, APDD: anteroposterior distance of dens, LALD: length of apical ligament of dens, SDFM: sagittal diameter of foramen magnum, APCSD: anteroposterior diameter of spinal canal, LRS: length of retropharyngeal space, ASDD: anteroposterior distance of dens, TCVL: total cervical vertebrae length, DA: dens angle

### Statistical Analysis

Statistical analysis have been performed with Minitab® 21.2 (64-bit) package program and R version 4.2.3 (2023-03-15 ucrt). The compatibility of the variables with normal distribution has been tested with Anderson Darling Test. The mean and standard deviation (sd) values of parametric variables and median (med), minimum (min) and maximum (max) values of nonparametric variables were calculated. To analyze the difference between genders, Two Simple T Test has been used for parametric tests and Mann Whitney U Test for nonparametric variables. Logarithmic transformation was performed for nonparametric variables. In the Anderson Darling Test performed as a result of logarithmic transformation, 95% confidence intervals have been calculated for variables that fit the normal distribution.  $P < 0.05$  has been accepted as significant.

## RESULTS

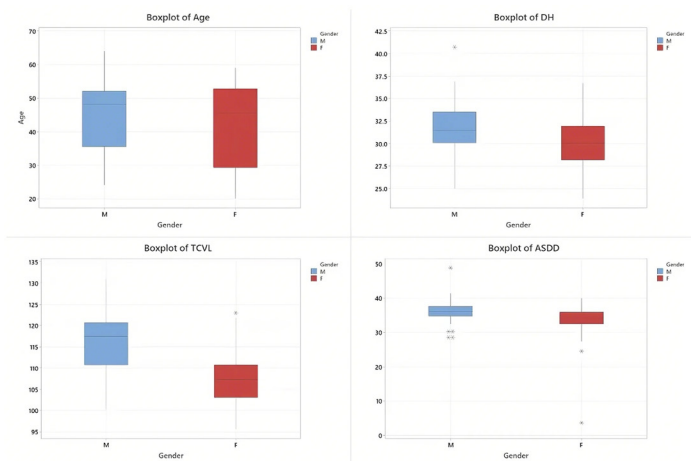
Following the analysis, med, min and max values have been given for age, APDD, SDFM, APCSD, LRS and ASDD variables because they have not been normally distributed, and mean and sd values have been given for DH, DA and TCVL variables because they have been normally distributed. Log transformation has been applied for the LALD variable and mean and 95% confidence intervals have been included (Table 1). As a result of the analysis, the differences between men and women in DH, ASDD and TCVL variables have been found statistically significant. Descriptive statistics, Mann Whitney U Test results and Two Simple T Test results of the variables have been presented in Table 1.

**Table 1.** The descriptive statistics of the variables, Two Simple T and Mann Whitney Test results

Variable	M (n=60)	F (n=60)	p-value
Age	48 (24-64)*	45.5 (20-59)	0.388 <sup>□</sup>
DH (cm)	31.5±2.8**	30.1±2.6	0.007 <sup>#</sup>
APDD (cm)	10.2 (8.1-16.5)	10.0 (7.3-14.3)	0.079 <sup>□</sup>
ASDD (cm)	36.1 (28.5-48.8)	34.2 (33.5-40)	<0.001 <sup>□</sup>
DA (°)	64.8±5.3	63.9±4.3	0.318 <sup>#</sup>
LALD (cm)	7.2 (6.6-7.7)***	6.5 (6.1-6.8)***	0.077 <sup>#</sup>
TCVL (cm)	116.2±7.2	107.7±6.1	<0.001 <sup>#</sup>
LRS (mm)	3 (1-6.4)	3.6 (2-5.9)	0.220 <sup>□</sup>
APCSD (mm)	15.6±1.6	15.8±1.7	0.662 <sup>#</sup>
SDFM (cm)	6.9 (3.1-8.3)	7.3 (4.5-8.8)	0.131 <sup>□</sup>

DH: dens height, APDD: anteroposterior distance of dens, ASDD: anteroposterior distance of dens, DA: dens angle, LALD: length of apical ligament of dens, TCVL: total cervical vertebrae length, LRS: length of retropharyngeal space, APCSD: anteroposterior diameter of spinal canal, SDFM: sagittal diameter of foramen magnum, M: male, F: female, <sup>□</sup>: the p value of the Mann whitney u test result, <sup>#</sup>: the p-value of the Two Simple T Test, \*: med (min-max), \*\*: mean±sd, \*\*\*: the means and 95% confidence intervals after logarithmic transformation

The boxplot graph of age, DH, TCVL, ASDD variables has been presented in Figure 2.



**Figure 2.** The boxplot graph of age, DH, TCVL, ASDD variables. DH: dens height, TCVL: total cervical vertebrae length, ASDD: anteroposterior distance of dens, M: male, F: female

## DISCUSSION

Age and gender both have an impact on the deformities and degenerative changes that occur in the vertebrae of the craniocervical area, which cause variations in the cervical lordosis angle throughout time. Finding the anatomical-morphometric characteristics that contributed to the changes in this region has been the objective of the current investigation.

In the current study, MRIs of individuals with reduced cervical lordosis angles aged 25 to 55 were used to examine changes in the gender-related variables of DH, ASDD, TCVL, APDD, DA, LALD, LRS, APCSD, and SDFM. The results showed that the variables related to the craniocervical region, including DH, ASDD, TCVL, APDD, DA, LALD, LRS, APCSD, and SDFM, had statistically significant levels.

According to the literature review, this is the first study to determine the impacted anatomical parameters and investigate gender-related modifications of the craniocervical region in Turkish individuals who have reduced cervical lordosis. We think that the anatomical parameters that were examined in the study and found to be changed will make pre- and post-operative procedures easier. Several studies have been published in the literature that highlight the significance of cervical lordosis in terms of function, surgery, and therapeutic management (9-12). Very few studies have investigated at how it relates to anatomical parameters.

A study that evaluated the anatomical parameters of cervical lordosis and how it affect gender and age investigated at 1020 individuals, 424 of whom were male and 596 of whom were female, ranging in age from 7 to 95. Cervical lordosis and intervertebral disc compression have been shown to increase significantly with age, with a greater increase in males than in women. Vertebral body compression has been demonstrated to have a smaller effect on C2-C7 cervical lordosis than disc compression. The morphological characteristics of sagittal compression of the intervertebral discs and vertebral bodies in the cervical spine are thoroughly investigated in this study, which is the largest investigation of this type reported in the literature (13). Cervical lordosis increases with aging, according to earlier research in the literature (14-17).

The effect of age and gender on cervical lordosis in lateral cervical radiographs of a total of 197 patients ranging in age from 6 to 50 years has been investigated in two groups: a juvenile group (76 children aged 6-19 years; 48 males and 28 females) and an adult group (121 adults aged 20-50 years; 61 males and 60 females). Consequently, it was found that children showed a considerably more significant gender difference than adults (7).

An examination of 120 adults' cervical lateral roentgenograms compared the corpus of the cervical vertebrae biometrically. It has been reported that the vertebral body of C2, especially its anteroposterior diameter value, is the best indicator of age independent of individual and external variables (18).

A total of 1,230 asymptomatic individuals have been studied for age-related changes in the bony anatomy, alignment and range of motion of the cervical spine on antero-posterior (AP), lateral, flexion and extension radiographs of the cervical spine. The antero-posterior diameter of the spinal canal, vertebral body and vertebral disc has been measured at all levels from C2 to C7. It has been found that with increasing age, both the AP diameter of the spinal canal and the disc height gradually decrease. There has been a significant difference between men and women in terms of C2-C7 alignment and range of motion (19).

It is also reported in the literature that neck pain and neck flattening due to nerve root irritations at the level of the foramen intervertebrale as a result of decreased cervical lordosis angle (20-24).

The present study has several limitations. The sample size is relatively limited, which is the first constraint. The second is that different spondylotic changes that can be observed at older ages have been omitted from the study because the participants under examination ranged in age from 25 to 55. Third, ethnic differences could not be taken into account because the study was single-centered. Another drawback is that, as it was a retrospective study, none of the cases that were studied at presented any clinical symptoms.

## CONCLUSION

In terms of normal values for comparison in clinical practice, it is thought that the study's data, which identify the anatomical parameters that are significantly determined among people with reduced cervical lordosis angle, may be helpful. Furthermore, based on an overview of the findings from this study and the literature, we believe that future research should investigate into the clinical consequences of anatomical features.

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**Conflict of interest:** *The authors have no conflicts of interest to declare.*

**Ethical approval:** *Research has been started with the approval decision numbered 2023/230 from the Bolu Abant İzzet Baysal University Clinical Research Ethics Committee.*

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