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Original Article

Lumbar spinal stenosis and morphometry of lumbar vertebral canal

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ABSTRACT

Introduction: Lumbar spinal stenosis (LSS) is a progressive degenerative process manifesting as low back pain. Though the causes for pain in lower lumbar region are multi-factorial, narrowing of vertebral canal has been documented to play a pivotal role. Hence, the objective of present study was to define the morphometry of lumbar canal by measuring the antero-posterior (AP) and transverse (TD) diameters and assess the prevalence of LSS in Indian population.
Materials and methods: An assessment by CT scan was done on 100 subjects within age range of 20–70 years after grouping them into healthy and symptomatic subjects based on a pre-defined questionnaire. The diameters were defined and compared amongst healthy and symptomatic subjects. The data was used to define prevalence of LSS in the population of Delhi-NCR.
Results: The antero-posterior diameter was smaller in females as compared to males while transverse diameter was smaller in males as compared to females. In both the study groups, the diameters were comparable and statistically significant. The prevalence of LSS was maximum in middle age group individuals with L5 vertebral level showing highest frequency of a narrow canal. LSS was seen in higher frequency in females than males.
Discussion: An early diagnosis and proper treatment of LSS may prevent intractable pain with its inherent neurogenic sequelae. All pain-physicians, neurologists, and neurosurgeons should be aware of antero-posterior and transverse diameters of canal for better prognosis.

1. Introduction

Lumbar spinal stenosis (LSS) is defined as anatomical narrowing of lumbar vertebral canal. There occurs compression of cauda equina and emerging nerve roots, manifesting as low back pain (LBP).[1–3] Stenosis of lumbar canal is a potentially disabling cause of lower back pain. Though treatable this condition is often a major cause of inactivity, loss of productivity and potential loss of independence of individual, especially older age groups. There occurs focal, segmental or diffuse narrowing of the central canal or the root canals by bony and/or soft tissue encroachments on the neural components eliciting as Central or Lateral stenosis, respectively.[4]

Central stenosis is the most common form of LSS which occurs at the disc level when the central spinal canal is narrowed secondarily to osseous and/or ligamentous thickening following degenerative changes.[5,6] Various earlier morphometric studies have demonstrated that this abnormality may involve the transverse, sagittal, or both the diameters of the canal.[7–9] Central spinal stenosis commonly affects middle and elderly age groups and has been shown to be the most common indicator for spinal surgery, especially in individuals over 65 years of age. Epidemiological data suggest an incidence of 5 cases per 100,000 for lumbar spine stenosis with an ever-increasing prevalence.[10] It has been predicted that over 64 million adults will be affected by this disabling condition over the next decade.[11–13]

The diagnosis of LSS depends largely on clinical history, physical examination supplemented by various imaging modalities. The lower lumbar levels are the most commonly involved segments and use of modern neuroimaging techniques have facilitated the diagnosis in recent years. Computed tomography (CT) scans provide excellent visualization of bony vertebral canal (Fig. 1) and hence, measurements of canal diameters can be made with improved accuracy and resolution compared to other imaging techniques.[14,15] The vertebral canal diameters are assumed to play a significant role with regard to development of symptoms of LBP.

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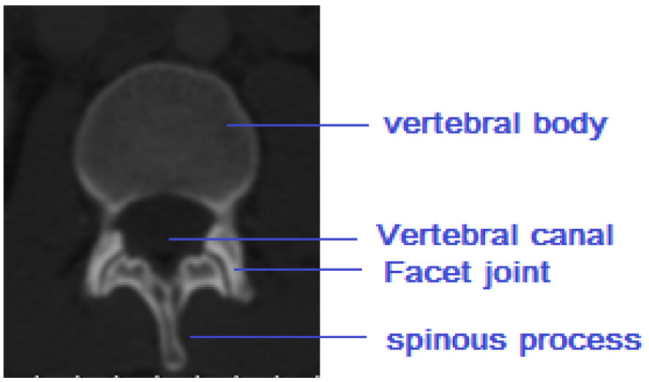

Fig. 1. Vertebral canal in CT reconstruction.

The aim of the present study thus is to test the hypothesis that decrease in vertebral canal diameters are significant risk factor for producing LBP, by comparing the diameters in symptomatic and asymptomatic individuals. The data was further utilized to assess the prevalence of LSS in individuals of Delhi NCR region and evaluate its distribution with respect to age and sex of an individual.

2. Materials and method

The present study was conducted in the department of Radiology of Santosh Medical College, Ghaziabad in collaboration with Safdarjung Hospital, New Delhi. The subjects were selected by structured performa for epidemiological details and further a pre-defined questionnaire was given to categorize into asymptomatic and symptomatic groups.[16,17] The subjects were explained the investigations involved and a written informed consent was taken. The complete project was approved by the Ethical Committee of the Institute.

Study groups: a total of two study groups with age ranging from 20 years to 70 years (mean age 43.88 ± 14.071) were formed as per the result of the questionnaire. The symptomatic groups consisted of 50 individuals of either sex (male = 23 and female = 27). The asymptomatic group included 50 individuals with 26 males and 24 females.

Exclusion criteria: (1) lumbar vertebrae fracture, (2) gross vertebral anomalies, (3) spinal tumors, (4) history of previous spinal surgery, (5) gross spinal pathology, and (6) contraindication for CT scanning.

Methodology: all subjects underwent CT scan of the lumbar spine with Philips Brilliance 40 CT scanner (MAS/MA-250/337, KV 120) with 2.5 mm image slice. Dimensions of lumbar canal at all vertebral levels from L1 to L5 of all 100 subjects were measured. Bone window with multi-planar reconstruction was used to obtain images in both axial and sagittal planes and these images were utilized to assess the diameters. The images were read on Philips dicom viewer and antero-posterior (AP) and transverse (TD) diameters for both the groups were measured. The AP diameter (sagittal diameter) was measured at the mid sagittal level as the distance between posterior border of the vertebra and the lamina posteriorly in the midline.[17] The transverse or inter-pedicular distance was measured at the mid pedicular level as the distance between inner borders of both the pedicles of vertebral body[18–20] (Fig. 2).

Statistical analysis: it was performed using SPSS version 19 and mean, standard deviation (SD), and standard error of mean (SEM) were computed for both the diameters. Student *t*-test was performed to find the statistical difference between two groups. A p value < 0.05 is considered to be significant. The prevalence of symptomatic LSS was assessed at 95% confidence interval and distribution with respect to age and gender was computed.

3. Results

The demographic profile of the two study groups is shown in Table 1.

3.1. Antero-posterior diameter

The result of antero-posterior diameter at all vertebral level in both normal and symptomatic groups is shown in Table 2.

In normal group, the mean of mid sagittal diameter showed a sharp decrease from fifth lumbar vertebrae to first lumbar vertebrae. In male subjects, there occurred a sharp decrease in diameter from L5 towards L3 vertebral level followed by gradual fall till first lumbar vertebrae. While in females the mean diametric values show an irregular pattern with lowest diameter being at L3 vertebral level (Fig. 3). The AP diameter at all vertebral levels was smaller in females than males.

On the other hand, in symptomatic group there was a decrease in diameter from first towards fifth lumbar vertebrae. On measuring the diameters separately for both the genders, there occurred a spike of increased diameter from the proximal to third vertebral level. The caudal end of the vertebral canal (L4 and L5) showed the narrowest diameters. There was a statistically significant difference in AP diameter at all except first lumbar vertebrae in both normal and symptomatic groups.

3.2. Transverse diameter

The result of transverse diameter in both normal and symptomatic group is shown in Table 3.

In normal group the mean diameter increased gradually from first to fifth lumbar vertebrae. Males followed the pattern as of the whole group while in females the greatest diameter was seen at L4

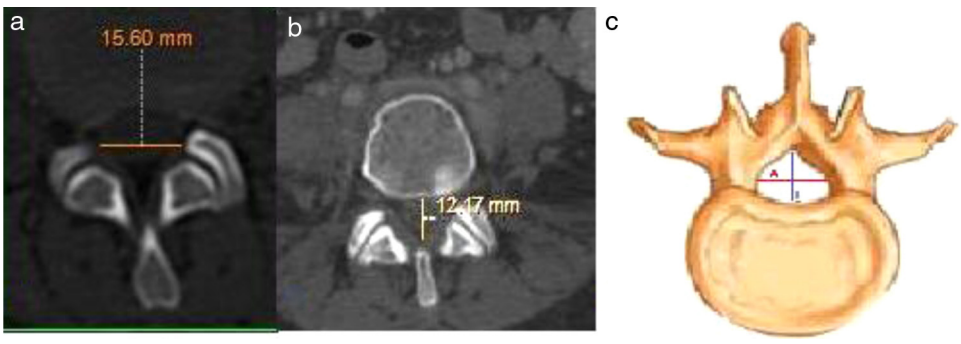

Fig. 2. Methods to measure transverse (A) and antero-posterior, (B) diameter in CT images and bone image, (C) defining both the diameters.