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MORPHOMETRIC ANALYSIS OF CERVICAL VERTEBRAL CANAL AND ITS CLINICAL SIGNIFICANCE IN CERVICAL PAIN

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ABSTRACT

Introduction: Neck pain is the most common complaint in majority of population. Cervical canal stenosis is one the predisposing factor contributing to neck pain. It is the narrowing of cervical spinal canal within vertebral column thereby compressing spinal cord and its nerve roots. Torg's ratio is sagittal spinal canal diameter divided by sagittal diameter of the corresponding vertebral body which if less than 0.80 can increase risk of neurologic injury.

Aims: To study cervical vertebral canal and its significance in patient of cervical pain through Torg's ratio.

Methods: A retrospective study done in GDMC and Associated Hospital included 50 subjects40 females and 10 males aged between 18 to 70 years. MRI Cervical spine was used for measuring Torg's ratio.

Result: All measurements were taken at the level of C6 and C7. The average sagittal vertebral column diameter at C6 in males is 15.2±2.58 and females 13.4±1.49, at C7 in males 16.1±1.74 and female 13.8±2.02 which is stastically significant. The average spinal canal at C6 in females is 11.62±1.65 and in males 11.11±1.50, at C7 in females 12.16±1.60 and in males 11.8±1.84. The Torg's ratio was found to be at C6 0.56-1mm (males) and 0.55-1.16mm (females) and at C7 0.56-0.88mm (males) and 0.53-1.27mm (females).

Conclusion: In the present study, Sagittal spinal canal diameter was found to be more in females as compared to males). The Torg's ratio was greater in females as compared to males.

KEYWORDS: Torg's ratio, cervical, vertebral canal, Cervical pain, Neck pain.

INTRODUCTION

A majority of proportion of the adult population develops cervical pain during their lifetime, often accompanied by radicular symptoms extending into the upper extremities. Cervical spinal canal stenosis is one of the underlying factor contributing to this condition. It involves a cervical spinal canal narrowing within the vertebral column, which accomodate the spinal cord along with its protective meninges, meningeal blood vessels, and spinal nerve roots [1]. This narrowing has long been recognized as a contributing factor for the onset of cervical spondylotic myelopathy associated with cervical spondylosis, as well as cervical neuropraxia, particularly in the context of trauma, degenerative changes, and inflammatory processes [2,3]. One study found that 82% of individuals aged 54 and older show radiological signs of degenerative changes of cervical spine [4]. In 1957, Payne and Spillane conducted one of the earliest assessments of the anteroposterior diameter of the adult cervical spinal canal using lateral radiographic imaging [5]. Since then, numerous studies across diverse populations have sought to establish normative values for this measurement,

yielding varying results. These discrepancies have been attributed not only to genetic and hormonal differences but also to technical limitations, particularly magnification errors associated with plain radiographs. To mitigate these inconsistencies, Torg et al. and Pavlov et al. introduced an alternative approach to evaluating stenosis of cervical spinal canal [6,7]. Their method involves calculating a ratioby dividing the sagittal diameter of the spinal canal by the sagittal diameter of the corresponding vertebral body, commonly referred to as the Torg's ratio, Pavlov's ratio, or the canal-to-body ratio [8,9]. A sagittal canal diameter, less than 13 mm, or a Torg's ratio below 0.80, is widely accepted as indicative of cervical spinal stenosis and is associated with an increased risk of neurologic compromise [6,9,10,11]. Although plain radiographs are effective in visualizing bony structures but they have limited capacity to assess soft tissue abnormalities, which are significant contributors to cervical spinal canal stenosis. In this context, magnetic resonance imaging (MRI) is especially valuable, as it enables a thorough assessment of both soft tissue and bone structures, in addition to offering accurate measurements of the spinal canal and spinal cord. MRI enables accurate calculation of the space available for the cord (SAC), defined as the difference between the sagittal diameter of the spinal canal and that of the spinal cord (SAC = sagittal diameter of the spinal canal − sagittal diameter of the spinal cord). This measurement is clinically relevant, as cervical spinal stenosis is fundamentally characterized by the narrowing of the spinal canal that impinges upon the spinal cord. [12,13].

MATERIALS AND METHODS

A retrospective study done in Dehradun district included 50 subjects aged between 18 to 70 years (average age 40.14 years, standard deviation 14.103). There were total 10 males and 40 females among these 50 subjects. All of these 50 individuals attended outpatient Department of Orthopedics and Department of Neurology in Doon Hopsital with complaints of neck pain often radiating to upper limbs and few of them had paresthesia in the neck and upper limb too between December 2023 to January 2024. Individuals below the age of 18 years were excluded from this study. Individuals with any evidence of trauma, infection, neoplasia or any congenital anomalies related to spinal canal were excluded from the study. Measurements of sagittal diameter of vertebral body, spinal canal and spinal cord were taken for the study. The sagittal vertebral body was measured at the level of midpoints between superior and inferior endplates and the sagittal spinal canal diameter was measured as the distance from the midpoint of vertebral body posteriorly to the nearest point of spinolaminar line [7,14]. The sagittal spinal cord was measured at the appropriate vertebral body level transversely in the midline. The Torg's ratio was determined by dividing the sagittal diameter of spinal canal by the sagittal diameter of vertebral body [6,7]. The SAC was determined by subtracting the sagittal cord diameter from corresponding sagittal canal diameter.

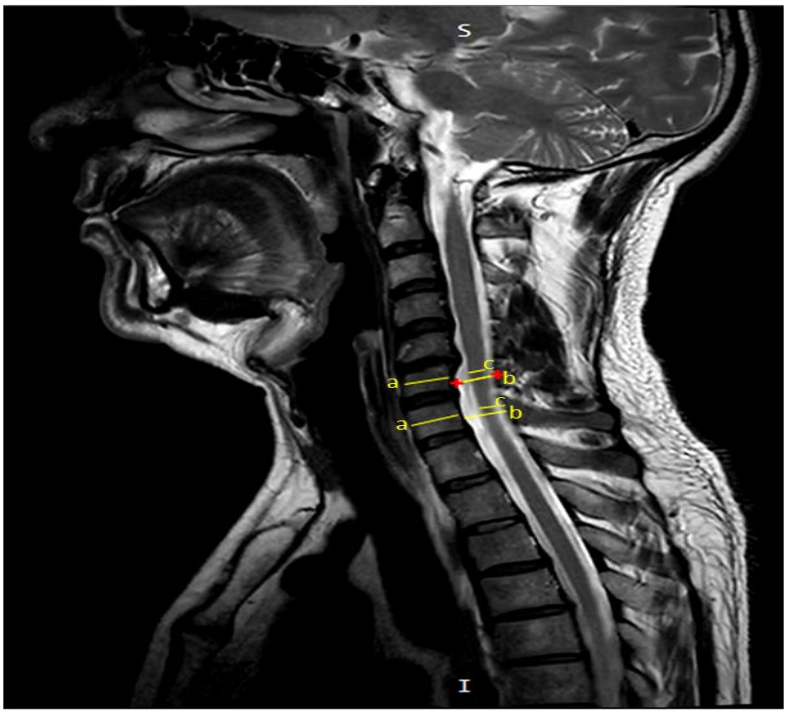

Fig 1 Mid-sagittal T2 weighted MRI image of cervical spine in a 49 year male patient, Sagittal-diameter measurements of the spinal cord, spinal canal, and vertebral body.

a-Vertebral column diameter b-Spinal canal diameter, c- Space available for spinal cord

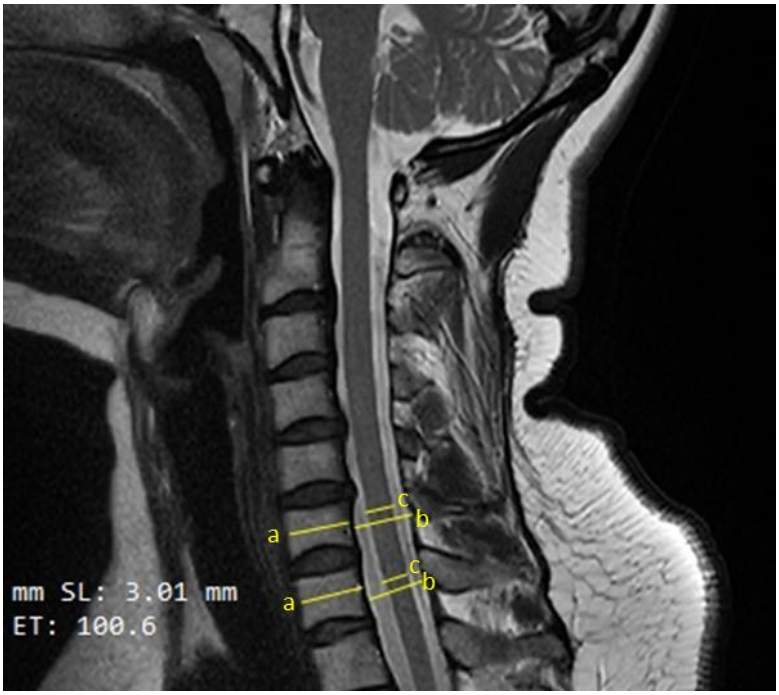

Fig 2 Mid-sagittal T2 weighted MRI image of cervical spine in a 59 year female patient. Sagittal-diameter measurements of the spinal cord, spinal canal, and vertebral body.

a-Vertebral column diameter b-Spinal canal diameter, c- Space available for spinal cord

Statistical Analysis

The Student's t-test was employed to assess statistical significance. A p-value of 0.05 or lower was considered statistically significant. All analyses were performed using IBM SPSS Statistics software, version 20.0.

RESULTS

All measurements were taken at the level of C6 and C7 vertebrae in 50 subjects aged between 18 to 70 years (average age 40.14 years, standard deviation 14.103). There were total 10 males and 40 females among these 50 subjects. The average sagittal vertebral column diameter at C6 in males is 15.2±2.58 and females 13.4±1.49, at C7 in males 16.1±1.74 and female 13.8±2.02 which is stastically significant. Males have a significantly larger sagittal vertebral bodies diameter than females ($p<0.001$). The average spinal canal at C6 in females is 11.62±1.65 and in males 11.11±1.50, at C7 in females 12.16±1.60 and in males 11.8±1.84. There was no significant gender difference in sagittal spinal canal diameter. The average spinal cord diameter at C6 in males is 6.31±1.20 and in females 6.54±0.60, at C7 in males 6.01±0.60 and in females 6.18±0.70. Again there was no significant gender difference. The Torg's ratio was found to be at C6 0.56-1mm (males) and 0.55-1.16mm (females) and at C7 0.56-0.88mm (males) and 0.53-1.27mm (females) which is statistically significant. The mean value of Torg's ratio was greater in females due to smaller vertebral body size in females. The SAC value in ranges from 2 mm to 9 mm at C6 and C7 level in both males and females with a mean of 4.80+1.67 mm in males and in females of 5.07+1.44 mm. At C7 level, mean of SAC value in males is 5.83+1.53 mm and in females 5.98+1.48 mm. There was no significant difference of SAC values.[refer to Table-1]

Table 1: Gender wise distribution of mean values for different vertebral parameters

Different vertebral parameters	Gender		t- value	p-value
	Female	Male		
Spinal cord diameter (mm)				
C6	6.54±0.60	6.31±1.20	0.756	0.227
C7	6.18±0.70	6.01±0.85	0.627	0.267
Spinal canal diameter (mm)				
C6	11.62±1.65	11.11±1.50	0.834	0.205
C7	12.16±1.60	11.8±1.84	0.505	0.308
Vertebral column diameter (mm)				
C6	13.4±1.49	15.2±2.58	-2.47	0.009
C7	13.8±2.02	16.1±1.74	-3.16	0.001
Torg's Ratio				
C6	0.86±0.15	0.74±0.17	2.003	0.02
C7	0.89±0.18	0.03±0.11	2.62	0.006
SAC (mm)				
C6	5.07±1.44	4.80±1.67	0.475	0.31
C7	5.98±1.48	5.83±1.53	0.25	0.40

DISCUSSION

Measurement obtained in the present study were on par with most of the studies (refer to table 2 & 3). The difference in the Torg ratio and other parameters can be accountable by various factors such as differences in genetic, occupational, sex, age and racial differences in sample population, modality of measurement and observer.

Table 2: Comparison of sagittal spinal canal diameter and Torg's ratio in different populations.

Author	Criteria	Year	Sample size	Sample population	Sagittal spinal canal Diameter (in mm.) Mean±standard deviation/range	Torg's ratio Mean±standard deviation/ range
Matveeva N et al., (10)	MRI based study on asymptomatic population	2013	50	Macedonian	14.59±1.01 (male) 15.26±1.11 (female)	0.89±0.09 (male) 1.1±0.11 (female)
Maqbool A et al., (11)	Dried specimen	2003	100	Pakistanis	15.1±1.6 (male) 14.5±2.07 (female)	0.95 (male) 1.08 (female)
Lee HM et al., [12]	Dried specimen	1994	90	Korean	13.2 ± 1.3 (male) 13.1 ± 2.6 (female)	0.93 ± 0.1 (male) 1.02 ± 0.09 (female
Tierney TR et al., [13]	MRI based study on asymptomatic population	2002	14	USA	13.28 ± 1.47 (male)	0.528-1.18 (range)
Karabulut O et al., [14]	Lateral plain radiograph based study on patients with neck pain	2007	90	Turkey	13.71-15.21 (male) 12.78-14.68 (female)	0.79-0.85 (male) 0.79-0.83 (female
Gupta M et al.,[15]	Radiograph based study on patients with neck pain	1998	200	Nepal	18.19±2.09 (male) 17.41±1.47 (female)	0.99 ± 0.09 (male) 1.01 ± 0.07 (female)
Kathole MA et al., [16]	Radiograph based study on asymptomatic	2012	300	Indian	16.06-16.93 (male range) 15.12-15.80 (female range	0.95-0.96 (male range) 1.06-1.08 (female range)
Kar M et al., '[1]	MRI based study on patients with neck pain	2017	71	Indian	11.99±1.34 (male) 12.15±1.24 (female)	0.81±0.31 (male) 0.92±1.18 (female
Our Study	MRI based study on patients with neck pain	2024	50	Indian	11.11±1.50, 11.8±1.84 (male) 11.62±1.65, 12.16±1.60 (females)	0.74±0.17, 0.03±0.11 (male) 0.86±0.15, 0.89±0.18 (females)

Table 3: Comparison of SAC between different populations

Author	Criteria	Year	Sample size	Sample population	SAC value (in mm) Mean±standard deviation/ range
Matveeva N et al., [10]	MRI based study on asymptomatic population	2013	50	Macedonian	6.47±0.94 (male) 7.04±1.28 (female)
Oda T et al., [17]	MRI based study on myelopathy and nonmyelopathy population	2009	140,99	Japan	11.1 (in myelopathy group) 16.5 (in non-myelopathy group
Tierney TR et al., [13]	MRI based study on asymptomatic population	2002	14	USA	2.5-10.4
Kar M et al., '[1]	MRI based study on patients with neck pain	2017	71	Indian	4.84±1.47 (male) 5.22±1.38 (female)

Our Study	MRI based study on patients with neck pain	2024	50	Indian	4.80±1.67, 5.83±1.53 (males) 5.07±1.44, 5.98±1.48 (females)

CONCLUSION

In the current study, it was observed that both the sagittal vertebral diameter and the sagittal spinal canal diameter exhibit sexual dimorphism. The sagittal vertebral body diameter is larger in males compared to females, while the sagittal spinal canal diameter is larger in females than in males. The mean sagittal spinal canal diameter in this study was slightly smaller than that reported in other studies. Additionally, the Torg's ratio was higher in females than in males, likely due to the smaller vertebral body size in females. The mean value of the space available for the cord (SAC) was also slightly smaller in this study compared to other studies. The Torg-Pavlov ratio continues to be an effective screening method for evaluating the risk of cervical spinal stenosis and associated complications.

Conflict of Interest

None

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