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Anatomy

MORPHOMETRIC STUDY OF THE THORACIC NEURAL CANAL IN SOUTH INDIAN POPULATION AND ITS CLINICAL SIGNIFICANCES

Ashwini S Shetty	Assistant Professor, Department of Anatomy, Yenepoya Medical College, Yenepoya University, Mangalore, 575 018, Karnataka, India - Correspondence Author:
Ramakrishna Avadhani K	Professor & Head, Department of Anatomy, Yenepoya Medical College, Yenepoya University, Mangalore, 575 018, Karnataka, India
Manjula Shantaram	Professor, Department of Studies in Biochemistry, Mangalore University, Post Graduate Centre, Chikka Aluvara, Kodagu District, 571 232 Karnataka, India

ABSTRACT **Objectives :**To establish normative data for spinal canal morphometry in thoracic vertebrae in South Indian population. The size of the spinal canal has attracted increasing interest since Scheslinger, Taveras and Verbiest described some of the effects of narrow canal. However, a few anatomic studies have been performed to determine the criteria and limits of normal serving as guidelines in assessing pathological conditions. Diagnosis of developmental spinal stenosis is based on the measurements of the bony spinal canal.

Material and Methods The present study comprises of 360 thoracic vertebrae from 30 thoracic spines. Shape of the neural canal was observed and following parameters were measured: Transverse diameter of neural canal; caudal anteroposterior diameter of neural canal; cephalic anteroposterior (A.P.) diameter of neural canal; transverse diameter of vertebral body.

Results Transverse diameter of neural canal from T1to T12 was measured. It first decreased from T1 toT12. Transverse diameter measured along the narrowest part of the vertebral body from T1 to T12. It was decreased from T1 to T4 and then increased to T12. Cephalic anteroposterior diameter of neural canal was increased from 15.36±1.72mm at T1 to18.53±2.25mm at T12 with slight dips at T7 and T9. Caudal anteroposterior diameter of neural canal from T1 to T12 measured, it was increased gradually from T1 to T12 with slight dips at T3, T7 and T9.

Conclusion Cephalic anteroposterior diameter of neural canal in the present study was less in south Indian population when it is compared with Americans and more when we compared with Negroes. Caudal anteroposterior diameter of neural canal is more at almost all levels in South Indian population when we compared with Italian population. Transverse diameter of neural canal was less in almost all levels when we compared with White American, Nigerian, Swiss, Japanese populations. Transverse diameter of the vertebral body was comparable to Caucasians and Negroes. It showed the difference ranging between 3-4 mm.

KEYWORDS : Vertebral body, Stenosis, Neural canal

INTRODUCTION

A stenosis which can produce compression of the nerve roots in the absence of other compressive agents, occur with mid-sagital diameter of 10 mm. So, thoracic canal stenosis may be more common than is currently recognized and account for a portion of the failures in anterior and lateral decompression of thoracic disc herniations. The complication can be avoided if the surgeon is familiar with the spinal anatomy, hypertrophy of the posterior spinal element leading to compromise of the spinal canal and its neural element is a well-recognised pathological entity affecting the lumbar or cervical spines. Such stenosis of the thoracic spine in the absence of generalized rheumatological, metabolic or orthopaedic disorder, or history of trauma is generally considered to be rare. So, thoracic canal stenosis may be more common than is currently recognized and account for a portion of the failures in anterior and lateral decompression of thoracic disc herniation. Stenosis is due to decreased sagital diameter which has been reported in cervical and lumber canal[1]. Verbiest[2] suggested the anatomical stenosis of lumbar canal as a cause of spinal stenosis syndrome. It consists of low back pain, usually in an adult approaching middle age, accompanied by claudication in lower limbs. Sarpyener3 and Verbiest[2] were pioneer to suggest anatomical stenosis of lumbar canal as a cause of spinal stenosis syndrome. Narrowing of spinal canal may be due to embryological or acquired as a result of degenerative changes from ageing, injury or disease or spinal operations. Reduced inter-pedicular distance is one of the causes of primary narrowing of spinal canal. However, several previous studies focussed on cervical and lumbar area. No study has been done on thoracic spine. It is very difficult to know the normal anatomical characteristics of adult in whom growth is complete and no degenerative changes have occurred. Because of recent development of spinal instruments, recent anatomical studies focussed on the pedicle instead of spinal canal. The cross sectional areas of the spinal canal are of clinical importance in traumatic, degenerative and inflammatory conditions and small spinal canal diameter has been associated with an increased risk of injury. It is difficult to measure cross sectional areas of the spinal canal, because it has various shape. Thus, we measured spinal canal anteroposterior diameter instead of cross sectional areas. The aim of this study was to establish normative data for spinal canal in an adult.

MATERIALS AND METHODS

Three hundred sixty thoracic vertebrae of 30 thoracic spines without any apparent deformity or previous spinal surgery were obtained from the discarding cadaver in our medical institution and used in the analysis. Exclusion criteria were history of diagnosed cancer, tumour or mass on the spine and the nervous system, spinal abnormality, inflammation, and previous surgery on the spine. 320 vertebrae from T1 to T12 were available for studies; all the vertebral canal measurements were studied by the same investigator.

Shape of the neural canal was observed and the following parameters were measured:

1. Transverse diameter of neural canal, transverse diameter of vertebral body along its narrowest point cephalic anteroposterior (A.P.) diameter of neural canal, caudal anteroposterior diameter of neural canal.
2. Shape of the neural canal was examined for its shape, whether circular or oval.
3. Cephalic anteroposterior diameter of neural canal was measured with Vernier callipers as the midsagittal diameter at the cephalic border of vertebral arches.
4. Caudal anteroposterior diameter of neural canal was measured with Vernier callipers as the midsagittal diameter at the caudal border of the vertebral arches.
5. Transverse diameter of neural canal was measured with Vernier callipers as the maximum distance between the inner surfaces of the two pedicles.
6. Transverse diameter of vertebral body was measured with Vernier callipers as the horizontal diameter at the level of the narrowest point of the vertebral body.

RESULTS AND DISCUSSION

Table 1 and Figures 1- 4 show the mean and standard deviation and range of cephalic and caudal anteroposterior diameter, transverse diameter of neural canal, transverse diameter of vertebral body at narrowest point.

A) Shape of neural canal

The shape of neural canal was found to be oval from T1-T12 and all the 30 vertebral columns. Newell [4] describes in thoracic region the shape is to be circular.

B) Transverse diameter of the neural canal

Table 1 describes the transverse diameter of neural canal from T1to T12. It first decreased from 17.60±3.8mm at T1 (Range: 13.12-26.44mm) to 15.83±1.72 mm at T3 (Range: 13.50-22.24mm).Then it remained almost constant till T7. Thereafter, it increased gradually to 19.83±2.68 mm at T12 (Range: 15.43-26.54mm). Earlier many authors measured it on different populations and at different levels. It was seen that it was less in South Indian at almost all levels by 0.25-12.70 mm as compared with White American[5], Nigerian[6], Swiss[7] and Japanese[8] populations. Differences in the mean values of different populations may be due to racial and ethnic variations. If we observe, it is seen that while A.P.

diameters increased up to T12, the transverse diameter increased uptoT12. It may be explained by the fact that caudal to T12, there lies cauda equina whose nerves may be going laterally to their respective intervertebral foramina for exit thus increasing transverse diameter of neural canal.

	Transverse Diameter of N.C.		Transverse Diameter of V.B.		Cephalic A.P. Diameter of N.C.		Caudal A.P. Diameter of N.C.	
THORACIC SPINE	Mean ± SD(mm)	Range (mm)	Mean ± SD(mm)	Range (mm)	Mean ± SD(mm)	Range (mm)	Mean ± SD(mm)	Range(mm)
T1	17.60± 3.8	13.12-26.44	27.76± 3.33	18.42-34.82	15.36± 1.72	12.56-17.13	13.77± 1.17	10.20-20.84
T2	16.65± 2.5	13.22-23.28	26.54± 2.44	18.05-33.78	16.08± 1.62	11.53-17.72	14.50± 1.30	12.08-22.86
T3	15.83± 1.72	13.50-22.24	25.74± 2.86	18.42-38.29	16.52± 1.78	11.27-17.54	14.34± 1.66	11.57-18.88
T4	15.84± 1.84	12.11-20.76	25.58± 2.10	18.70-30.46	16.63± 1.68	12.42-19.13	14.54± 1.83	12.43-19.79
T5	15.88± 1.87	12.29-21.35	26.38± 2.68	18.61-32.31	16.66± 1.79	11.99-18.34	14.84± 1.77	12.32-19.21
T6	15.95± 1.86	11.43-20.70	26.38± 2.67	18.80-31.76	16.73± 2.05	12.14-18.34	15.07± 1.05	12.42-20.77
T7	15.93± 1.94	12.12-20.43	27.49± 2.08	19.30-32.00	16.68± 2.06	11.36-18.56	15.12± 1.08	10.48-19.71
T8	16.06± 2.13	12.76-19.76	28.13± 2.25	21.05-33.04	16.97± 2.09	11.53-19.14	15.27± 2.09	11.86-20.79
T9	16.45± 1.98	12.68-19.87	29.56± 2.57	20.06-34.00	16.82± 2.10	10.52-19.56	15.16± 2.08	11.15-20.40
T10	16.75± 2.14	12.56-20.55	31.70± 3.32	20.26-41.88	17.22± 2.20	11.59-20.21	15.38± 2.06	12.09-20.68
T11	17.64± 2.45	13.12-23.03	33.72± 3.22	22.21-41.16	17.33± 2.21	12.32-20.32	15.88± 2.12	12.80-22.12
T12	19.83± 2.68	15.43-26.54	35.65± 3.29	25.13-45.37	18.53± 2.25	14.06-21.05	16.57± 2.15	12.87-22.07

N.C. -Neural Canal, V.B. -Vertebral Body

C) Transverse diameter of vertebral body along narrowest point

Table 1 also depicts the transverse diameter along the narrowest point of vertebral body from T1 to T12. It first decreased from 27.76±3.33mm at T1 (Range: 18.42-34.82mm) to 25.58±2.10mm at T4 (Range: 18.70-30.46mm) and then increased to 35.65±3.29mm at T12 (Range: 25.13-45.37). Earlier many authors measured this parameter at T2, T7, T12. It was seen that, this parameter was comparable to Caucasians and Negroes[9] at L1 L2 level but increased by 2-4 mm at L3-L5 when compared to T12 level in the present study. However, when compared with other populations, a marked difference ranging between 5-10 mm was observed.

FIG:1

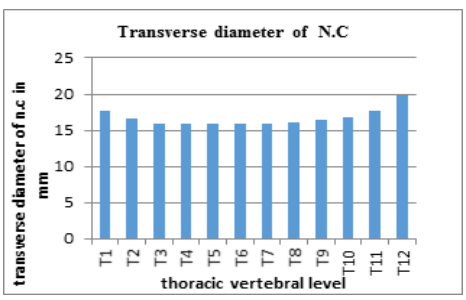


FIG:2

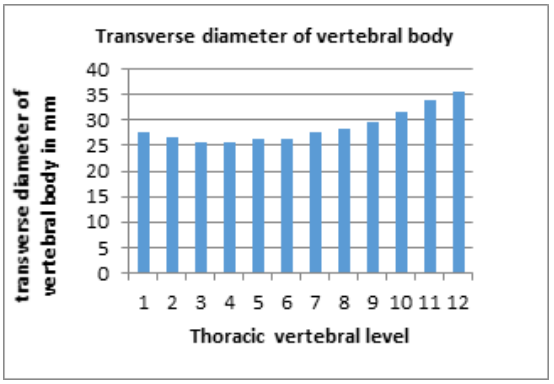


FIG. 3

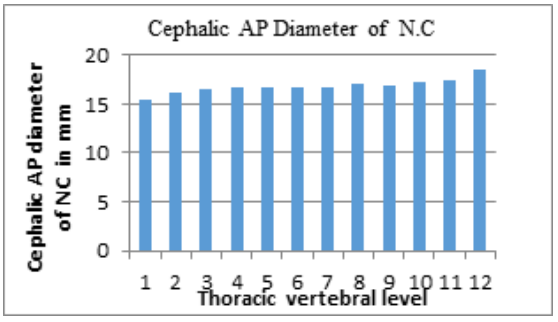
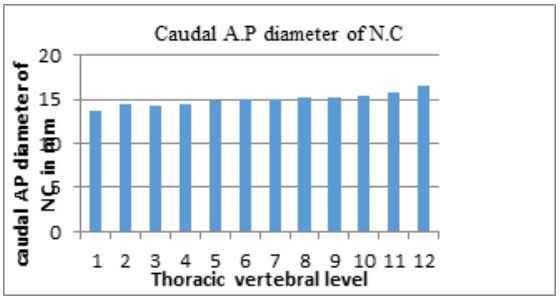


FIG.4



D) Cephalic anteroposterior diameter of neural canal

Table 1 shows the cephalic anteroposterior diameter of neural canal from T1 to T12. It was increased from 15.36±1.72mm at T1 (Range: 12.56-17.13 mm) to18.53±2.25mm at T12 (Range: 14.06-21.05 mm) with slight dips at T7 and T9. When compared with previous studies conducted, on different populations by different authors it was seen that in South Indians, it was almost comparable to Caucasian[9] and Swiss7 populations. However, it was less in South Indians at almost all levels by 0.1-0.54 mm as compared with Americans[10]. It was more in South Indians at almost at all levels by 1.56-2.38mm as compared with Zulu and Sotho Negroes[11], by 2.2-3.4mm as compared with Indian12 and by 0.5-1.5mm as compared with Italian[12] populations.

E) Caudal anteroposterior diameter of neural canal

Table 1 also shows the caudal anteroposterior diameter of neural canal from T1 to T12. It was increased gradually from 13.77±1.17mm at T1 (Range: 10.20-20.84mm) to 16.57±2.15mm at T12 (Range: 12.87-22.07mm) with slight dips at T3,T7 and T9. It was seen that it was more in South Indians at all levels by 2-2.5mm as compared with Indian and by 0.5-1mm (except at L5) as compared with Italian populations.

When it was compared with cephalic anteroposterior diameter, it was found to be more at almost all levels by 0.1-0.5mm except at T1, T3, T12 where it was almost equal. If we have a close look at **Table 1,** it is seen that both cephalic and caudal A.P. diameter of neural canal is maximum at T12 levels which may be attributed to the lumbar enlargement of the spinal cord lying at next level.

The anteroposterior diameter of the spinal canal has a clinical

importance in traumatic, degenerative and inflammatory conditions. Narrowing of the spinal canal can usually occur in the central part of the spinal canal or in the intervertebral foramen.

A knowledge of anteroposterior diameter and transverse diameters of neural canal may be useful in the detection of conditions like spinal canal stenosis[13]. Generally, with greater initial size of the canal, there is more space around the spinal cord and more encroachment can be tolerated without cord compression. Accordingly, the individual with developmental stenosis of the spinal canal is more susceptible to cord damage from spondylosis than the one with a canal of more generous proportions. Also since transverse diameter was the largest dimension of spinal canal, it indicates that A.P. diameter is clinically the most significant dimension of spinal canal. The lumbar part of spinal canal houses the cauda equina so its narrowing which may be congenital or acquired, may lead to compression of these roots causing low backache. Transverse diameter of the spinal canal at any segmental level is proportional to the size of vertebral body at that level[14-16]. This observation is significant as clinicians while assessing the size of spinal canal from anteroposterior radiographs need not take into consideration variables like build of the individual and X ray magnification factor. It also helps in specifying whether an individual's measurement on spinal canal are within the normal limits for respective body size or not, thus, helping to identify a stenosis or dilatation of spinal canal. The purpose of this study was to establish the range of normal values of the thoracic spinal canal midsagittal diameter in adults in the interest of facilitating clinical investigation of vertebral canal stenosis.

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CONFLICT OF INTEREST : None Declared

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