

A Study Of Inter-Pedicular Distances Of The Lumbar Vertebrae Measured In Dried Vertebrae in Gujarat

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Abstracts: The reduced inter-pedicular distance is one of the common causes of primary narrowing of the spinal canal. Stenosis of the spinal canal due to decreased inter-pedicular distance is to the best of our knowledge, virtually unexplored so we under took this study of inter-pedicular distance. Eisestein S measured inter-pedicular distance in Caucasoid, Zulu Negroid and Sotho Negroid population which is compared with data of present study. Methods: All measurements were made by using Electronic Digital Vernier Calipers. Transverse diameter of the lumbar spinal canal was measured as the minimum distance between the medial surfaces of the pedicles of a given vertebra (Inter-pedicular distance. Results & Observation: Inter-pedicular distances of lumbar vertebral canal at levels L₁ to L₅ was measured in dry vertebrae of 63 subjects (32 male, 31 female) from Gujarat of age group 35 to 80 yrs. Mean transverse diameter (Inter-pedicular distance) is minimum at L₁ (22.6 mm in male and 21.3 mm in female) and maximum at L₅ (27.0 mm in male and 26.4 mm in female) showing a gradual increase from level L₁ to L₅. The inter-pedicular distance increased steadily from L₁ to L₅ in all populations in both sexes. The Gujarati population has greater IPDs at all level from L₁ to L₅ than that of Zulu Negroid and Sotho Negroid. But IPDs in Gujaratis are lower at L₁, & L₂ in male and L₁, L₂ & L₃ in female and greater at L₃, L₄ & L₅ in male and L₄ & L₅ in female than that of Caucasoid. Conclusions: A comparison between the present data and the data published data on inter-pedicular distance at lumbar levels of other populations also shows that there are marked differences between the mean values reported for the population of different geographic areas. The present study confirms that there is ethnic as well as racial variation in the size of the lumbar vertebral canal, thus, emphasizing the need to have normal values and ranges for the transverse diameter of the canal for different populations. [Patel J et al NJIRM 2012; 3(2) : 61-64]

Key words: Inter-pedicular distance, Lumbar vertebrae, Spinal canal

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Introduction: Various causes have been attributed to low backache, but lumbar spinal canal stenosis as a causative factor is of great interest in "lumbar stenosis" especially in the extent to which the cauda equina may be compressed within the lumbar spinal canal by constriction or narrowing of the bony ring of the canal, in contrast to impingement by soft tissues.

Stenosis due to decreased sagittal diameter has been reported in the cervical spine as well as in the lumbar spine. It has been suggested that reduced inter-pedicular distance is one of the cause of primary narrowing of the spinal canal¹. Stenosis of the spinal canal due to decreased inter-pedicular distance is to the best of our knowledge, virtually unexplored so we under

took this study of inter-pedicular distance. The present study aims at determining the norms of inter-pedicular distance of the lumbar spinal canal in Gujrati population measured in dried bone.

Material and Methods : Sixty-three adult skeletons belonging to Gujarati population from the department of Anatomy of different Medical and Dental colleges of Gujarat were used for the study. Age at death ranged from 35 to 80 years. All skeletons were of known sex. Three hundred and fifteen complete vertebrae were available for study. All measurements were made by using Electronic Digital Vernier Calipers and were recorded to the nearest hundredth of a millimetre. Keeping in view the aims of the study, following observations were made on dry bone:

Transverse diameter of the lumbar spinal canal was measured as the minimum distance between the medial surfaces of the pedicles of a given vertebra (Inter-pedicular distance²).

Observations were made on the skeletal material to determine the nature and incidence of alterations the anatomy, whether pathological or normal variation, including “arthritic” osteophytosis, lumbarization of first sacral vertebra, sacralization of fifth lumbar vertebra, sacro-transverse joints, spina bifida, wedge compression vertebral bodies, and trefoil or “maple-leaf” configuration of the lumbar canal.

From the above measurements, mean values and standard deviation were computed for each vertebral level, separately for each sex. Differences between the mean transverse diameter of the spinal canal of male and female at all five lumbar levels were statistically evaluated. Differences between transverse diameters of the spinal canal of adjacent lumbar segments were also calculated for both sexes. These were calculated from available mean transverse diameters. Knowledge of normal values of this parameter could be of importance in detecting isolated segmental changes.

Result: Table – 1 & 2 shows the range and mean transverse diameter of spinal canal in both sexes. The diameter gradually increases from L₁ to L₅. It is minimum at L₁ and maximum at L₅. The differences between the mean transverse diameters in male and female at all the five lumbar levels were found to be highly significant.

Table-1: Ranges of inter-pedicular distances of each segmental level measured in dried bone in adult Gujarati males and females.

| Level | Ranges of transverse diameter (IPD in mm.) | |
|-------|--|----------------|
| | Male | Female |
| L1 | 21.00 to 24.50 | 18.70 to 24.00 |
| L2 | 21.40 to 25.00 | 19.70 to 24.20 |
| L3 | 21.30 to 25.70 | 20.00 to 24.70 |
| L4 | 20.00 to 27.70 | 20.30 to 26.00 |
| L5 | 23.30 to 30.00 | 21.40 to 30.80 |

The value of standard deviation is highest at fourth lumbar level in male and fifth lumbar level in

female, suggesting greater variation in the size of inter-pedicular distance at fourth and fifth lumbar level respectively. The inter-segmental difference in case of vertebral body is largest at L₄ /L₅.

Table-2: Mean inter-pedicular distances (IPD in mm.), standard deviation (S.D.) and coefficient of variation (CV %) of the lumbar spinal canal of male and female adult Gujaratis.

| Level | Mean inter-pedicular distance (mm) | | | | | |
|-------|------------------------------------|--------|------|--------|--------|------|
| | Male | | | Female | | |
| | IPD | ± S.D. | CV % | IPD | ± S.D. | CV % |
| L1 | 22.6 | 0.97 | 4.25 | 21.3 | 1.31 | 6.15 |
| L2 | 23.3 | 1.09 | 4.67 | 21.8 | 1.18 | 5.41 |
| L3 | 23.8 | 1.14 | 4.78 | 22.5 | 1.17 | 5.20 |
| L4 | 24.1 | 1.80 | 7.46 | 23.3 | 1.58 | 6.78 |
| L5 | 27.0 | 1.78 | 6.59 | 26.4 | 2.47 | 9.35 |

Table-3: Comparison of mean IPD measured in dried bone (in mm.) of males in present study and previous study by Eisestein S3.

| Authors | Vertebral level | | | | |
|---------------------------------|-----------------|------|------|------|------|
| | L1 | L2 | L3 | L4 | L5 |
| Sotho Negroid | 21.0 | 21.0 | 22.0 | 23.0 | 25.0 |
| Zulu Negroid | 21.0 | 22.0 | 22.0 | 23.0 | 26.0 |
| Caucasoid | 23.0 | 24.0 | 23.0 | 24.0 | 26.0 |
| Present study (Gujarati) (2003) | 22.6 | 23.3 | 23.8 | 24.1 | 27.0 |

Discussion: In the present study attempt has been made to determine standard normal minimum IPD as a preliminary to clinical investigation of transverse spinal canal stenosis. It has been found that the reduction of coronal diameter of the lumbar spinal canal, caused by reduction in the inter-pedicular distance, is second most common cause of narrowing of the lumbar spinal canal after the reduction in the sagittal diameter, caused by short pedicles. So, we undertook the determination of normal inter-pedicular distance standard to detect spinal canal stenosis. It has been reported that dried bone study are of considerable value in the recognition of the inter-pedicular distance. As the age group selected for the present study is very

much same as the age group used for earlier such studies, the ethnic differences in the trait could be well compared. Hinck et al.⁴ have shown that before the age of 19 years, the lumbar spinal canal is distinctly narrower than it is in the adult. Inclusion of such young subjects in the sample could result in lowering of the value of mean IPD. So dried bone of normal adults skeleton aged 35 years and above, were included in the study.

95 percent tolerance range is expected to contain 95 percent of the normal population. Any transverse diameter falling outside this range has to be viewed critically. The Mean IPD of the lumbar spinal canal obtained from dried bone in Gujarati male and female, when compared with the data available from previous studies showed significant difference at all lumbar levels, thus, necessitating separate normal ranges for male and female. There is considerable overlapping of the ranges of male and female. This probably reflects the wide variations of body sizes among the male and female subjects.

Table 4 & 5 show a comparison between the mean inter-pedicular distances of lumbar spinal canal obtained from dried bone at levels L₁ to L₅ in males and females observed in the present study and those reported for other populations of the world. The inter-pedicular distance increased steadily from L₁ to L₅ in all populations. It is evident from table 4 & 5 that Gujaratis have greater IPDs at all level from L₁ to L₅ than that of Zulu Negroid and Sotho Negroid. But IPDs in Gujaratis are lower at L₁, & L₂ in male and L₁, L₂ & L₃ in female and greater at L₃, L₄ & L₅ in male and L₄ & L₅ in female than that of Caucasoid. Graph-1 & 2 showing comparison of mean IPDs of present study with previous studies of both sexes. Table-4 & 5 confirms the findings of ethnical difference in the different races of world and support the statement, "There are no mean values of the vertebral dimensions that are valid for all populations."

It is evident from table-6 that the inter-segmental difference between mean inter-pedicular distances of adjacent lumbar segment is seen to be highest at L₄/L₅ in both sexes, but in male difference decreases from L₁/L₂ to L₃/L₄ and in female increases from L₁/L₂ to L₃/L₄. Knowledge of the

Table-4: Comparison of mean IPD measured in dried bone (in mm.) of females in present study and previous study by Eisestein S3.

| Authors | Vertebral level | | | | |
|--------------------------|-----------------|------|------|------|------|
| | L1 | L2 | L3 | L4 | L5 |
| Sotho Negroid | 20.0 | 20.0 | 21.0 | 22.0 | 24.0 |
| Zulu Negroid | 20.0 | 21.0 | 21.0 | 22.0 | 24.0 |
| Caucasoid | 22.0 | 22.0 | 23.0 | 23.0 | 25.0 |
| Present study (Gujarati) | 21.3 | 21.8 | 22.5 | 23.3 | 26.4 |

Table-5: Inter-segmental differences between inter-pedicular distances measured in dried bone in present study.

| Vertebral level | In mm. | |
|-----------------|--------|--------|
| | Male | Female |
| L1/L2 | 0.7 | 0.5 |
| L2/L3 | 0.5 | 0.7 |
| L3/L4 | 0.3 | 0.8 |
| L4/L5 | 2.9 | 3.1 |

magnitude of the inter-segmental differences between the diameters of adjacent segment could be of value in the detection of isolated segmental changes. The increase of IPDs of Gujarati female is of pattern similar to that of the male but of a slightly smaller magnitude. A comparison between the present data and the data published data on inter-pedicular distance at lumbar levels of other populations also shows that there are marked differences between the mean values reported for the population of different geographic areas. The reasons for these differences are not clear, but interplay of racial, ethnic and environmental factors cannot be ruled out.

Conclusion: A comparison between the present data and the data published data on inter-pedicular distance at lumbar levels of other populations also shows that there are marked differences between the mean values reported for the population of different geographic areas. The present study confirms that there is ethnic as well as racial variation in the size of the lumbar vertebral canal, thus, emphasizing the need to have normal values

and ranges for the transverse diameter of the canal for different populations.

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