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Clinical implications morphometric study of the cervical spine on MRI

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ABSTRACT

Degenerative changes, history of trauma or inflammation usually progressed to cervical spinal canal stenosis. This condition leads to cervical spondylosis neuropraxia and cervical spondylotic myelopathy (CSM). SAC (space available for the cord) value is important to understand the symptoms of spinal cord compression in cervical canal stenosis. The aim of our study is to establish cervical spinal canal morphometry in Western Maharashtra population observed by MRI of cervical region. 70 subjects aged between 18- 70 years. The sagittal vertebral body diameter, the sagittal spinal canal diameter and the sagittal spinal-cord diameter were measured at the C3 - C7 level. The SAC was determined. For each variable a two-way ANOVA was performed, sagittal canal diameter, sagittal spinal cord diameter and SAC were significant with p-value P< 0.0001**. Mean vertebral body diameters observed were 1.49-1.51. Values of SAC observed were C3-1.5 cm, C4-1.51cm, C5- 1.49cm, C6- 1.5cm, C7- 1.49cm. Average sagittal spinal canal diameter from C3-C7 was 14.1± 1.3 mm. The range of SAC was between 6.4-9.5mm, least at the C5 level. We conclude that subjects in our study do not have an increased risk of spinal cord compression.

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INTRODUCTION

At large complaint of neck pain pertaining to adult population is common. Such presentation is accompanied by pain radiating to the upper limb. A predisposing factor for such clinical presentation is cervical spinal canal stenosis. Cervical spinal canal contains spinal cord along with meninges if the diameter of the spinal canal is reduced it is labelled as cervical canal stenosis (Amonoo-Kuofi HS *et al.,* 1990). Degenerative changes, history of trauma or inflammation usually progressed to cervical spinal canal stenosis. This condition leads to cervical spondylosis neuropraxia and cervical spondylotic myelopathy (CSM) (Chhabra S *et al.,* 1991; Edwards WC, La Rocca H 1983; Gore DR 2001). The Previous study done on radiograms was showed degenerative changes of the cervical spine to a high tune of 82% with an average age of 54 years. (Hayashi H *et al.,* 1997) Review of literature mentions different spinal canal morphological values. This is a result of variations in magnification of plane radiographs. In 1987 scientist Pavlov and Torg (Herzog RJ *et al.,* 1991) described the ratio "Torg's ratio" as a suitable indicator of cervical canal stenosis. Previous studies commented that reliable indicator for cervical canal stenosis was the value of the sagittal diameter of the spinal canal less than 13mm (Jones ET, Mayer P. 1994, Lee MJ *et al.,* 2007, and Maitre-yee Kar *et al.,* 2017) with the era of MRI, they are superior to plane radiographs for accurately measuring different morphological measurements. If we need to calculate space available for the spinal cord from the sagittal diameter of the spinal canal. (Meyer SA *et al.,* 1994, Pavlov H *et al.,* 1987) SAC value is important to understand the

symptoms of spinal cord compression in cervical canal stenosis. (Rema Devi, N Rajagopalan 2003) The aim of our study is to establish cervical spinal canal morphometry in Western Maharashtra population observed by MRI of the cervical region and followed by calculation of space available for canal (SAC) values.

MATERIAL AND METHODS

A retrospective study done in D.Y. Patil Medical College, Kolhapur included 70 subjects aged between 18-70 years. All individuals who underwent MRI of the cervical region during period 21 August 2018 to 30 September 2018. Care was taken to exclude individuals with congenital anomalies of the vertebral column and cervical region.

MRI was done with the help of 1.5 Tesla MRI machine (Avanto, Siemens, Germany), using a spinal coil and standardized neutral head position. T1-weighted and T2-weighted images were taken for the MR imaging study. Sagittal T1-weighted Fast Spin Echo sequence (FSE) (repetition time msec/echo time msec, 700/11; section thickness, 3 mm; field of view, 250 mm x 250 mm; matrix, 384 x 288), sagittal T2- weighted turbo- spin echo sequence (2920/101; section thickness, 3 mm; insertion gap, 1 mm;) and a transverse T2-weighted Fast Recovery Fast Spin Echo (FSE) sequence at one or multiple levels (3960/88; section thickness, 3 mm; insertion gap, 0.5 mm; field of view, 200mm x 200 mm; matrix, 384 x214) was used for this purpose. All measurements were made by using Osirix DICOM viewer 64-bit software, and a mean value of three measurements was considered as the final measurement. All the measurements were made midsagittal at each spinal level from C3 to C7 vertebra.

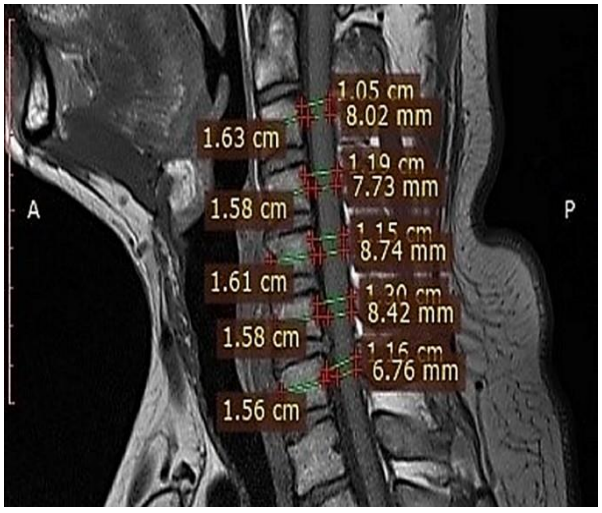

Figure 1: MRI of Cervical Spinal Canal

As shown in Figure 1, to measure the sagittal vertebral body diameter, the midpoint between the superior and inferior endplates was considered. The sagittal spinal canal diameter was measured from the centre of the vertebral body's superior and inferior surfaces to the point of junction of the spine and laminae. The sagittal spinal-cord diameter was measured at midline transverse line of the vertebral body at the level of C3, C4, C5, and C6 & C7. To calculate SAC that is space available for the spinal cord, we subtracted the sagittal cord diameter from the corresponding sagittal canal diameter.

Statistical analysis: For analysis, we used a software SPSS. For all variables a two way ANOVA was performed. A p-value of 0.05 was considered as statistically significant. In our study sagittal canal diameter, sagittal spinal cord diameter and SAC were significant with p-value P< 0.0001**. Whereas vertebral body diameter was non-significant as shown in Table 1.

RESULTS

In our study data was collected from 70 subjects, with an average age of 48.53 years. Mean vertebral body diameters observed were 1.49-1.51 as shown in Table 1. Sagittal canal diameter and sagittal spinal cord diameter were analysed, showed a significant difference as shown in Table 1.

SAC value was calculated by using formula sagittal canal diameter minus sagittal cord diameter at different vertebral levels. Values of SAC observed were C3-1.5 cm, C4- 1.51cm, C5- 1.49cm, C6-1.5cm, C7- 1.49cm. Different cervical vertebral levels as shown in Table 2. Statistically, SAC value was strongly significant showing p-value, P<0.0001** as shown in Table 1.

DISCUSSION

On comparison of studies done on morphometric measurements of the vertebral canal they have reported variations on bases of races and ethnicity. Studies performed on Indian population conclude that canal size is definitely smaller than others. (Standring S 2016, Tierney RT *et al.,* 2002a, Tierney TR *et al.,* 2002b)

A couple of authors have shown differences in spinal canal diameter at different levels; our study also shows the difference in mean value at different levels. Tierney *et al.* used MRI and reported average spinal canal diameter 13.28 mm ± 1.47and average sagittal vertebral body diameter17.7 mm ± 2.18. The reported average sagittal cervical canal diameter (C3–C7) by Lee (18) was 14.1 ± 1.6 mm. In our study, we reported an average sagittal spinal canal diameter from C3 to C7 as 14.1±1.3 mm which is comparable with previous studies (Torg J *et al.,* 1986; Torg JS *et al.,* 1987; Torg JS *et al.,* 1997).

Table 1: Statistical analysis of variables

		C3	C4	C5	C6	C 7	'P'value	
Vertebral bodies	MEAN	1.5	1.51	1.49	1.5	1.49	0.81	NS
diameter (cm)	SD	0.17	0.19	0.18	0.17	0.16		
Sagittal canal	MEAN	1.47	1.43	1.38	1.38	1.39	P<.0001**	SIGN
diameter (cm)	SD	0.13	0.14	0.13	0.12	0.13		
Sagittal Spinal cord	MEAN	0.77	0.76	0.74	0.7	0.63	P<.0001**	SIGN
diameter (cm)	SD	0.095	0.078	0.079	0.08	0.066		
SAC value (cm)	MEAN	0.947	0.677	0.638	0.692	0.757	P<.0001**	SIGN
	SD	0.127	0.155	0.138	0.138	0.122		

Table 2: Mean of variables

	C3	C4	C5	C6	C 7
Mean of Vertebral bodies diameter(cm)	1.5	1.51	1.49	1.5	1.49
Mean of Sagittal canal diameter(cm)	1.47	1.43	1.38	1.38	1.39
Mean of Sagittal Spinal cord diameter(cm)	0.77	0.76	0.74	0.7	0.63
Mean of SAC value(cm)	0.947	0.677	0.638	0.692	0.757

C- Cervical; SAC- Space Available for Cord

A study conducted in2002 by Tierney *et al.,* concluded that SAC values are between from 2.5 to 10.4 mm in the cervical region. He has mentioned SAC values are lower at C3 & C5 Levels, in our study also we observed differences of SAC values at each level that is C3, C4, C5, C6, C7. Our study showed the least SAC value of 6.4 mm at the C5 level. The range has been from 6.4 - 9.5mm. The studies have mentioned that individuals with less SAC have increased rate of cervical cord neuropraxia (Jones ET, Mayer P. 1994, Torg JS *et al.,* 1996).

Herzog *et al.,* have mentioned that athletics having symptoms should undergo morphometric studies to calculate SAC. Further, he mentioned that the SAC value below 5 mm is a good indicator of cervical canal stenosis. Subjects with less SAC value definitely have less space for a spinal cord, is associated with herniated discs; osteophytic spurs, etc. are more susceptible for spinal cord compression.

Morishita *et al.,* in her study concluded that spinal canal diameter with a value below 13mm is at increased risk of developing intervertebral disc pathologies. In our study minimum sagittal spinal canal diameter observed is 13.8mm, so we can conclude that subjects in our study are not at increased risk of spinal cord compression.

CONCLUSION

Calculation of morphometric parameters of cervical region is superior with MRI as compared to plane Radiograms. Our study was performed on Indian population; average sagittal spinal canal diameter from C3-C7 was 14.1± 1.3 mm. A range of SAC was between 6.4-9.5mm, least at C5 level. We conclude that subjects in our study do not fit into the criteria of cervical spinal canal stenosis. So they do not have increased risk of spinal cord compression.

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