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CERVICAL SPINE CANAL MEASURES IN AN ASSYMPTOMATIC NIGERIAN POPULATION

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ABSTRACT
Background: The canal dimension is very important for determining the predisposition of an individual to spinal cord compression and entrapment. The Torg-Pavlov ratio is a dimensional proportion used as a universal indicator of cervical spine stenosis. **Aim:** To determine the reliability of the Torg's ratio in a non-athletic asymptomatic Nigerian population. **Metarials and methods:** Radiographs of 60 (40 males, 20 females) asymptomatic adult volunteers aged 18-40 years were used for the study. The parameters measured were the anterior-posterior diameter of the spinal canal and the anterior-posterior diameter of the vertebral body. The Torg's ratio was determined by dividing the AP canal diameter by the AP body diameter. The obtained values were statistically analyzed using a Student's t-test, and a p value of less than 0.05 was considered statistically significant. **Results:** Mean canal AP for males at C3=13.29±0.53, C4=13.32±0.27, C5=13.86±0.39, C6=13.85±0.38 and C7=13.72±0.43. Mean canal AP for females at C3=13.23±0.53, C4=13.38±0.41, C5=13.61±0.40, C6=13.72±0.42 and C7=13.96±0.46. The Torg's ratio for males at C3=0.84, C4=0.84, C5=0.83, C6=0.80 and C7=0.78 while for females, at C3=0.90, C4=0.90, C5=0.88, C6=0.87 and C7=0.85. **Conclusion:** Using 12mm to determine stenosis seems more apt for this population than does the Torg's ratio due to the parameters used in determining the ratio (the vertebral body) which is larger in males. The ratio seems to overestimate the presence of stenosis in non-athletic males. We hypothesize that strength exercise affecting the posterior elements that make up the spinal canal may have the ability to increase the size of the canal. This should be taken into consideration when determining stenosis in the general non-athletic population.

KEYWORDS: Cervical spine, Torg's ratio, stenosis, plain radiograph.

INTRODUCTION
Vertebral column, also called the spinal column, is comprised of the spine and spinal cord[1], which, supporting the head and enclosing the spinal cord, is regarded as one of the most complex structures of the human body.[1,2] The size of the cervical spinal canal is clinically important in traumatic, degenerative, and inflammatory conditions. Thus, the knowledge of the normal morphometry of the spine is of importance in procedures involving abnormal spinal management, but first it is required to obtain normal values for the specific population being evaluated.[3] Narrowing of the spinal canal referred to as spinal stenosis has long been associated with neurological injury.[4,5] A ratio method to determine the presence of stenosis has been in use, known as the Torg's ratio, Pavlov ratio, or the canal-to-body ratio. This ratio is determined by dividing the anterior posterior diameter of the spinal canal by the vertebral body of the same vertebra.[5,6] Measurements are typically done on plain radiographs and this ratio method is said to eliminate errors related to magnification, which are observed frequently on lateral X-rays.[7] This ratio is currently used as a universal indicator of cervical spinal canal stenosis, in spite of the fact that differences between race and sex have been reported.[8] In normal individuals, the ratio is close to one and where the ratio is less than 0.85 stenosis is said to be present. A ratio below 0.8 is believed to be a significant risk factor of neurological injury, and establishes a canal to be congenitally narrow. Absolute or relative stenosis (smaller than 10 mm and 10-13 mm, respectively) are risk factors for radiculopathy, myelopathy or both due to trauma or relatively minor spondylosis.[5] The finding of a spinal canal diameter less than 11 mm and a Pavlov index of less than 0.8mm support suspicion of cervical spinal myelopathy.[9] Study on the cervical spinal canal on dried bones showed that the Torg's ratio rendered all males stenos.[10] Thus, there is need to investigate it with imaging techniques.

The aim of this study was to determine the reliability of Torg's ratio and identify the most accurate screening method for the Nigerian population.

MATERIALS AND METHODS

Radiographs of 60 (40 males, 20 females) asymptomatic adult volunteers aged 18-40 years were used for the study. Any spinal column showing radiological evidence of osteophyte formation or any other vertebral abnormality was not included in this study. The vertebral levels examined included C3 to C7. For this study, individuals that have undergone previous spinal surgery were excluded and an informed consent was obtained from each volunteer. An institutional ethical review board approved this study.

Radiometric studies were made directly from the console of the digitized plain radiographs using AMX 0.5 General Electric X-ray machine (England) with a Agfa CR30-Xm (Belgium) radiograph digitizer.

The measured parameters were

1. Anterior-posterior diameter of canal measured on lateral radiographs from the middle of the back of the vertebral body to the base of the opposing spinous process.
2. Anterior-posterior diameter of vertebral body measured at the level of the inferior margin of the spinous process.

The Torg's ratio was calculated by dividing the anterior posterior (mid-sagittal) diameter of the spinal canal by the anterior posterior diameter of vertebral body of the same vertebra as described by Torg *et al.*[5]
Statistical analysis was done using a Student's t-test and a p value of less than 0.05 was considered statistically significant.

RESULTS

Table 1: Mean values for CANAL-AP and t-test of mean difference between females and males.

Group Statistics				
Vertebral level		**N**	**Mean ± S.D**	**P-value**
C3	Male	40	13.29 ± 0.37	*0.612*
	Female	20	13.23 ± 0.53	
C4	Male	40	13.32 ± 0.27	*0.499*
	Female	20	13.38 ± 0.41	
C5	Male	40	13.86 ± 0.39	*0.024*
	Female	20	13.61 ± 0.40	
C6	Male	40	13.85 ± 0.38	*0.233*
	Female	20	13.72 ± 0.42	
C7	Male	40	13.72 ± 0.43	*0.047*
	Female	20	13.96 ± 0.46	

P values < 0.05 are statistically significant N = 40 males and 20 females

Table 2: Mean values for VBAP and t-test of mean difference between females and males.

Group Statistics				
Sex		**N**	**Mean±S.D**	**P-value**
C3	Male	40	15.80 ± 0.76	*< 0.0001*
	Female	20	14.76 ± 0.85	
C4	Male	40	15.92 ± 0.74	*< 0.0001*
	Female	20	14.95 ± 0.80	
C5	Male	40	16.58 ± 0.58	*< 0.0001*
	Female	20	15.46 ± 0.82	
C6	Male	40	17.22 ± 0.51	*< 0.0001*
	Female	20	15.84 ± 0.80	
C7	Male	40	17.67 ± 0.48	*< 0.0001*
	Female	20	16.35 ± 0.81	

P values < 0.05 are statistically significant N = 40 males and 20 females

Table 3: Canal-to-body ratio for males and females.

Vert. Level	**Cbr (Males)**	**Cbr (Females)**	**P-value**
C3	0.84	0.90	*< 0.0001*
C4	0.84	0.90	*< 0.0001*
C5	0.84	0.88	*< 0.0001*
C6	0.80	0.87	*< 0.0001*
C7	0.78	0.85	*< 0.0001*

P values < 0.05 are statistically significant N = 40 males and 20 females

DISCUSSION

The size of the spinal canal has been correlated with the safety of the spinal nerve as small canal diameter has been implicated in cervical myelopathy.[11,5,12,13] The morphometric measurements of several authors.[14,15,16] have been used to establish the minimal normal values, however, the differences between values raises great concern with regards to absolute or standard measurements, which is a result of the distinct variability.[17] These morphometric observations prompted the Torg-Pavlov ratio for statistical determining the cervical stenosis with ratios less than 0.85 described as cervical stenosis.[5]

The canal dimension is very important for determining the predisposition of an individual to spinal cord compression and entrapment. In this study, it was observed that the smallest vertebral canal was at C3, while the mean anteroposterior (AP) diameter of the cervical spinal canal was almost constant from C4 to C5, with a slight increase towards C7. The values (12.5mm-14mm) obtained in this study were similar to the value (13.9±1.2mm) observed for the Swiss population by Monier *et al.*[8] Several studies have evaluated the dimensions of the spinal canal because smaller canals correlate with increased risk of injury.[14,19,20,21] Variations in spinal canal dimensions have been reported among different populations.[10,1,22], with some evidence suggesting that our values are close to the South African values[23,24,25], but larger than the Asian subjects which tend to have smaller mid-sagittal anteroposterior diameters (APDs) than Europeans or Americans.[26,27]

Aebi *et al.*[28] suggested that the Torg-Pavlov ratio cut-off value of 0.85 can be used to identify patients who are at risk of spinal cord injury (SCI) after a minor trauma to the cervical spine. In this study, at all cervical levels, the ratio for females are well above 0.85, while that for males are below 0.85. Maqbool and colleagues [6] in their study population also observed a higher value for females than males. The decreasing canal ratio is in agreement with previous report on Swizz population.[18]

Considering the discrepancies of the values obtained by different researches, applying the Torg's ratio for the determination of stenosis in a given population, there is a need for further investigation since Torg's study population included athletes who engage regularly in exercise, whereas the general population averagely do not. A notable study conducted in 1989 established that increasing levels of physical activity were associated with increasing strength of the vertebral column in individuals aged 18 years and over.[29] Also, the posterior elements of the vertebral bodies are said to have the ability to undergo regrowth and remodeling.[30,31] Amonoo-Kuofi[32] infers that, if the pedicles were subjected to varying mechanical stresses, they would probably show variations in diameters. The author of this present study goes further to add that the spinal canal diameters will therefore be affected since the laminae and pedicles form the posterior and lateral borders of the canal. Therefore, the canal diameters of athletes will be markedly different from non-athletes. We hypothesize that this is rather a contributing factor why the Torg's ratio rendered almost all our study population made up of asymptomatic young men stenotic, since Pavlov's study population used in establishing the ratio for determining cervical spine stenosis was made up of young male athletes whose normal spinal canal diameter as we have seen is different from those of non-athletes. Thus, the Torg-Pavlov ratio of 0.85 could be said to be an inaccurate predictor of stenosis at the cervical region in this study population since it renders almost all males to be stenotic, which was not so in the general population studied. On the contrary, using the 12mm dividing line to determine a narrow canal, seems more reliable in this population since the AP diameter of both males and females at all levels (C3-C7) are well above the 12mm dividing line. Therefore, we agree with Prasad *et al.*[33] that the ratio method should not be the only means for identifying stenosis in the anterior posterior plane of the spinal canal.

In conclusion, our study suggests that males are more prone to myelopathy using either the Torg's ratio of 0.85 or the dividing line of 12mm to determine stenosis. The Torg's ratio was significantly higher in females than males, thus suggesting a more spacious spinal canal for females. From the observed difference in canal AP diameter and Torg's ratio between males and females in this study, we conclude that males will be more predisposed to having neurological deficit due to stenosis of the canal in the slightest manifestation of pathology than do females. Owing to this conclusion, strength exercise that will impact positively on the vertebra is encouraged to limit to a considerable degree the percentage of individuals at risk of myelopathy due to a narrow spinal canal and also to increase the strength and quality of the pedicles.

The results from this study will furnish clinicians with the information needed to treat spondilosis as a result of stenosis in our environment. Also further studies are encouraged to investigate the outcome between symptomatic and asymptomatic group.

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