ORIGINAL ARTICLE https://doi.org/10.3126/njms.v8i1.54309

Assessment of Anteroposterior Diameter, Interpedicular Distance and Cross-Sectional Area of the Lubar Spine in Patients Undergoing CT Scan in a Tertiary Care Center

Acharya S[1], Pradhan S[2], Sharma P[3], Bajimaya N[4]

[1]Lecturer, Department of Radiology, Manipal College of Medical Sciences, [2]Professor, Department of Radiology, Nepal Medical College and Teaching Hospital, Kathmandu, [3]Associate Professor, Department of Radiology, Manipal College of Medical Sciences, Pokhara, Nepal, [4]Medical Officer, Urban Health Promotion Centre, Kathmandu, Nepal.

Received: October 11, 2022 **Accepted:** December 30, 2022 **Published:** January 31, 2023

Cite this paper: Acharya S, Pradhan S, Bajimaya N, Sharma P. Assessment of anteroposterior diameter, interpedicular distance and cross-sectional area of the lubar spine in patients undergoing CT scan in a tertiary care center. *Nepal Journal of Medical Sciences*. 2023;8(1):12-7. https://doi.org/10.3126/njms.v8i1.54309

ABSTRACT

Introduction: Lumbar spinal stenosis is a frequent cause of low back pain. Decreased lumbar spinal canal parameters are major risk factors for canal stenosis. This study was done to assess anteroposterior diameter, interpedicular distance and cross-sectional area of the lumbar spinal canal on a CT scan.

Methods: It was a cross-sectional descriptive study conducted at Nepal Medical College Teaching Hospital. Anteroposterior diameter, interpedicular distance and cross-sectional area of the lumbar spinal canal were measured.

Results: A total of 171 subjects were selected. The mean of anteroposterior diameter from L1-L5 was 16.46 mm, 16.05 mm, 15.04 mm, 15.08 mm and 15.23 mm respectively. The means of interpedicular distance from L1-L5 were 22.71 mm, 23.20 mm, 24.52 mm, 26.29 mm and 29.90 mm respectively. The means of cross sectional area from L1-L5 were 288.79 mm^2, 2773.15 mm^2, 266.84 mm^2, 282.89 mm^2 and 317.04 mm^2 respectively. A statistically significant difference between sex and anteroposterior diameter was noted at L2 and the interpedicular distance was at L4 and L5 levels. The cross-sectional area has increased with increased age in all five vertebral levels but it showed statistically significant variation only at L1.

Conclusion: Anteroposterior diameter, interpedicular distance and cross-sectional area varies at each level on the lumbar vertebra and may vary according to age and sex.

Keywords: *Lumbar Vertebrae; Spinal Canal; Spinal Stenosis*

Correspondence to: Dr Sabanam Acharya
Department of Radiology
Manipal College of Medical Sciences,
Pokhara, Nepal
Email: sabanamacharya@gmail.com

Licensed under CC BY 4.0 International License which permits use, distribution and reproduction in any medium, provided the original work is properly cited

INTRODUCTION

Spinal stenosis (SS) is defined as the narrowing of the spinal canal and/or foramina which compresses the canal contents, spinal cord, cauda equina, meninges, nerve roots and vessels and manifests as "buttock or lower extremity pain, which may occur with or without low back pain (LBP), associated with diminished space available for the neural and vascular elements in the lumbar spine".[1,2] Verbiest H, in 1950, laid out the fundamental concept of SS, who for the first time evaluated the size of the spinal canal in developmental stenosis.[3] The most often reported parameter for SS has decreased Anteroposterior Diameter (APD). However, decreased Interpedicular Distance (IPD) and Cross-Sectional Area (CSA) of the spinal canal are also risk factors for the development of central LSCS (Lumbar Spinal Canal Stenosis).[4] LSCS is a frequent cause of LBP. LBP affects many individuals at some point in their life.[5] Different studies have suggested different reference ranges for these parameters.[6-8] So using values derived from other populations may be fallacious in the diagnosis of LSCS in the Nepalese population. So, this study aimed to evaluate the lumbar spinal canal anteroposterior diameter (LSCAPD), Lumbar Spinal Canal Interpedicular Distance (LSCIPD) and Lumbar Spinal Canal Cross Sectional Area (LSCCSA), to make a nomogram of these dimensions in Nepalese population undergoing abdominal CT scan in a tertiary care centre.

METHODS

This was a cross-sectional study performed on patients undergoing CT scans of the abdomen and pelvis in the Department of Radiology of Nepal Medical College Teaching Hospital (NMCTH), from January 2019 to December 2019. Ethical clearance was taken from the Institutional Review Committee (IRC) of NMCTH before performing the study. Written informed consent was taken before including them in the study. CT scan was performed using a 64-slice spiral CT scan (TOSHIBA AQUILON 64 SLICE) with appropriate imaging parameters for an abdominal CT scan. Patients aged more than 18 years and less than 60 years with a normal lumbar spine on CT scans were included in the study. Data entry was done in Microsoft Excel and was converted to SPSS Version 16 software where statistical analysis was made using relevant statistical tests. A comparison of the obtained data according to gender was done using an independent t-test. ANOVA test was used to compare the mean of different age groups. The Pearson correlation was used to determine the correlation of these parameters between gender and between different age groups. A p-value of < 0.05 was regarded as statistically significant.

RESULTS

Total of 171 cases who underwent a CT scan of the abdomen and fulfilled the entry criteria were enrolled in the study. The mean age of the participants was 39 years, ranging from 19 to 60 years. Among the participants, 88 (51%) were males and 83 (49%) were females.

The mean of APD from L1 to L5 was 16.46 mm, 16.05 mm, 15.04 mm, 15.08 mm and 15.23 mm. There is a decreasing trend of APD from L1 to L3 with an increasing trend from L3 to L5 with maximum value at L1 and minimum at L3.

The mean of IPD from L1 to L5 was 22.71 mm, 23.20 mm, 24.52 mm, 26.29 mm and 29.90 mm. IPD increased gradually from L1 to L5 level with a maximum at L5 and a minimum at L1.

The mean of CSA from L1 to L5 were288.79 mm^2, 273.15 mm^2, 266.84 mm^2, 282.89 mm^2 and 317.04 mm^2 This demonstrated decreasing trend of CSA of the spinal canal from L1 to L3 with an increasing trend from L3 to L5, with maximum CSA at L5 level and minimum at L3 level.

The APD of the spinal canal was comparatively larger in females at all levels except at the L5 level with a statistically significant difference only at the L2 level (p-value: 0.012). At other levels, the differences were statistically insignificant. The IPD was larger in males at all 5 levels with statistically significant differences at L4 (P- 0.029) and L5 (P- 0.014) levels. The cross-sectional area was also larger in males at all levels but the differences were statistically insignificant.

DISCUSSION

Lumbar spinal stenosis is a frequent cause of LBP. Decreased LSCAPD, IPD and CSA are major risk factors for the development of central spinal canal stenosis. This observational cross-sectional study enrolled 171 cases and APD, IPD and CSA of all five lumbar vertebral levels were measured to provide quantitative data. The APD of the lumbar spine was maximum at L1 which gradually decreased up to L3 followed by an increase in L4 and L5 resulting in an hourglass shape. The findings in our study were consistent with that reported by Aly T and Amin O in Egyptian, Lee et al. in Korean and Amonoo-Kuofi HS.[7] in Nigerian populations.[7,9,10] This hourglass shape is explained to be due to the lumbar enlargement of the spinal cord at L1, which is the region of functional transition between the relatively immobile thoracic spine and the mobile lumbar spine. So this increase in size at L1 may be adopted to ensure the protection of those contents during complex movements of this transitional region.[7] However, the findings of Pawar et al. are inconsistent with our study who demonstrated a gradual increase in the APD from L1 to L5 with maximum value at L5 level.[4] This difference may be attributed to the difference in ethnicity.

The APD in our study was larger as compared to the Indian and Korean populations.[4,10] However it was Amonoo-Kuofi HS. in a study that concluded that the APD of the spinal canal is subject to racial variation and is determined by the thickness and orientation of the lamina and to a lesser extent by the height of the pedicle.[7] So it can be concluded that the APD varies according to ethnicity. In this study, the measurement of APD was larger in females as compared to males but the difference was statistically significant at L2 only. (Table 1)

Table no 1: Comparison of the mean of APD (mm) of our study with the findings of other studies

APD (mm)	This study	Indian[4]	Korean[10]	Italian[11]	Egypt[9]
L1	16.46	11.85	15.4	18.7	16.75
L2	16.05	12.27	14.5	17.9	15.85
L3	15.04	12.73	13.8	16.9	15.09
L4	15.08	12.98	14.0	16.9	15.46
L5	15.23	13.11	14.8	17.3	16.36

There was a gradual and steady increase in IPD from L1 to L5 with a maximum at L5 and a minimum at L1. This coincides with the findings by Lee et al. Zhou et al., Amadou A., Sethi et al. and Ahmad T et al. [1,10,12-14]In this study the IPD was larger in males at all five levels with a statistically significant difference at L2 level. But Sethi et al. in a study of the Indian population showed the IPD to be larger in females as compared to males.[14] Amadouet A. and Elhassan et al. in their study showed no significant differences in the measurement of IPD between males and females. [6,13] Unlike APD, the IPD in our study is comparable to that of the Indian population. [5] However Korean and Malagasy people have comparatively smaller IPD. [10,15]

Table no 2: Comparison of mean of IPD (mm) of this study with other population

IPD (mm)	This study	Indian[4]	Korean[10]	Malgasy[15]
L1	22.71	21.96	21.2	20.8
L2	23.20	22.06	21.5	20.79
L3	24.52	23.25	22.1	21.09
L4	26.29	26.45	22.9	23.16
L5	29.90	30.59	25.7	24.95

In this study, CSA of the spinal canal was maximum at L5 and minimum at L2. From L2 it gradually increased to L5. In our study, the CSA was found to be larger in males at all levels but the difference was statistically significant at L5 only. With increasing age, the CSA steadily increased at all five vertebral levels. CSA of LSC is smaller in the Indian population as compared to the Nepalese population at all five lumbar levels.[1] Whereas the Greek population have comparable CSA as compared to our population.[16] (Table 3)

Table 3: Comparison of mean of CSA of the spinal canal (mm2) of our study with other population

CSA (mm)	This study	Indian[4]	Greece[16]
L1	288.79	192.84	-
L2	273.15	180.85	-
L3	266.84	170.42	269.3
L4	282.89	168.28	269.3
L5	317.04	135.14	319.2

In clinical practice, different modalities, as well as different parameters, are used for the diagnosis of SS and there are different ranges of values of APD, IPD and CSA of the spinal canal for the diagnosis of SS.[17-19] However this study revealed that for each level from L1 to L5, a specific cut off value should be made for the diagnosis of SS. Moreover, for the diagnosis of LSCS, it is necessary to correlate these parameters with the clinical symptoms or signs attributable to stenosis rather than using the imaging modality alone.[20,21]

CONCLUSION

Spinal stenosis is a major cause of low back pain. Decreased APD, IPD and CSA of LSC are major parameters for the diagnosis of spinal stenosis. In a comparison of the findings of this study with other studies, some studies showed larger parameters whereas others showed smaller parameters. This suggests population-specific variation in dimensions of the spinal canal and thus necessitates different studies in various populations. This also emphasizes the need for different criteria for the evaluation of LSCS. Moreover, the measurement criteria cannot be used solely for the evaluation of SS, instead, it needs equal clinical correlation. This is a single-centric study so the data of this study should not be used in all Nepalese populations instead a larger study is required before extrapolating it to different communities.

CONFLICT OF INTEREST

None

SOURCES OF FUNDING

None

REFERENCES

1. Ahmad T, Goel P, Ramesh Babu CS. A study of the lumbar canal by M.R.I. in clini-

cally symptomatic and asymptomatic subjects. J Anat Soc India. 2011;60(2):184–7. http://dx.doi.org/10.1016/s0003-2778(11)80022-5
2. Kreiner DS, Shaffer WO, Baisden J, et al. Diagnosis and treatment of degenerative lumbar spinal stenosis. Boulevard, USA: North American Spine Soc. 2011.
3. Verbiest H. Further experiences on the pathological influence of a developmental narrowness of the bony lumbar vertebral canal. J Bone Joint Surg Br. 1955;37-B(4):576–83. http://dx.doi.org/10.1302/0301-620X.37B4.576
4. Kohli S, Kumar V, Narang S, Pawar I, Singhal A, Dalal V. Magnetic resonance imaging in the diagnosis of lumbar canal stenosis in Indian patients. J Orthop Allied Sci. 2014;2(1):53. http://dx.doi.org/10.4103/2319-2585.134200
5. Lafian AM, Torralba KD. Lumbar spinal stenosis in older adults. Rheum Dis Clin North Am. 2018;44(3):501–12. http://dx.doi.org/10.1016/j.rdc.2018.03.008
6. Elhassan YA, Ahmed A, Ali Q. Sagittal diameter of the lumbosacral spinal canal in normal (asymptomatic) adult Sudanese population 2014. Sudan Med Monit. 2014;9(4):153. http://dx.doi.org/10.4103/1858-5000.153030
7. Amonoo-kuofi HS. The sagittal diameter of lumbar vertebral canal in normal adult Nigerians. J Anat. 1985; 140: 69-78
8. Andersson GB. Epidemiological features of chronic low-back pain. Lancet. 1999;354(9178):581–5. http://dx.doi.org/10.1016/S0140-6736(99)01312-4
9. Aly T, Amin O. Geometrical dimensions and morphological study of the lumbar spinal canal in the normal Egyptian population. Orthopedics. 2013;36(2):e229-34. http://dx.doi.org/10.3928/01477447-20130122-27
10. Lee NJ, Kim JS, Park P, Riew KD. 31. A comparison of various surgical treatments for cervical spondylotic myelopathy: a propensity score matched analysis. Spine J. 2020;20(9):S15. http://dx.doi.org/10.1016/j.spinee.2020.05.134
11. Pierro A, Cilla S, Maselli G, Cucci E, Ciuffreda M, Sallustio G. Sagittal normal limits of lumbosacral spine in a large adult population: A quantitative magnetic resonance imaging analysis. J Clin Imaging Sci. 2017;7(35):35. http://dx.doi.org/10.4103/jcis.JCIS_24_17
12. Zhou SH, McCarthy ID, McGregor AH, Coombs RR, Hughes SP. Geometrical dimensions of the lower lumbar vertebrae--analysis of data from digitised CT images. Eur Spine J.2000;9(3):242–8. http://dx.doi.org/10.1007/s005860000140
13. Amadou A, Sonhaye L, James YN, et al. Normative dimensions of lumbar canal and dural sac by computer tomography in Togo. Med Imaging Radiol. 2017;5(1):3. http://dx.doi.org/10.7243/2054-1945-5-3
14. Sethi R, Singh V, Chauhan BK, et al. A study of transverse diameter of lumbar vertebral canal in north Indian population. Int J Anat Res. 2015;3(3):1371–5. http://dx.doi.org/10.16965/ijar.2015.239
15. Hasina RF. Measurement of the Lumbar Spine Canal in CT-Scan Malagasy Population.EC Orthop. 2019; 10: 646-51.
16. Karantanas AH, Zibis AH, Papaliaga M, Georgiou E, Rousogiannis S. Dimensions of the lumbar spinal canal: variations and correlations with somatometric parameters using CT. Eur Radiol. 1998;8(9):1581–5. http://dx.doi.org/10.1007/s003300050590
17. Talekar KS, Cox M, Smith E, Flanders AE. Imaging spinal stenosis. Appl Radiol. 2017;8–17. http://dx.doi.org/10.37549/ar2342
18. Chatha DS, Schweitzer ME. MRI criteria of developmental lumbar spinal stenosis revisited. Bulletin NYU Hosp Joint D.is. 2011; 69: 303.
19. Mamisch N, Brumann M, Hodler J, Held U, Brunner F, Steurer J, et al. Radiologic criteria for the diagnosis of spinal stenosis: results of a Delphi survey. Radiology. 2012;264(1):174–9. http://dx.doi.

org/10.1148/radiol.12111930

20. Frymoyer JW. Back pain and sciatica. N Engl J Med. 1988;318(5):291–300. http://dx.doi.org/10.1056/NEJM198802043180506
21. Schizas C, Schmit A, Schizas A, Becce F, Kulik G, Pierzchała K. Secular changes of spinal canal dimensions in western Switzerland: A narrowing epidemic? Spine (Phila Pa 1976). 2014;39(17):1339–44. http://dx.doi.org/10.1097/brs.0000000000000445