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A Cadaveric Study of the Morphometry of the Cervical Spinal Canal in Nigerians

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Abstract

Morphometry of the cervical spinal canal is of clinical importance in traumatic, degenerative and inflammatory conditions. A small canal diameter has been associated with an increase of injury mainly in athletes who participate in contact or collision sports. Before abnormal spinal morphometry can be determined, it is first necessary to establish normal values for the specific patient population being evaluated. The authors study of 105 anatomical specimen of the cervical spine (70 males, 35 females) was to determine the spectrum of the sagittal diameter of the cervical spinal canal in Nigerians. Normal spinal canal mean for C3 was 17.82mm, C4 17.14mm; C5 17.35mm; C6 17.35mm and 17.42mm in C7 for male specimen while for female specimen was C3 17.45mm, C4 16.40mm; C5 17.21mm, C6 17.13mm and C7 17.38mm. The mean canal-body ratio was 0.82 and 0.91 for males and females respectively. The findings offer valuable information for a symptomatic cervical spinal stenosis and also highlights the importance of normative data of the cervical spinal canal for the population under study.

Key words: Morphometry, Cervical Spinal Canal, Nigerians.

The cervical vertebrae are an integral part of the vertebral column. They form the skeleton of the neck and are the smallest of the 24 movable vertebrae located between the cranium and the pelvis. Their main functions are to protect the spinal cord and to support the head (Keith and Dalley 2000).

Studies to determine the spectrum of the cervical spinal canal among various populations have sparked off a lot of interest in recent times. This is due to the clinical importance of the size and shape of the spinal canal in relationship to medullary compression and/or myelopathy, which can be due to spondylosis or congenital narrowing of the spine bony elements. The clinical manifestations range from a progressively slow incapacity occurring spontaneously, to a sudden tetraplegia after a minor or major trauma (Torg et al 1986, Pavlov et al1987, Ladd and Scranton 1987,Herzorg et al 1991). Acute myelopathy after minor trauma of cervical spine can occur without fracture or dislocation. This is linked to spondylosis which leads to gradual reducation of the canal reported to be present in 82% of people aged 85 years or more (Jones and Mayer 1994).

Several workers have reported that many young athletes who participate in collision or physical contact sports and presenting with quadriplegia or neuro-aprexia after minor trauma in the head or neck region have developmental narrowing of the cervical spinal canal (Funk and Wells 1975, Grant and Puffer 1976, Stratford 1978, Kang et al 1994, Torg et al 1996). Other researchers have shown that the incidence of “stingers” or “burners”(traumatic upper extremity paresthesias) in athletes is associated with a narrow spinal canal (Kelly et al 1992, Meyer et al 1994, Levitz et al 1997, Kelly 1997).

Some surgeons recommend surgical treatment of asymptomatic patients with a narrow canal as prophylaxis against paralysis, whereas others recommend observation (Gore 2001, Boden et al 1993, Bednari et al 2004). This controversy is partly due to a lack of normative data on spinal canal morphometry of different population (Cantu 2000, Michael et al 2007).

It is a known fact that the vertebral column morphology is influenced externally by mechanical and environmental factors and internally by genetic, metabolic and hormonal factors (Williams et al 1995).

Different authors have reported different measurements of the normal range of the anteroposterior diameter of the spinal canal at each cervical level (Payne and Spillan 1957, Wolf et al 1966, Burrows 1963, Boijsen 1964, Nagashima 1973). These assessments of the diameter of the cervical spinal canal are based on plain radiographs which may not accurately reflect the true dimensions of the cervical spinal canal because of magnification factors, mainly due to the object film distance which depends upon individual shoulder width (Boijsen 1954). In an attempt to bypass this difficulty, Torg et al (1986) and Pavlov et al (1987) established a ratio method: canal-body proportion, in plain lateral cervical spine radiograph, it is the ratio of the sagittal diameter of the spine canal to the anterior posterior length of the body, at its mean point. This ratio method known as Torg's ratio, Pavlov's ratio or Canal-body ratio is used to screen athletes who are at risk of neuropraxia. Lee et al (1994) suggested that the measurement of the dimensions of the vertebral body and spinal canal should be done on anatomical specimen since radiographs may not exactly depict the true dimensions of the cervical spinal canal. They carried out their study on dried human spinal columns with the aim of determining the normal sagittal diameter of the cervical spinal canal and Torg's ratio in Koreans. Despite the increasing awareness of the clinical importance of the dimensions of the cervical spinal canal, a literature search by the authors did not show any study previously done on the Nigerian population. This study, therefore, is an attempt to bridge this gap in knowledge since our young people are actively involved in athletics globally and may be predisposed to neuropraxia.

It is recommended that before an abnormal spinal morphometry can be determined, it is necessary to establish normal values for the specific population being evaluated. In addition, this study aims to highlight the importance of normative data of the cervical spinal canal for the Nigerian population since Asian and caucasian data of the cervical spinal canal may not be applicable to our environment due to racial and geographical differences.

MATERIALS AND METHODS

One hundred and five sets of adult skeletal specimens of the cervical spine were obtained from the Anatomy museums of the Colleges of Health Science of some universities across Nigeria: Niger Delta University, University of Port Harcourt, University of Benin, University of Calabar and University of Ibadan. Seventy of the spinal column belonged to male subjects while thirty five belonged to female subjects.

The vertebral levels examined were C3 to C7. The first and second cervical vertebrae were excluded because they have different shapes as compared with other cervical vertebrae.

With the use of sliding vernier calipers the sagittal diameter of the cervical spinal canal and the anteroposterior diameter of the vertebral body at the mid waist level were measured for each specimen at every level from C3 to C7. The technique for the measurements of the vertebral body (B) and the canal (A) shown in Fig. 1 were described by Torg et al (1986) and Pavlov et al (1987). The canal-to body ratio for each vertebrae was determined by dividing the mid sagittal diameter of the spinal canal (A) by the anteroposterior diameter of the vertebral body (B).

Data collected were analyzed using statistical package for the social sciences version 13.0

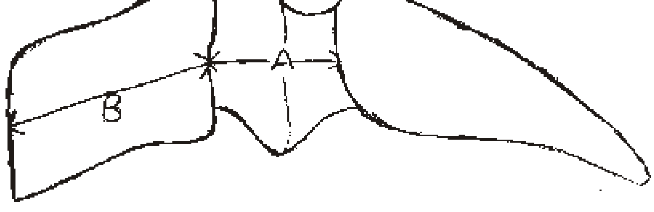

Fig.1. Diagram showing the technique for measuring the diameters of the cervical spinal canal (A); and the vertebral body (B).

RESULT

The mean mid sagittal diameter of the cervical spinal canal (C3 to C7), and the mean anteroposterior diameter of the vertebral body and Torg's ratio for both males and females are shown I Tables 1 and 2

Table 1: The mean dimensions of the canal, body and Torg's ratio of cervical spinal canal of male Nigerians

Level	Canal (mm) Mean S.D	Body (mm) Mean S.D	Torg's ratio Mean S.D
C3	17.80 ± 2.7	21.10 ± 3.1	0.86 ± 0.2
C4	17.10 ± 2.9	23.30 ± 2.9	0.73 ± 0.2
C5	17.35 ± 2.8	21.60 ± 2.7	0.81 ± 0.2
C6	17.38 ± 2.9	20.70 ± 3.6	0.87 ± 0.2
C7	17.42 ± 2.9	21.10 ± 3.1	0.85 ± 0.2
Mean	17.41 ± 2.8	21.56 ± 3.0	0.82 ± 0.2

Table 2: The mean dimensions of the canal, body and Torg's ratio of cervical spinal canal of Female Nigerians

Level	Canal (mm) Mean S.D	Body (mm) Mean S.D	Torg's ratio Mean S.D
C3	17.50 ± 7.1	16.10 ± 2.6	1.09 ± 0.1
C4	16.40 ± 1.6	21.60 ± 1.6	0.75 ± 0.1
C5	17.21 ± 1.5	18.00 ± 2.1	0.94 ± 0.1
C6	17.13 ± 1.3	20.00 ± 2.3	0.86 ± 0.1
C7	17.39 ± 1.8	18.60 ± 2.0	0.93 ± 0.2
Mean	17.13 ± 1.6	16.86 ± 2.0	0.91 ± 0.1

The mean mid sagittal diameter at C3 is wide 17.80mm, it then narrowed at C4 (17.10mm) and gradually increases from C5 to C7 (17.35mm, 17.38mm and 17.42 mm) respectively. In females the mean mid sagittal diameter of the cervical spinal canal is wide at C3 (17.45mm), decreases at C4 (16.40mm), increased at C5 (17.21mm), decreased at C6 (17.13mm) and then increased at C7 (17.39mm). The lower value for sagittal diameter of the spine canal for males was in C4, while the lower anterior-posterior lengths of the body was in C6 followed by C3/C7 without statistical difference. For Torg's ratio, the lower index was in C4 followed by C5. The lower value for sagittal diameter of the spine canal for females was in C4, while the lower anterior-posterior lengths of the body was in C3. The lower index for Torg's ratio was in C4.

The analysis of the mean variance of all levels shows that there are statistical differences ($P<0.01$) between the cervical spine vertebrae, that is there is no statistical similarity between C3, C4, C5, C6 and C7 both for canal and vertebral body in the two groups of specimen.

Table 3: Shows comparative data of mean mid sagittal diameter of cervical spinal canal of males in different population groups from previous studies.

Authors	Population	Instrumentation	N	Mean sagittal diameter of CSC
Hashimoto & Tak (1977)+	Japanese	Radiograph	48	13.60mm
Lee et al (1994)+	Koreans	Actual Measurement	63	13.10mm
Maqbool A et al (2003)+	Pakistanis	Actual Measurement	75	15.10mm
Micheal J.L et al (2007)+	Americans	Actual Measurement	265	14.28mm
Augustus M. et al (2007)++	Brazilians	Radiograph	500	18.34mm
Present Study+	Nigerians	Actual Measurement	70	17.41mm

N = Number of subjects.
\+ = C3 to C7 measured.
++ = C3 to C6 measured.

Table 4: Comparative data of mean mid sagittal diameter of cervical spinal canal of females in different population groups from previous studies.

Authors	Population	Instrumentation	N	Mean sagittal diameter of CSC
Hashimoto & Tak (1977)+	Japanese	Radiograph	44	13.40mm
Lee et al (1994)+	Koreans	Actual Measurement	27	13.10mm
Maqbool A et al (2003)+	Pakistanis	Actual Measurement	25	14.50mm
Micheal J.L et al (2007)+	Americans	Actual Measurement	204	13.68mm
Present Study+	Nigerians	Actual Measurement	35	17.13mm

DISCUSSION

Direct measurement in cadaver is one of the means for accurately determining the dimensions of the osseous spinal canal. It is part of the diagnostic evaluation of the cervical spine. However for it to be clinically useful it is necessary to establish normal parameters for our environment.

The interest for cervical canal measures has a particular relationship with medullary compression and or myelopathy, which can more frequently occur due to spondylosis and/or congenital narrowing of spine bony elements. The clinical manifestations range from a progressively slow incapacity occurring spontaneously, to a sudden tetraplegia after a major or minor trauma in the head or neck region. Acute myelopathy after minor trauma of cervical spine can occur without any fracture or dislocation. This condition is linked to spondylosis, which leads to gradual reduction of the canal, present in older people and whether or not linked to congenital stenosis which occurs in younger people, who practice collision or physical contact sports. Measurements of the cervical spinal canal diameter started to gain importance by the middle of the past century with the works by Boijsen (1954) and later by Wolf et al (1956).

We undertook this cadaveric study to accurately determine the spectrum of the cervical spinal canals in the Nigerian population under study.

The mean mid sagittal diameter of the cervical spinal canal in males was 17.41mm and that for females was 17.13mm. The mean anterior-posterior diameter of vertebral body for males was 21.56mm and that for females was 16.86mm while the mean Torg's ratio was 0.82 and 0.91 for males and females respectively. In medical literature there is no unanimity in regard of the normal values of spinal canal dimensions. Some authors (Edwards et al 1983, Odor et al 1990, Yue et al 2001, Tierney 2002, Lim et al 2004, Boijsen 1954, Wolf et al 1956) tried to determine the stenosis by values below 13.00mm. Edwards et al (1983) predicated that patients with canal size of < 10.00mm had myelopathy, those with a canal size of 10 to 13.00mm were less prone to myelopathy but were prone to symptomatic cervical spondylosis and those with a canal size of > 17.00mm were asymptomatic. Wolf et al (1956) who repeated the work by Boijsen (1954), changing the distance between the X-ray source and the film to 18.3cm, showed that the most frequent value for normality was 17.00mm from C3 to C7, and this agrees with the findings in this trial.

The analysis of the mean variance of all levels together showed that there are statistical significant difference (P <0.01) between cervical spine vertebrae, that is there is no statistical similarity between C3, C4, C5, C6, and C7 both for canal and body in the two groups of specimen. The lowest value for spine canal were found in levels were Torg's ratio was lesser or equal to 0.80, these measurements were below 17.00mm.

In both sexes the C4 level was the most frequently stenotic. This finding is in keeping with studies by Lee et al (1994), Maqbool et al (2003) and Micheal et al (2007).

The mean values of the mid sagittal diameter for males and females in our study population were larger than those reported in Japanese by Hashimoto and Tak (1977), in Koreans by Lee et al (1994), in Pakistanis by Maqbool et al (2003) and in Americans by Micheal et al (2007) but smaller than the values reported for Brazilians by Malzac et al (2002).

There are series of researches registering the relationship between the dimensions of the cervical spinal canal and medullary dysfunction secondary to cervical spine trauma (Eismont et al 1984, Kothari et al 2000, Yue et al 2001, Torg et al 1986, Torg et al 1996 and Torg et al 1997, particularly during sports practice involving physical contact, mostly because a narrow canal predisposes the athlete to a worse neurological prognosis after a minor spine trauma, also there is an increased risk of medullary damage due to a narrow canal in non-athletes when exposed to head and neck traumas, particularly in aged people (Yue et al 2001).

The observed differences in the morphometry of the cervical spinal canal between the population under study and those of other populations suggest the influence of racial and geographical differences in the spinal canal.

The findings from this research offer valuable information to the clinician considering a decompressive operation for a symptomatic cervical spinal stenosis. It also highlights the importance of normative data of the cervical spinal canal for each population and the need to prevent medullary injuring due to a minor trauma in those who practice collision or physical contact sport in our environment.

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