



MORPHOMETRIC ANALYSIS OF THE SAGITTAL DIAMETER OF THE CERVICAL SPINAL CANAL BY MRI IN ADULT POPULATION

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Abstract

Background: The reference values for the sagittal diameter of the cervical spinal canal derived from MRI are still not available in adult population of Uttar Pradesh. The sagittal diameter of the cervical spinal canal is important in traumatic and degenerative conditions of cervical region. The study is done in MRI as the accuracy of MRI is more than the normal plain radiographs.

Aim and Objectives:

1. To measure the sagittal diameter of the cervical spinal canal by MRI in both sexes from C3 to C7 vertebrae
2. To provide standard MRI values for the sagittal diameter of the cervical spinal canal with respect to spinal level in male and female.
3. To compare the morphometric data in different age groups.

Materials and methods: Magnetic Resonance Imaging (MRI) based on midsagittal diameter of the cervical spinal canal of the lower cervical spine (C3-C7) from 320 subjects (160 males and 160 females) of 18 to 59 years of age. This cross-sectional study was conducted in the Department of Radiology, Santosh Medical College, Ghaziabad Uttar Pradesh in collaboration with Department of Radiology, Hind Institute of Medical Sciences, Barabanki Uttar Pradesh.

Results: The sagittal diameter of the spinal canal ranged from 12.08 mm to 18.65 mm in males and 12.01 mm to 17.87 mm in females. The mean values of sagittal diameter of vertebral canal from C3 to C7 are 14.59 mm \pm 1.01 in males and 15.26 mm \pm 1.11 in females.

Conclusions: The sagittal diameter of the cervical spinal canal in general was higher in males as compared to females at all vertebral levels and in all age groups. The sagittal diameter of the spinal canal was narrowest at the level of C4 vertebra in all age group and sexes. Standard MRI values for the sagittal diameter of the cervical spinal canal were established for the adult population of each sex and each age group by this study.

Keywords: Cervical canal, MRI (Magnetic Resonance Imaging), cervical spinal stenosis, Spinal canal dimensions, Spinal cord compression.

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INTRODUCTION

The dimensions of the vertebral canal in the cervical region vary widely among ethnic groups and even between populations within the same region and this variation may influence the outcome of various diseases.⁽¹⁾ It has been observed that morphometry of the spinal canal at the cervical region varies according to the geographic region.⁽²⁾ Normal values of cervical canal diameter show gender and regional variations, and their values have been used to diagnose cases of spine disorders.⁽³⁾ The sagittal diameter of the cervical spinal canal is of clinical importance in traumatic, degenerative, and inflammatory conditions. A greater chance of injury has been related to a narrow canal diameter.⁽⁴⁻⁸⁾ As a result, some surgeons recommend surgical treatment of asymptomatic patients with a narrow canal as prophylaxis against paralysis, whereas others recommend observation.^(6,7,9) Accurate anatomic descriptions of vertebral anatomy are necessary for the diagnosis of various spinal diseases.

The cervical spinal canal contains the spinal cord and its covering meninges, meningeal blood vessels and spinal nerve roots.⁽¹⁰⁾ The mean values of the sagittal diameter of the vertebral canal from C3 to C7 are 14.59 mm \pm 1.01 in males and 15.26 mm \pm 1.11 in females.⁽¹¹⁾

Payne EE and Spillane JD measured the anteroposterior diameter of the adult cervical spinal canal in 1957 with the help of lateral radiographs as a threshold indicator for spinal stenosis.⁽¹²⁾

According to most of the literature to date, a mid-sagittal diameter of the spinal canal of less than 12 mm is considered to be suggestive of cervical spinal stenosis. When the spinal canal sagittal diameter is less than the lower limit normal (usually 12 mm), the spinal cord may be compressed. This is seen frequently in individuals reporting neurological symptoms similar to those of cervical spinal canal stenosis.⁽¹³⁻¹⁸⁾ Previous studies commented that a reliable indicator for cervical canal stenosis was the value of the sagittal diameter of the spinal canal less than 13mm.⁽¹⁹⁻²¹⁾

Cervical spinal canal stenosis is a condition in which the diameter of the spinal canal is reduced than the normal measurement for the relevant age or sex of the individuals. Cervical canal stenosis is one of the predisposing factors for neck problems.⁽²²⁻²⁶⁾ So far, there are several

radiological and morphological anatomic studies on the size of the spinal canal in different populations in the world.⁽²²⁻²⁷⁾ Patients with a developmentally narrow cervical canal are prone to neurological damage after even minor cervical discopathy or trauma.⁽²⁸⁾ Cervical spinal stenosis is more dangerous because it involves compression of the spinal cord.⁽¹⁰⁾ It has been shown that greater canal diameters reduce the probability of neurological damage secondary to fractures or dislocation of the cervical spine.⁽²⁹⁾ Spinal stenosis may involve any region of the spine.⁽¹⁰⁾ Spinal stenosis is a major predisposing factor for cervical myelopathy and spinal cord injury and plays a decisive role in the outcome of injury patterns.^(5,8,30-32) Stenosis may be congenitally present but is most commonly acquired. Cervical spinal stenosis is occurring most frequently in the sixth decade of life.⁽³³⁾ According to a study, 82% of people aged 54 years or above have radiologic evidence of degenerative changes in the cervical spine.⁽¹⁹⁾ Tumours, infections, trauma, and degenerative changes such as intervertebral disc herniation, osteophytes, and ossification of the posterior longitudinal ligaments can cause the narrowing of the cervical spinal canal.^(34,35) Neck pain, headaches, weakness, and paresthesias can result from a narrowing of the cervical spinal canal.⁽³⁶⁾ The definition of a narrow cervical spinal canal varies.⁽³⁷⁻⁴⁰⁾ but it should be based on the diameter found in healthy adult human subjects.⁽²⁸⁾ The spinal canal can be narrow or enlarged as a result of a pathological process,⁽⁴¹⁾ such as an intraspinal tumor, which causes enlargement of the vertebral canal.⁽²⁷⁾

From top to bottom, the cervical canal is a triangular tube that decreases in size.⁽⁴²⁾ The transverse (interpedicular) diameter is nearly twice that of the sagittal (anteroposterior) diameter.⁽⁴³⁾ The sagittal diameter of the cervical spinal canal has been identified as a predictor for the development of cervical myelopathy^(12,44) as well as spinal cord injury.^(45,46) Although the pathology of cervical spine stenosis is primarily in the sagittal plane, narrowing only in the sagittal diameter may not indicate a significant reduction in the area of the canal.⁽⁴⁷⁾ The sagittal spinal canal diameter has a major diagnostic and therapeutic decisive role in cases of degenerative stenosis.^(8,31,32)

Direct determination of standard dimensions of the cervical canal area is impossible in cadavers by dissection. So various techniques are used to evaluate the dimensions of the cervical spinal

canal. A frequently used method is a direct measurement of lateral cervical spine radiographs. Determination of the diameter of the cervical canal by plain radiography is unreliable.⁽⁴⁸⁾ as in x-ray variations in magnification and the distance from the x-ray source to the film as well as from the subject to the film can confound these measurements.⁽²⁰⁾ Review of the literature mentions different spinal canal morphological values. This is a result of variations in the magnification of plane radiographs. A stenosis measured by magnetic resonance imaging (MRI) would be of benefit as MRI avoids the magnification error which is common in radiographs. Further plain radiographs can only evaluate osseous structures. In this situation, MRI is extremely effective as it can detect not only anomalies of bones and soft tissues but also accurately measure the spinal canal and spinal cord.^(49,50)

As per our findings, the reference values for the Sagittal Diameter of the cervical spinal canal derived from MRI are still not available in the adult population of Uttar Pradesh. The purpose of this research was to establish standard MRI values for the Sagittal Diameter of the cervical spinal canal from C3 to C7 vertebra in both age groups and both sexes in the adult population of Uttar Pradesh.

MATERIALS & METHODS

This Cross-sectional study was conducted in the Department of Anatomy and Radiology, Santosh Medical College, Ghaziabad, Uttar Pradesh in collaboration with the Department of Radiology, Hind Institute of Medical Sciences, Barabanki, Uttar Pradesh India. This study was carried out for the period of four years. This study included 320 patients out of which 160 were males and 160 were females of 18 to 59 years of age group.

The sample was divided into groups according to sex and then subdivided into two age groups with the following ranges: young age: 18 to 39 years old and middle age: 40 to 59 years old. This division was based on the degenerative patterns that occur in the spine with age.⁽⁵¹⁾ This study was approved by the Institutional Ethics Committee, Santosh deemed to be University, Ghaziabad. During the study period, Adult patients of Uttar Pradesh aged between 18 to 59 years, who underwent an MRI of the cervical spine or MRI screening of the cervical spine due to any region

and were found to be normal were included in the present study. Patients with any evidence of trauma, destroying the normal morphology of the cervical vertebra, cervical myelopathy, tumor, previous surgery of the cervical spine, infection, neoplasia or any congenital anomalies related to the cervical spinal canal were excluded from the study.

Before starting the MRI examination of the cervical spine a detailed history of the patients related to the cervical spine was taken as well as consent of the patients was also taken and then prepared for the MRI examination. Then the MRI examination of the cervical spine was performed according to standardized protocol with the help of Philips Achieva 1.5 Tesla 8 channel MRI Machine with a spinal coil and standardized neutral head and neck position. MRI was done in all routine sequences but for study purposes, only the sagittal T2-weighted turbo spin-echo (TSE) sequence was considered. All the images of cervical spine MRI were interpreted by a single radiologist. Only soft copies of virtually normal cervical spine MRIs were selected and recorded in the form of DICOM (Digital Imaging and Communications in Medicine) format and stored on CDs for further evaluation. The same set of protocols was applied to every patient. All the MRI scans were done by a trained and experienced MRI Technician.

The midsagittal image of the cervical spine MRI was selected. The sagittal diameters of the spinal canal from C3 to C7 vertebral level were traced in the image and were measured by computerized measurements on Philips DICOM viewer Release 3.0 SP3 (Software) and values of these parameters were noted in data collection sheet.

The Sagittal diameter of the vertebral canal was measured as the shortest distance from the midpoint of the vertebral body's superior and inferior surfaces to the corresponding spinolaminar line.⁽¹¹⁾ [Figure 1] All the measurements were made midsagittally at each spinal level from C3 to C7 vertebra. The first and second cervical vertebrae were excluded as they have different shapes as compared with other cervical vertebrae and, also because most cases of cervical spinal stenosis occur at the levels between C4 and C6. All these measurements were taken in millimeters (mm) in the presence of a diagnostic radiologist.



Figure 1: Midsagittal T2-weighted pulse sequence of the cervical spine in 46 years old Female. Measurements of the sagittal diameter of the spinal canal from C3 to C7 level.

Statistical Analyses:

The Mann-Whitney U test was used to test the significance of differences between the mean of two independent groups the male and female. Total samples were divided into male and female subjects, and then the data for male and female subjects were calculated separately. For each of the four groups, the mean, standard deviation, minimum and maximum values of all the parameters were determined independently for C3–C7 cervical vertebrae. The data were entered into Microsoft Excel Sheet 2007 and statistical analysis was performed by a professional medical statistical consultant by using Statistical Package for the Social Sciences (SPSS) version 19.0 statistical software was used for all statistical analysis. When the p-value of 0.05 or less was considered to be statistically significant.

Result

For normal values of the sagittal diameter of the spinal canal, cervical vertebrae from C3 to C7 level were measured in 320 subjects (160 males and 160 females) of 18 to 59 years of age. Above morphometric parameter and their differences regarding age and sex are presented in three sections in this research: general and intersegmental differences, sex differences and age differences.

General and intersegmental differences: Table 1, shows the minimum and maximum values of sagittal diameter of the spinal canal obtained at each vertebral level and for each age group and sex. Table 2, shows the sagittal diameter of the spinal canal obtained at each vertebral level and for each age group and sex. Figure 2, is presented a graphic with the variations in the sagittal diameter of the spinal canal in each vertebral level by age group and sex.

In females, the mean value of the sagittal diameter of the cervical spinal canal was highest at the level of the C3 vertebra and lowest at the level of the C4 vertebra in all age group. Thereafter, the mean value of sagittal diameter gradually increased from C4 to C7 vertebrae. In males, the mean sagittal diameter of the spinal canal was lowest at C4 vertebrae in all age group. Thereafter it gradually increased and was highest at the C7 vertebra. The sagittal diameter of spinal canal at the level of C3 vertebra was higher as compared to C4 vertebra in all age group (Table 2).

Sex differences: The sagittal diameter of the cervical spinal canal in general was higher in males as compared to females at all vertebral levels and in all age groups (Table 1 and 2, and Figure 2).

In the age group of 18-39 years old, the mean value of the sagittal diameter of the spinal canal

was compared between males and females at all vertebral levels found statistically nonsignificant differences at all vertebral levels but only at the level of C7 vertebrae found statistically significant differences (Table 2).

When values of the sagittal diameter of the spinal canal were compared between male and female found statistically significant difference at the level of C6, C7, and even from C3 to C7 vertebral level but at the level of C3, C4, and C5 vertebra was not found a statistically significant difference in the age group of (40-59 years) of age (Table 2). Mean values of the sagittal diameter of the spinal canal at different vertebral levels like C3, C4, C5, C6, and C7 and from C3 to C7 were compared between males and females found statistically nonsignificant differences only at the level of C4 and C5 vertebrae but at the level of C3, C6, C7

and even from C3 to C7 vertebra were found statistically significant (Table 2).

Age differences: Table 3 shows a comparison of the sagittal diameter of the spinal canal by age group for both sexes. There are no statistically significant differences were found between age groups in females as well as males at any of the vertebral levels but in males at the level of C6 vertebra, statistically significant differences were found between age groups.

The value of the sagittal diameter of the spinal canal was higher in the age group of 40 to 59 years old than age group of 18 to 39 years old in both sexes at all vertebral levels except at the level of C5 where values of the second and first age group of the male were same (figure 2).

Table 1: Distribution of minimum and maximum values of the sagittal diameter of the spinal canal among various age groups in both sexes at different cervical vertebral levels

Age group (Years)	Sex	Vertebral level (Min-Max, mm)					
		C3	C4	C5	C6	C7	Overall(C3 to C7)
18-39	Male	12.53-16.89	12.20-16.45	12.3-17.53	12.25-18.04	12.51-18.65	12.2-18.65
	Female	12.07-17.87	12.09-16.44	12.04-16.76	12.02-15.92	12.34-16.86	12.02-17.87
40-59	Male	12.67-16.78	12.08-16.55	12.21-16.23	12.48-17.67	12.56-18.28	12.08-18.28
	Female	12.16-16.33	12.01-16.24	12.19-17.25	12.08-16.92	12.27-16.97	12.01-17.25
Overall (18-59)	Male	12.53-16.89	12.08-16.55	12.21-17.53	12.25-18.04	12.51-18.65	12.08-18.65
	Female	12.07-17.87	12.01-16.44	12.04-17.25	12.02-16.92	12.27-16.97	12.01-17.87

Table 2: Distribution of mean values of Sagittal diameter of the spinal canal for each age group and vertebral level. Comparison between both sexes

Age group (Years)	Sex	Vertebral level (Mean±SD, mm)					
		C3	C4	C5	C6	C7	Overall(C3 to C7)
18-39	Male	14.58±1.13	14.14±1.10▼	14.31±1.22	14.35±1.37	14.71±1.38▲	14.42±1.26
	Female	14.31±1.25▲	13.92±1.13▼	13.97±1.14	14.03±1.05	14.26±0.93	14.10±1.11
	P-Value	0.094	0.141	0.107	0.381	0.043*	0.072
40-59	Male	14.78±1.16	14.15±1.05▼	14.31±1.12	14.76±1.19	15.03±1.35▲	14.61±1.22
	Female	14.41±1.17▲	14.12±1.02▼	14.22±1.24	14.25±1.21	14.38±1.01	14.27±1.13
	P-Value	0.134	0.773	0.565	0.017*	0.011*	0.041*
Overall (18-59)	Male	14.67±1.14	14.14±1.07▼	14.31±1.17	14.52±1.31	14.85±1.36▲	14.50±1.24
	Female	14.35±1.21▲	14.00±1.08▼	14.08±1.18	14.12±1.12	14.31±0.97	14.18±1.12
	P-Value	0.027*	0.224	0.115	0.031*	0.001*	0.010*

*p-values less than 0.05 were considered statistically significant

▲ Widest level

▼ Narrowest level

Table 3: Comparison of the sagittal diameter of the spinal canal between age groups

Vertebral Level	Comparison by	Male	Female
C3	18-39 vs 40-59	0.430	0.474
C4	18-39 vs 40-59	0.677	0.159
C5	18-39 vs 40-59	0.659	0.286
C6	18-39 vs 40-59	0.005*	0.378
C7	18-39 vs 40-59	0.103	0.419
Overall(C3 to C7)	18-39 vs 40-59	0.064	0.309

*p-values less than 0.05 were considered statistically significant

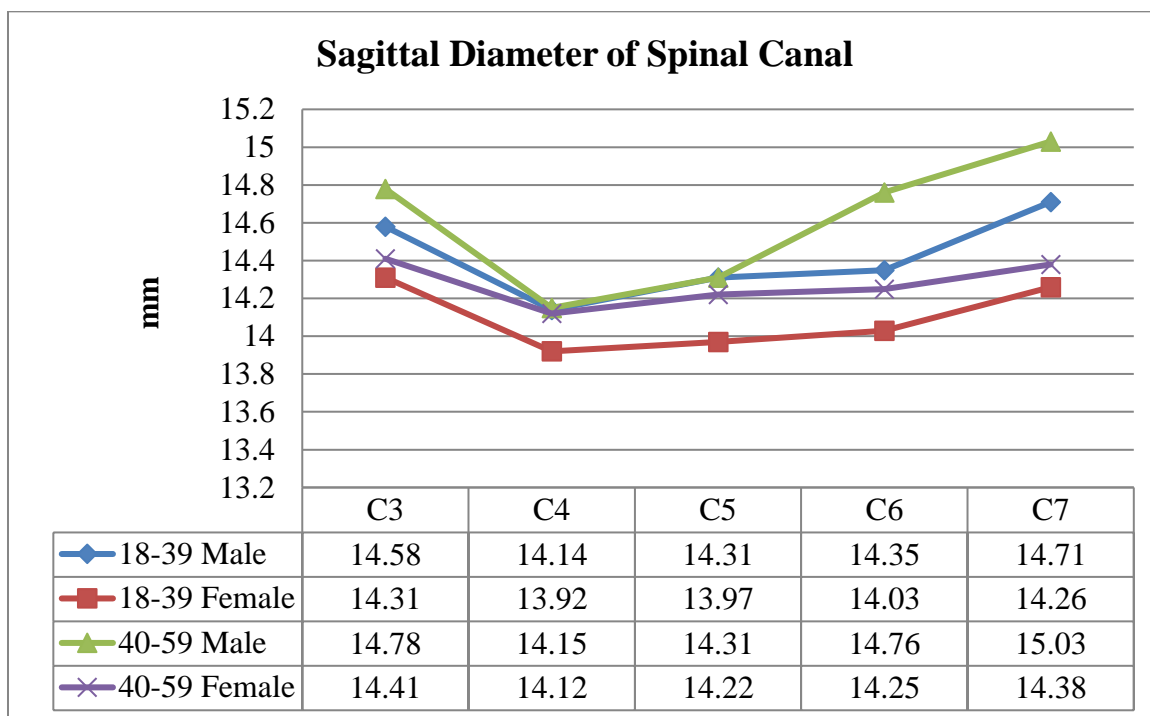


Figure 2: Variations in the dimensions of the sagittal diameter of the spinal canal (C3 to C7) by sex and age group.

Discussion

Different researchers working in various parts of the world have been attempting to determine the mean anteroposterior diameter of the cervical spinal canal at different vertebral levels in normal subjects, so that clinicians may be able to diagnose cervical spinal stenosis by consulting these reference values. These workers have employed different methods of investigation like plain radiography,^(5,12,46,52,53) CT scanning, and MR imaging⁽⁴⁵⁾ on living subjects or cadavers, while still others have carried out actual measurements on dried bony specimens.⁽⁵⁴⁻⁵⁶⁾

Although there are many studies describing normal dimensions of the cervical spinal canal in different geographical regions in India, MRI-based studies are scarce in the adult population of Uttar Pradesh. So we measured the sagittal diameter of the cervical spinal canal by MRI in both age groups and both sexes for the first time in the adult population of Uttar Pradesh.

The cervical canal size in the normal Indian population was much smaller than that in other races.⁽⁵⁷⁻⁵⁹⁾ Many authors have reported differences in the mean sagittal spinal canal diameter, our spinal canal diameters were 1 to 5 mm different from measurements reported in several studies (Table 4). These differences are because we used MRI in determining measurements, and some authors used

radiographs or dried specimens or computed tomography scans.⁽⁴⁹⁾ Calculation of morphometric parameters of the cervical region is better with MRI as compared to plain radiograms.⁽⁶⁰⁾ MRI can provide more accurate cervical spinal canal measurements that could serve as morphometric determinants of cervical canal stenosis.⁽¹¹⁾

Lee et al.⁽²⁰⁾ reported average spinal canal diameter was 14.4 mm ± 1.6 in male specimens and 13.7 mm ± 1.3 in female specimens. These results were obtained by direct measurements using cadaver specimens. Singh et al.⁽⁶¹⁾ used radiographs and reported average spinal canal diameter was 17.31 mm ± 1.74 in males and 16.97 mm ± 1.56 in females. An average sagittal cervical spinal canal diameter (C3–C7) reported by Toki et al.⁽⁶²⁾ was 13.3 mm ± 1.3 in males and 13.0 mm ± 1.1 in females. These results were obtained by using a CT scan. In the study of Matveeva et al.⁽¹¹⁾ the reported average sagittal spinal canal diameter from C3 to C7 was 14.59 mm ± 1.01 in males and 15.26 mm ± 1.11 in females. These measurements were obtained by using MRI, as we used in our study. In the present study, the sagittal diameter of the cervical spinal canal was 14.50 mm ± 1.24 in males and 14.18 mm ± 1.12 in females.

Table 4 shows a comparison of the mean sagittal diameters of the cervical spinal canal reported by

various workers, including the present work. The mean sagittal diameter of the cervical spinal canal of the present study was larger than the study conducted by Sureka et al.⁽⁶³⁾ and Kumar et al.⁽⁶⁴⁾ They used a CT scan in their study. Lee et al.⁽⁵⁴⁾ used dried specimens and also found the mean value of the sagittal diameter of the cervical spinal canal lower than the present study. Maqbool et al.⁽²²⁾ used dried specimens and measured the sagittal diameter of the cervical spinal canal and found the mean value of it slightly similar to the present study. The mean value of the sagittal diameter of the cervical spinal canal was smaller in our study population than the study conducted by other researchers.^(2,27,30,65) They used Radiographs in their study.

The maximum and minimum diameters at each level are more important than the mean sagittal diameters of the cervical canal. Since it is the accurate measurements and not on the average diameter we base our opinion on whether the canal is narrowed or enlarged in a particular case. In our study, from C3 to C7 the range of the sagittal diameter of the cervical spinal canal was recorded from 12.08 mm to 18.65 mm in males and from 12.01 mm to 17.87 mm in females. Almost similar observations were reported by Matveeva et al.⁽¹¹⁾ Any value lying outside the calculated range, suggests the pathological condition of the spine and requires further investigations and clinical evaluation.

In our study, the sagittal diameter of the spinal canal in males and females in every age group diminished from C3 to C4 and increased from C5 to C7 vertebrae (Figure 2). This result is similar to the studies reported by Avalos et al.⁽⁵¹⁾ and Lim et al.⁽⁶⁶⁾

Our study showed the least value of the sagittal diameter of the spinal canal at the level of the C4 vertebra in both sexes and in both age groups. This result is similar to other studies.^(54,63,64,66) but in the study of Matveeva et al.⁽¹¹⁾ and Kathole et al.⁽²⁷⁾ found the mean value of the sagittal diameter of the spinal canal was narrowest at the level of C5 vertebra in both sexes.

The present study showed statistically significant differences in the sagittal diameter of the spinal canal between the males and females in most age groups except at the level of C4 and C5 vertebrae. Similarly, the study reported by Avalos et al.⁽⁵¹⁾ and Lim et al.⁽⁶⁶⁾ found significant differences in males and females in most age groups. There

are contradictions reported by other researchers who concluded that there are no significant differences in canal diameter between males and females at all cervical vertebral levels.^(2,11,21,64)

We found that the sagittal diameter of the spinal canal is higher in males than in females in all age groups and at all vertebral levels (Figure 2). This result is similar to other studies.^(2,20,29,51,61,65,66-68)

In the present study, the value of the sagittal diameter of the spinal canal was higher in the age group of 40 to 59 years old than age group of 18 to 39 years old in both sexes at all vertebral levels except at the level of C5 where values of the second and first age group of the male were same (figure 2). We predicted that the sagittal diameter of the spinal canal increases as age increases except at the level of C5 where values of the second and first age groups of males were the same. Although previous studies report that the diameter of the cervical canal decreases as age increases.^(67, 69-71)

The transverse (interpedicular) diameter is nearly twice that of the sagittal (anteroposterior) diameter of the cervical spinal canal.⁽⁴³⁾ The sagittal diameter of the cervical spinal canal has been identified as a predictor for the development of cervical myelopathy^(12,44) as well as spinal cord injury.^(45,46) Although the pathology of cervical spine stenosis is primarily in the sagittal plane, narrowing only in the sagittal diameter may not indicate a significant reduction in the area of the canal.⁽⁴⁷⁾ The sagittal spinal canal diameter (SCD) has a major diagnostic and therapeutic decisive role in cases of degenerative stenosis.^(8,31,32)

An anteroposterior spinal canal diameter of <10 mm indicates absolute spinal stenosis, whereas a diameter of <12 mm indicates relative spinal stenosis. CT and MRI are more reliable and can perform accurate measurements, thus avoiding the issues of magnification, positioning, and other technical errors.⁽⁶³⁾ The risk of spinal cord injury with damage to the cervical vertebrae is greater in patients with a narrow sagittal canal diameter than in patients with a wider canal diameter.

The size of the cervical spinal canal and the space available for the cord are important determining factors to decide on the treatment of traumatic, degenerative, and inflammatory conditions of the cervical spine.⁽²¹⁾

Morishita et al.⁽⁷²⁾ in their study concluded that spinal canal sagittal diameter with a value below 13mm is at increased risk of developing intervertebral disc pathologies. In our study out of 320 subjects about 18% showed values lower than 13 mm at various levels and all of these were normal subjects. So, we can conclude that the values which are designed for the Western population might not apply to the population of Uttar Pradesh (India).

In our study, we examined cervical spinal canal diameter by MRI because it measures the diameter of the spinal canal accurately too and it also avoids magnification problems that occur in plain radiographic measurements. Another strength of our study is that we measured cervical

spinal canal diameter in individual age groups of people like the age groups of 18 to 39 years old and 40 to 59 years old and even from 18 to 59 years old (overall) in both sexes because this division of age was based on the degenerative patterns that occur in the spine with age.⁽⁵¹⁾

We believe that our findings on an adult population of Uttar Pradesh will help doctors in the diagnosis of various clinical conditions associated with the cervical spine, such as spinal canal stenosis or predicting the prognosis of cervical spinal cord injury, space-occupying lesions, etc. and also for the concerned researcher to perform different studies in future.

Table 4: Comparison of Sagittal Diameter (in mms) of Spinal Canal in different population

Author's (Year)	Country	Instrumentation	Sex	No. of cases	Vertebral level				
					C3	C4	C5	C6	C7
Gupta SK et al., (1982) ⁽⁶⁵⁾	Varanasi, India	X-rays	♂	207	17.07	16.59	16.64	16.73	16.42
			♀	93	16.13	15.60	15.72	15.84	15.54
Lee HM et al., (1994) ⁽⁵⁴⁾	Korea	Bone	♂	63	13.3±1.3	12.8±1.4	13.0±1.4	13.2±1.3	13.4±1.3
			♀	27	13.3±2.5	12.9±2.7	13.0±2.7	12.9±2.6	13.3±2.3
Hukuda S et al., (2002) ⁽³⁰⁾	Japan	X-rays	♂	105	16.6±1.5	15.8±1.4	15.9±1.3	15.9±1.3	15.8±1.4
			♀	114	16.8±1.7	15.8±1.7	15.7±1.6	15.6±1.6	15.5±1.6
Maqbool A et al., (2003) ⁽²²⁾	Pakistan	Bone	♂	75	15.1±1.2	14.8±1.7	15.0±1.8	15.1±1.6	15.3±1.6
			♀	25	14.8±2.1	14.3±2.07	14.6±2.09	14.4±2.1	14.6±2.06
Kathole MA et al., (2012) ⁽²⁷⁾	Maharashtra, India	X-rays	♂	150	16.93±2.45	16.36±2.27	16.06±2.29	16.41±2.45	16.69±2.39
			♀	150	15.8±1.81	15.36±1.81	15.12±1.76	15.38±1.8	15.7±1.82
Sureka B et al., (2018) ⁽⁶³⁾	New Delhi, India	CT Scan	♂	84	13.29±1.46	12.88±1.50	12.95±1.53	13.66±1.49	13.85±1.29
			♀	42	12.26±1.51	12.08±1.88	12.51±1.84	13.14±1.47	13.16±1.44
Ude RA et al., (2018) ⁽²⁾	Nigeria	X-rays	♂	57	18.82±1.85	18.52±1.77	18.97±1.72	19.45±1.73	19.75±2.17
			♀	43	18.84±2.49	18.70±2.08	18.85±2.44	19.30±2.53	19.63±2.47
Kumar A et al., (2020) ⁽⁶⁴⁾	Madhya Pradesh, India	CT scan	♂	53	12.6±1.5	12.6±1.4	12.4±1.8	12.8±1.6	12.8±1.2
			♀	47	13.11±1.43	12.98±1.52	13.16±1.78	13.16±1.74	12.81±1.49
The present study (2023)	Uttar Pradesh, India	MRI- based study	♂	160	14.67±1.14	14.14±1.07	14.31±1.17	14.52±1.31	14.85±1.36
			♀	160	14.35±1.21	14.00±1.08	14.08±1.18	14.12±1.12	14.31±.97

Male = ♂, Female = ♀, Radiographs = X-rays, Dried specimen = Bone

Conclusion

MRI can provide more accurate cervical spinal canal measurements that could serve as a useful guide in the determination of cervical spinal canal stenosis. The dimensions of the cervical spinal canal in healthy individuals are dependent on the spinal level in both sexes and both age groups. The mean sagittal diameter of the spinal canal at different cervical vertebral levels increased as the age advances in both sexes and both age groups. The value of the sagittal diameter of the spinal canal was higher in the age group of 40 to 59 years old than age group of 18 to 39 years old in both sexes at all vertebral levels except at the level of C5 where values of the second and first age group of the male were same.

The mean sagittal diameter of the spinal canal from C3 to C7 was 14.50 mm ± 1.24 in males and 14.18 mm ± 1.12 in females. The range of sagittal diameter of the spinal canal was 12.08 mm to 18.65 mm in males and 12.01 mm to 17.87 mm in

females. In males, the sagittal diameter of the spinal canal was 0.32 mm more than that of females.

In all age group of females, the mean value of the sagittal diameter of the cervical spinal canal was highest at the level of the C3 vertebra and lowest at the level of the C4 vertebra. Thereafter, the mean value of sagittal diameter gradually increased from C4 to C7 vertebrae. In all age group of males, the mean sagittal diameter of the spinal canal was lowest at C4 vertebrae. Thereafter it gradually increased and was highest at the C7 vertebra. The sagittal diameter of spinal canal at the level of C3 vertebra was higher as compared to C4 vertebra in all age group.

The values which are designed for one geographical population might not apply to other geographical populations. So this type of study should be conducted in every geographical population in India as well as in the world.

Standard MRI values for the sagittal diameter of the cervical spinal canal were established for the adult population of each sex and each age group by this study.

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