A STUDY ON THE CERVICAL LORDOTIC ANGLE AND TORG'S RATIO IN ADULTS POPULATION OF CROSS RIVER STATE NIGERIA

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Abstract: Radiographic evaluation of Cervical Spine alignment parameters assists in the diagnosis of degenerative and traumatic conditions of the cervical spine, for example, cervical spondylosis, stenosis, whyplash injury and neuroplasia. Two prominent parameters used in assessing the Cervical part of the spine is the Lordotic angle and Torg's ratio, whose normative values have been established to vary from region to region. The aim of this study was to elucidate the baseline or normative values of Cervical Lordotic angles and Torg's ratio in healthy indigenes of Cross River State, Nigeria. Comparison was made between the two parameters to determine if there is any relationship between them. Lateral radiographs for Lordotic angle and Anterior-Posterior (A-P) radiographs for Torg's ratio of one hundred images of asymptomatic subjects (100: Male 57 and Female 43) were used to carry out the measurements of these important alignment parameters. Cervical lordotic angle was measured using Cobb's method. Torg's ratio was calculated using Mid-sagittal Canal diameter to Body diameter estimation. Different normative mean values for Cervical lordotic angles have been obtained, confirming the fact that lordotic angles varies from region to region. In this research, the cervical lordotic angle was 25.45 ±11.21, with a range of 4.55-46.90 for males and 25.22 ±11.46 with a range of 3.4-50.40 for females. Torg's ratio value obtained ranged from 0.80-1.03. These findings have successfully elucidated the normal and mean values of Cervical lordotic angles .and Torg's ratio in the adult population of Cross River State, Nigeria. These values will not only be utilized in the spine treatment, it will also be used by teachers of Anatomy in the teaching of medical students in Nigeria.

Key words: Cervical lordosis, Mid-sagittal diameter, Body diameter, Torg's ratio, Stenosis, Cervical vertebrae.

I. INTRODUCTION

The cervical region is the most mobile part of the entire spine. Its mobility makes it prone to certain degenerative and neurological diseases such.as cervical spondylosis. The major morphometric parameters that should be evaluated during a routine check of the cervical spine on an X-ray or MRI are alignment of bones, cartilages and soft tissues, among others. The alignment parameter includes the following radiographic lines; Cervical lordosis, Sagittal canal diameter, vertebral body diameter (Yochum and Rowe, 2005). It has been observed that morphometry of spinal canal at cervical region varies according to the geographic region studied, (Austin., *et al*.,2002). In many degenerative pathological conditions (especially in cervical spondylosis), there is a reduction in the cervical canal known as cervical stenosis. In this condition there is a slow degeneration or herniation of the intervertebral discs, which in turn leads to a disruption or reversal of the normal lordotic curvature of the cervical spine. This alteration of the cervical curvature causes the generation of bone spurs as a compensation to the loss in intervertebral disc height. Canal narrowing slowly occurs as the degenerative process worsens. In other words, there is an existing association between the lordotic angle (curve) of the cervical spine and the cervical canal size (Wilkinson *et al*., 1969; Ferrara, 2012). Also normal values of Cervical Canal diameter show gender and regional variations, and their values have been used to diagnose cases of spine disorders (Amonoo-Kuofi et al., 1985). This present research work therefore tried to elucidate the normative values of Lordotic angle and Torg's ratio in Cross River State Nigeria. The values obtained will not only be used in the clinical practice but will also be utilized in the teaching of Human Anatomy in Nigeria. Comparison will also be made with the values obtained in this research and the previous work done by other researchers.

II. MATERIALS AND METHODS

All the Cervical MRI and X-ray images were measured in axial position for each Cervical vertebra level separately. The software, ISSA DICOM VIEWER was designed specifically to give accurate measurements of all radiographic parameters of the spine. All the radiographs used where taken from patients who had undergone the radiographic examination of the cervical spine at Asi-Ukpo Diagnostic and Medical Center Calabar, Cross River. A total of 100 radiographs of the cervical spine (both lateral and postero-anterior views) were measured. The exclusive criteria adopted for use was lateral and postero-anterior films of the cervical spine of adults, excluding those radiographs that may be pathological or fractured. The measurement of the cervical angle was carried out by adopting Cobb's method (Harrison *et al*., 2000). The measurement was taken between C2-C7 vertebrae through a line constructed by clicking with the mouse pointer through and parallel to the inferior endplate of C7 and another was drawn through and parallel to the inferior endplate of C2, perpendiculars were constructed to the point of intersection and the resultant angle was automatically measured (Figure 1). Measurement of Canal diameter was taken from the posterior surface of the mid-vertebral aspect of the body to the nearest surface of the same segmental spinolaminar junction [point a] (Wolf *et al*., 1956; Hinck *et al*., 1962). The distance between the two points was automatically calculated using the software as the canal diameter. The vertebral body was measured from the anterior surface of the mid-vertebral aspect of the body to the posterior aspect [point b]. This procedure was used in accordance to the Torg-Pavlov ratio to access a possible stenosed vertebra. In this method, the sagittal diameter of the vertebral canal is divided by the diameter of the corresponding vertebral body. This ratio is the so called Torg-Pavlov ratio or Canal to Body ratio (Maitreye *et al.*, 2017). Data obtained from measurements were analyzed for descriptive statistics and represented as mean ± standard deviation, and range. Gender differences were compared using Student t-test. Pearson's correlation coefficient (r) was used to determine the association between the canal size and Cervical Lordotic angle of individuals. Statistical significance was set at $P<0.05$. GraphPad Prism 5 (GraphPadInc.,USA) was the statistical software used for analysis.

III. RESULTS

Results in Table 1 display all the normative values and their ranges of the Cervical vertebral canal diameter at all cervical vertebral levels(C2-C7). It showed no significant difference in the Canal diameter, between the males and females at all cervical vertebral levels [C2-C7] measured. In table 2, there was a significant difference ($P<0.05$) in the Cervical body diameter, between the males and females at all vertebral levels measured. There was significant difference ($P<0.05$) between the male and female Torg's ratio, from C3-C7. No difference was seen in C2 vertebra. As regards to the Cervical Lordotic angle, there was no significant difference in the lordosis of the cervical spine between the males and females. Cervical lordotic Angle and Torg's ratio, using Pearson's correlation coefficient (r), values showed no significant correlation between the angle and Torg's ratio in males from C2-C7. But in females, there was a positive correlation in Lordotic angle and Torg's ratio at all cervical vertebral levels (C2-C6) except at C7.

Table 1: Gender difference in Canal diameter of cervical vertebrae

Cervical Level	Sex	Mean± SD (mm)	Range (mm)
C2	**Male**	22.00±2.15	18.25-29.03
	Female	21.68±2.80	16.54-29.27
	Total	21.86±2.44	16.54-29.27
C3	**Male**	18.82±1.85	15.95-23.49
	Female	18.84±2.49	12.49-25.44
	Total	18.83±2.13	12.49-25.44
C4	**Male**	18.52±1.77	15.20-22.89
	Female	18.70±2.08	14.14-22.99
	Total	18.60±1.90	14.14-22.99
C5	**Male**	18.97±1.72	15.71-23.87
	Female	18.85±2.44	13.47-24.61
	Total	18.92±2.05	13.47-24.61
C6	**Male**	19.45±1.73	15.35-23.40
	Female	19.30±2.53	16.10-25.02
	Total	19.38±2.10	15.35-25.02
C7	**Male**	19.75±2.17	13.00-23.67
	Female	19.63±2.47	14.24-24.67
	Total	19.70±2.29	13.00-24.67

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Table 2: Gender difference in Body diameter of cervical vertebrae

Cervical Level	Sex	Mean± SD (mm)	Range (mm)
C2	**Male**	19.52±1.96[u]	15.59-23.57
	Female	18.09±1.63[u]	15.50-23.78
	Total	18.90±1.95	15.50-23.78
C3	**Male**	20.81±1.99[v]	16.80-25.73
	Female	19.08±2.19[v]	15.60-26.85
	Total	20.06±2.24	15.60-26.85
C4	**Male**	18.52±1.77[w]	15.45-26.63
	Female	18.88±2.24[w]	15.40-27.66
	Total	19.92±2.42	15.40-27.66
C5	**Male**	20.57±2.03[x]	15.26-25.89
	Female	18.53±2.09[x]	15.10-24.46
	Total	19.69±2.29	15.10-25.89
C6	**Male**	20.42±2.05[y]	15.25-26.70
	Female	18.83±2.03[y]	14.30-24.04
	Total	19.73±2.18	14.30-26.70
C7	**Male**	20.65±2.07[z]	16.70-25.50
	Female	19.14±2.07[z]	15.30-25.50
	Total	19.99±2.19	15.30-25.50

Same superscript letters "u v, w, x, y, z" indicates significant difference (P<0.05) between the males and females

Table 3: Gender difference in Torg's ratio of cervical vertebrae

Cervical Level	Sex	Mean± SD (mm)	Range (mm)
C2	**Male**	1.14±0.17	0.85-1.62
	Female	1.20±0.15	0.90-1.48
	Total	1.17±0.16	0.85-1.62
C3	**Male**	0.91±0.14[u]	0.71-1.35
	Female	0.80±0.16[u]	0.56-1.35
	Total	0.95±0.16	0.56-1.35
C4	**Male**	0.91±0.15[v]	0.65-1.48
	Female	1.00±0.14[v]	0.67-1.39
	Total	0.95±0.15	0.65-1.48
C5	**Male**	0.93±0.14[w]	0.76-1.56
	Female	1.03±0.16[w]	0.55-1.50
	Total	0.97±0.16	0.55-1.56
C6	**Male**	0.96±0.13[x]	0.68-1.53
	Female	1.03±0.16[x]	0.71-1.61
	Total	0.99±0.15	0.68-1.61
C7	**Male**	0.97±0.14[y]	0.63-1.32
	Female	1.03±0.14[y]	0.64-1.41
	Total	0.99±0.14	0.63-1.41

Similar superscript letters "u-y" indicates significant difference (P<0.05) between males and females.

Table 4: Gender difference in Angle (lordosis) of entire Cervical vertebrae.

Sex	Mean± SD (degrees)	Range (degrees)

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Male	25.45±11.21	3.40-50.40
Female	25.22±11.46	4.55-46.90
Total	25.35±11.25	3.40-50.40

Table 5: Correlation between Angle and Torg's Ratio.

Cervical Level	Sex	Angle and Torg's ratio
C2	**Male**	0.185
	Female	0.387*
	Total	0.259*
C3	**Male**	0.194
	Female	0.437*
	Total	0.295*
C4	**Male**	0.101
	Female	0.383*
	Total	0.203
C5	**Male**	0.148
	Female	0.454*
	Total	0.273*
C6	**Male**	0.072
	Female	0.392*
	Total	0.215
C7	**Male**	0.020
	Female	0.255
	Total	0.118

Values are Pearson's correlation coefficient (r).Two tailed significance. * denotes significant correlation between Lodotic angle and Torg's ratio.

IV. DISCUSSION

Cervical Lordotic angle and Canal size are essential parameters used for the evaluation of the cervical spine for degenerative diseases and stenosis. Limited study has been done on the use of the cervical lordotic angle as an indicator for canal stenosis. Such a study is necessary not only for better diagnosis of stenosis, but also provides normative values for the particular population studied. On lateral plain radiographs, Torg's ratio is used to find evidence of cervical stenosis, as it has the advantage of not being affected by magnification (David and Onibala, 2010; Gour *et al*., 2011). The present study showed no significant difference in canal diameter between the males and females. It also showed the canal diameter being least at cervical vertebra four (C4), in both genders. This contradicts reports by other researchers (Gupta *et al*., 1982; Lim and Wong, 2004; Ozlen and Zulfu, 2007), who concluded that there is significant difference in canal diameter between the males and females; the males having a larger canal diameter than the females at all vertebral levels. In agreement with the results from this study is the research by Lee *et al*., 1994. They concluded that there is no sexual dimorphic variation in canal size. The present study also indicated significant difference in body diameter between the males and females at all vertebral levels. The sexual dimorphism in body diameter showed a higher vertebra body diameter in males than in females, except at C4 vertebra; where females have a significantly higher body diameter (18.88mm) than the males (18.52mm). A higher body diameter in the C4 vertebra of the females, contradicts the research by various authors (Gupta et al., 1982; Lim and Wong, 2004; Ozlen and Zulfu, 2007), they revealed that males have a higher cervical body diameter than females at all vertebral levels. Furthermore, Torg's ratio values in the present study indicated significant difference between genders, with the females having a higher Torg's ratio value than the males at all cervical vertebral levels except at C2. The increased Torg's ratio values in the present study in females could be as a result of the decreased body diameter in this gender when compared to males. Cervical lordotic angle showed no significant difference in gender, with a mean value of 25.45◦ and 25.22◦ in males and females respectively. A cervical lordosis of <200 has been established to be associated with neck pain, The differences in normative mean and range values of cervical lordotic angle that is observed between this study and previous ones is a further proof that these parameters vary from region to region., The results obtained in this study will be adopted as a useful indicative tool for diagnosis of degenerative diseases and stenosis within the geographical region of Cross River State Nigeria. The normative data obtained can also be useful to teachers of Anatomy in the medical School within the studied population.

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V. CONCLUSION

The study has made available the hitherto non-existing baseline or normative values of Lordotic angles and Torg's ratio in Cross River State Nigeria. The study also showed that there is a statistically significant relationship between the Cervical lordotic angle and Torg's ratio in females, and. any alteration of the Cervical lordosis will automatically affect the Torg's ratio. So, in females, the Cervical lordosis can therefore be a useful indicator of stenosis and other degenerative diseases of the spine. The study also demonstrates sexual dimorphism between the males and the females; the males exhibiting a larger body diameter than the females, and therefore a smaller Torg's ratio.. The females have a larger canal diameter than the males and a higher Torg's ratio. Since the main determinant of stenosis is the canal diameter, the females therefore are less vulnerable to stenosis than men.

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