Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 4204 - 4211
Received 16 February 2021; Accepted 08 March 2021.

Anatomical Radiographic Study of the Lumber Spinal Canal by Magnetic Resonance Imaging

Majid HadiJassim
Lecturer, Department of Anatomy and biology, college of medicine, JabbirIbnHayyan Medical University, Iraq
Email: m.hadi@jmu.edu.iq

Abstract

The measure of the mid-sagittal diameter of the lumber spinal canal in patient attending the MRI unit complaining of chronic low back pain is important.Lumbar spinal stenosis (LSS) is a Common case relativelydiverse etiologywhich leads to chronic pressureof the caudalequine which forms a bundle within the lowest part of the spinal column. It turnsinto clinically relevant when symptoms of neurogenic claudicating or leg pain appear. Lumbar spinal stenosis can be categorizedon anatomy or etiology and in any case, the diagnosis must take into account both the site and the cause. Plain radiography is of limited value. Myelography withextension views and erect lateral flexion will show the Dynamic component of narrowingwhich cannot berecognize the full worth of on plain computed tomography (CT) or magnetic resonance imaging (MRI). Therefore, in patients with a good history of symptomatic LSS, and a borderline stenosis on MRI, CT Myelography is bespoke as the final imaging investigation prior to surgery.**Method**: Sagittal, axial and coronal MRI image of the lumbar spine were obtained for L1, L3, and L5 levels.**Aim of the study**: To measure the mid-sagittal diameter of the lumber spinal canal. **Result:**Anatomical study of coronal images wasbeneficial in demonstrating the different anatomical structures of the lumbar spine. The mean mid sagittal diameter at the level of L1 was 15.08 millimeters. **Conclusion:**No significant sex deference was found in measurement of the mid sagittal diameter, and there was no significant relationship between vertebral heights and mid sagittal diameter of the spinal canal.

Keyword: The measure of the mid-sagittal diameter of the lumber spinal canal

INTRODUCTION

Measurements of the sagittal diameter in the lumber region, below 14 mm are considered as potentially developmental narrowing [1]. When the epidural space is narrow and normal annuli may cause slight impressions on it [2-3]. The normal adult lumber spinal canal sagittal diameter ranges from 14mm to 15mm [4]. Manifestations of lumber spinal stenosis by CT scan include a sagittal diameter of less than 11mm. spinal canal area of less than 1.45cm2 5, and a lateral recess depth of less than 3 mm [5].Lumbar spinal stenosis (LSS) has been defined as all the type of narrowing of the spinal canal, nerve root canals (or tunnels) or intervertebral foramina' which may be local, segmental orgeneralized [6]. It becomes clinically significant when givingrise to the symptoms and signs of neurogenic claudicating or ridiculer pain,figure(1). Lumbar spine scans, but asymptomatic or low back pain is few without evidence of progressive neurological claudicating, which is the hallmark of clinical symptoms with LSS [7-8].Ironically, patients often present with symptoms of neurological

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 4204 - 4211
Received 16 February 2021; Accepted 08 March 2021.

claudicatingthey have very similar radiological findings to the asymptomatic patient with radiological evidence of LSS, indicating that there is no simple direct relationship between the presence and degree of radiological narrowing of the lumbar canal seen on MRI and CT and clinical symptoms of neurological claudicating [9].The purpose of this article is to review the imaging of LSS and also to discuss the clinical features, aetiology and pathophysiology of the pathophysiology of the condition.

A B

Figure(1): (a) Sagittal T1 weighted MRI and (b) axial fast spin-echo T2-weighted MRI showing a severe degree of central canal stenosis at the L4/5level, associated with a grade 1 degenerative spondylolisthesis. The patient had a 10-year history of low back pain but no leg symptoms

Aims of the study

1. To measure the mid-sagittal diameter of the lumber spinal canal in patient attending the MRI unit complaining of chronic low back pain.
2. To find relation between the mid sagittal diameter of the lumber spinal canal and the measurement of the vertebral height.

PATIENTS AND METHODS

Patients

The study involved forty-one patients, 22 (54.1%) were male and 19 (45.9%) were female with age range between 28 and 59 years.

MATERIALS AND METHODS

All procedures for patients were performed in the special centers for chronic pain and vertebrae in Najafin many patients with spinal instability, a relevant and important finding in reviewing MRI examinations is the presence of facial joint fluid primarily on axial images coexisting with spinal instability [10-11]. The presence of spinal instability can alter the type of surgical procedures chosen when treating neurological claudicating. Other spinal deformities such as lumbar scoliosis, especially if there more than 11% angularity at the corners, it could cause lateral rest and foramen stenosis on the concave side of the scoliosis in addition to complicating the use of various implants, especially if the scoliosis extends in the form of several parts. Imaging in the sagittal plane, especially on an MRI scan, is the most common way to assess the number of levels of channel stenosis, but sagittal view alone can

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 4204 - 4211
Received 16 February 2021; Accepted 08 March 2021.

reduce the degree of lateral lumen stenosis. The axial plane, using both CT and MRI scans, is the best level for identifying central lumen stenosis versus lateral narrowing [12-13].Sagittal, axial and coronal MRI image of the lumbar spine were obtained for L1, L3, and L5 levels (figure 2). A correlation was made between the vertebral height and the mid-sagittal diameter of the spinal canal at the same level,by using correlation statistical analysis. The male and female measurement was compared using the student's t-test.

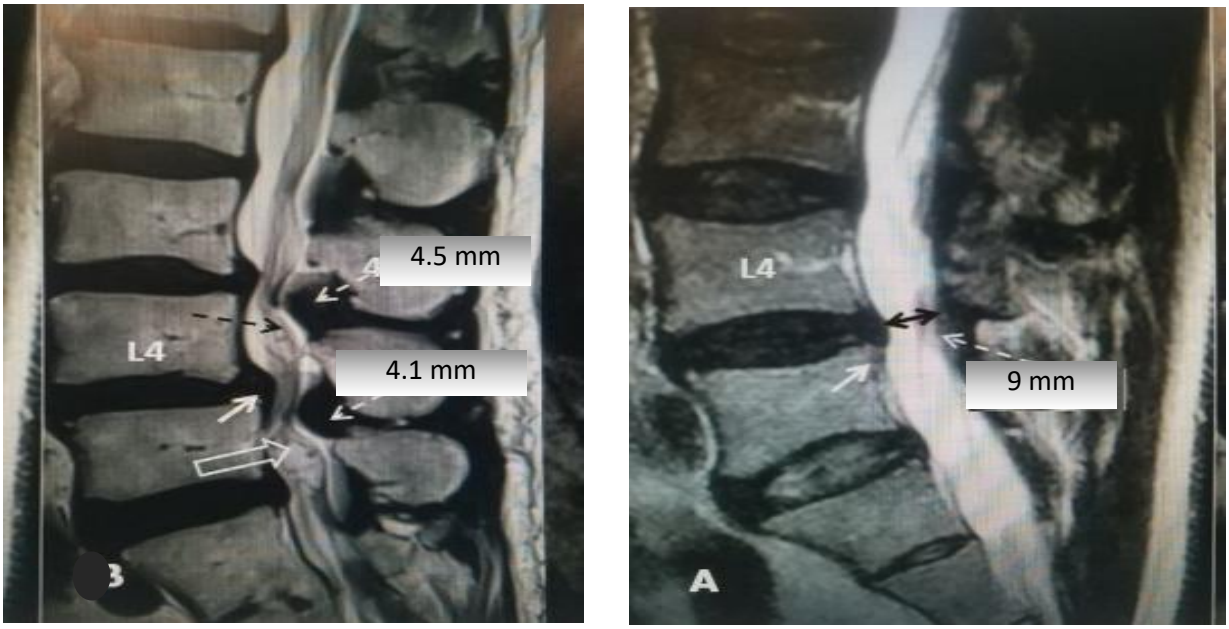

Figure (2):MRI scans compared in different patients with different grades of spinal stenosis

RESULTS

Anatomical study of mid-sagittal image show normal disc spaces and normal discs. Anatomical study of coronal images wasbeneficial in demonstrating the different anatomical structures of the lumbar spine. The mean mid sagittal diameter at the level of L1 was 15.08 millimeters.

Statisticalstudies

1- Measurements of Mid sagittal of the Lumbar spinal canal (table 1)

a- The mean mid sagittal diameter at the level of L1 was 15.08 millimeters (±0.228 SEM)from total sample of patients. It was 15.25 millimeter ($\pm_{0.265}$SEM) in females and 14.75 millimeter (±0.349SEM) in male patients.

b- The mean mid sagittal diameter at the level of L3 was 13.98 millimeters (±0.304 SEM)from total sample of patients. It was 13.56 millimeter (±0.265SEM) in females and 14.75 millimeter (±0.349SEM) in male patients.

c- The mean mid sagittal diameter at the level of L5 was 13.51 millimeters (±0.256 SEM)from total sample of patients. It was 13.25 millimeter (±0.419SEM) in females and 13.73 millimeter (±0.312SEM) in male patients.

2- Measurements of the Mid sagittal Diameter of thecal Sac At L5 Bv MRIMyelography Technique spinal canal (table 1)

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 4204 - 4211
Received 16 February 2021; Accepted 08 March 2021.

a- Measurements of Mid sagittal of the theca Sac at L5 level was 11.71 millimeters (±0.195 SEM) from total sample of patients. It was 11.71 millimeter (±0.331 SEM) in females and 11.73 millimeter (±0.231SEM) in male patients.

b- The average distance between the wall of the lumbar spinal canal and the theca sac at the mid sagittal plane of L5 level was calculated to be 1.79 millimeter (13.51-11.72) This was finding the difference between the mean mid sagittal diameter of the spinal canal at L5 (measured on T2weighted image) and the mean sagittal diameter in the mid sagittaltheca diameter at L5 Measured on myographic images

3- Measurements of Vertebral body heights (Table 1)

a- The mean vertebralheights at L1 were 23.17 millimeter (± 0.229SEM) for the total patients. It was 22.91 millimeter (± 0.302SEM) for females and 23.4 millimeter (± 0.337SEM) for males.

b- At L3 it was 23.12 millimeter (± 0.297SEM) for the total patients, 21.97 millimeter (±0.376SEM) in females' patients and 23.24 millimeter (± 0.455SEM) in male patients.

c- At L5 it was 21.9 millimeters (± 0.27SEM) for the total patients, 21.84millimeter (± 0.268SEM) for females' patients and 21.95 millimeters (±0.454SEM) for male patients.

4- The Relationship Between Vertebral body heights and Mid sagittal Diameter of the spinal canal At L1, L3 and L5 levels figure(3)

There was non-significant relation ($P > 0.05$) between the mid sagittal diameter of the vertebral canal the vertebral body at L1, L3and L5 levels (Fig 3-a,b,c)

5- Sex differences in Measurements (Table- 2)

Using the student t- test, there was no significant differences ($P > 0.05$) between male and female Measurements as regard:

a- The mid sagittal diameters of the lumber spinal canal in all levels measured

b- The mid sagittal diameter of the theca sac L5

c- Vertebralbody heights at all levels measured.

6- Measurements of mid sagittaldiameter of lumbar spinal canal less than 14 mm.

a- At L1 ten patients out of forty one (24.4%) were having relatively narrow mid sagittaldiameter of the lumbar spinal canal less than (<14 millimeter)

b- At L3 level twenty one patients out of forty one (51.2%) were having relatively narrow mid sagittaldiameter of the lumbar spinal canal less than (<14 millimeter)

c- At L5 level twenty -two patients of forty one (53.6%) were having relatively narrow spinal canal mid sagittal diameter (<14 millimeter)

	L1 MID sagittal diameter	L3 MID sagittal diameter	L5 MID sagittal diameter	L5 MID sagittal theca diameter	L1 Vertebral heights	L3 Vertebral heights	L5 Vertebral heights
Female Number	19	19	19	19	19	19	19

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 4204 - 4211
Received 16 February 2021; Accepted 08 March 2021.

Mean	15.485	14.468	13.258	11.711	22.916	22.979	21.847
SDE	1.154	1.462	1.824	1.443	1.316	1.640	1.167
SEM	0.265	0.335	0.419	0.331	0.302	0.376	0.268
Minimum	13.4	11.2	9.9	9.5	20.2	19.1	19.8
Maximum	16.9	16.0	17.4	14.5	25.2	25.6	23.7
MALE Number	22	22	22	22	22	22	22
Mean	14.759	13.568	13.732	11.736	23.405	23.245	21.950
SDE	1.629	1.427	2.463	1.082	1.580	2.133	2.128
SEM	0.349	0.304	0.312	0.131	0.337	0.455	0.454
Minimum	11.5	11.1	10.5	9.1	20.1	20.1	18.8
Maximum	17.5	17.7	16.1	13.1	25.8	27.9	26.0
Total Number	41	41	41	41	41	41	41
Mean	15.083	13.985	13.512	11.724	23.178	23.122	21.907
SDE	1.461	1.296	1.637	1.246	1.467	2.902	1.730
SEM	0.228	0.234	0256	0.195	0.229	0.297	0.270
Minimum	11.05	11.1	9.9	9.1	20.1	19,9	18.5
Maximum	17.5	17.7	17.4	14.5	25.8	27.9	26.0

Table (1)

1- The mean of mid sagittal diameter of lumber spinal canal at L1,L3and L5 levels with the standard deviation (SD) and the standard error of the mean (SEM) with Minimum and Maximum Measurements .

2- The mean of mid sagittal diameter of theca sac at L5 with the (SD) and (SEM) and Minimum and Maximum Measurements.

3- The mean for Vertebral body heights at L1,L3and L5 with(SD) and (SEM) and Minimum and Maximum Measurements

Type OF Measurements	t-test CALCULATED	t-test TABULATED
L1 MID sagittal diameter	2.414	0.128
L3 MID sagittal diameter	3.968	0.053
L5 MID sagittal diameter	0.852	0.362
Thecal L5 MID sagittal diameter	0.004	0.948
L1 height	2.136	0.293
L3 height	0.196	0.660
L5 height	0.041	0.840

Table (2): Comparison Between female and male Measurements, using the student t-test

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 4204 - 4211
Received 16 February 2021; Accepted 08 March 2021.

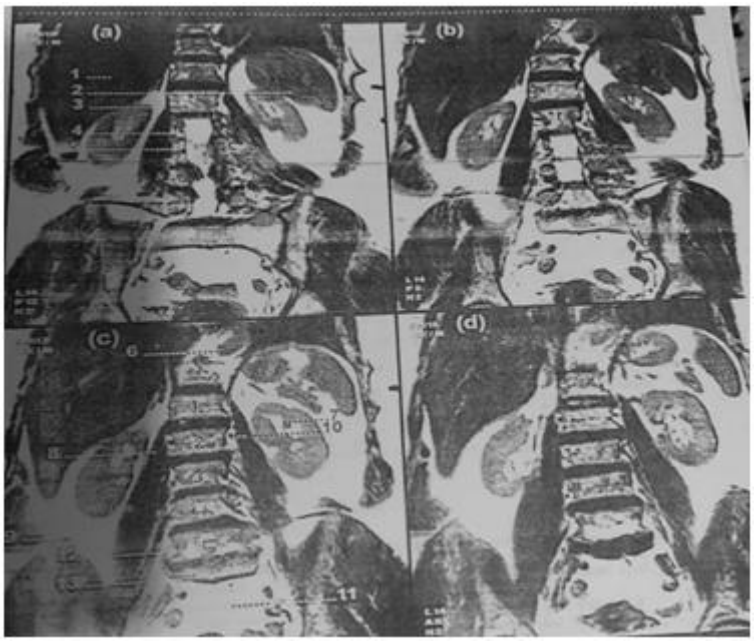

Figure (3): Four serial coronal sections in T1imaging sequence showing the lumper spine and the surrounding viscera

DISCUSSION

Most of the measurements found the normal adult sagittal diameter of the lumber spinal canal ranges from 14 – 15 mm as measured by CT scan, bellow 11 mm are considered abnormal and usually manifested by signs and symptoms of lumbar spinal stenosis [1, 5, 14]. In the present study, it was found that the mean mid sagittal diameter of the lumbar spinal canal was 15.08 mm at L1, 13.98 mm at L3and (4.1,4.5) L4 and 13.5 mm at L5 level, for the total of patient examined [8-10]. These measurements slightly differ from the range given by previous workers 14 – 15 mm [1, 15]. This difference is probably due to different way of measurements, besides, most of the previous studies were done by using CT scan. Other factor could be thedifference between the patient samples. We found that most of the critical measurements less than 14 mm for the mid sagittal diameter, were at L5 level, this coincide with the results given by previous study [16], who found that L5 is commonly affected by narrowing. The range mid sagittal diameter of the thecal sac at L5 was measured, using this type of imaging technique, to be 11.72 mm for the total of patients. The extradural space at L5 could be known simply if we subtract this value from the value of the mean mid sagittal diameter of the spinal canal at L5. This different was 1.79 mm. It may give a better idea about the severity of the stenosis, if present. In this study the average vertebral height was 23.17 mm at L1, and 23.12 mm at L3, and 21.9 mm at L5. Here we can see that the fifth lumbar vertebra have shorter body than the rest, in spite of having the largest body among the lumbar vertebrae [1]. In this study, it was found that there was a direct, significant relationship ($P< 0.05$) between the vertebral heights and the mid sagittal diameter of the spinal canal at L5 in the female samples only. This is possibly because the female fifth lumbar vertebra is different in shape from that of the male, as the case with the pelvis and muscles of the lumbar spine [12-13]. The shape and size of the fifth lumbar vertebral is

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 4204 - 4211
Received 16 February 2021; Accepted 08 March 2021.

slightly different from the rest [17]. In the present study it was found that there was no sex difference in measurements concerning the mid sagittal diameter of the spinal canal.

CONCLUSIONS

1. No significant sex deference was found in measurement of the mid sagittal diameter at the three levels measured and no significant sex deference was found in measurement of vertebral heights and thecal mid sagittal diameter at l5.
2. There was no significant relationship between vertebral heights and mid sagittal diameter of the spinal canal at the levels measured (L1, L3, and L5).

REFERENCES

[1] Ullrich CG, Binet EF, Sanecki MG, Kieffer SA. Quantitative assessment of the lumbar spinal canal by computed tomography. Radiology 1980; 134: 137 – 143.
[2] Crosby EC, Humphrey T, Lauer EN, Correlative Anatomy of the Nervous System, Macmillan, New York, 1962.
[3] Jacobson RE, Lumbar stenosis. An electromyography evaluation. ClinOrthop 1976; 115; 68 -71.
[4] Nagler W, Hausen HS. Conservative management of lumbar spinal stenosis: Identifying patients likely to do well without surgery. Post grad Med 1998; 104(4): 60 – 88.
[5] Moreland LS, Lopes, Mendez A, Alarcon GS, Spinal stenosis: A comprehensive review of the literature. Semin Arthritis Rheum. 1989; 19(2): 127 – 149.
[6] Arnoldi CC, Brodsky AE, Cauchoix J, et al. Lumbar spinal stenosis and nerve root entrapment syndromes. Definition and classification, ClinOrthop 1976;115:4–5
[7] Spinal stenosis prevalence and association with symptoms: the Framingham study. Kalichman C, Cole R, Kim DH, et al. Spine J. 2009; 9:545–550.
[8] Radiologic criteria for the diagnosis of spinal stenosis: Results of a Delphi survey. Manish N, Brumann M, Hodler J, Held U, Brunner T, Steurer T. Radiology. 2012; 264:174–179.
[9] Quantitative radiologic criteria for the diagnosis of lumbar spinal stenosis: a systematic literature review. Steurer J, Roner S, Gnannt R, Holdler J. BMC Musculoskeletal Disord. 2011; 12:175.
[10] Lumbar disc nomenclature: version 2.0 recommendations of the combined task forces of the North American Spine Society, the American Society of Spine Radiology, and the American Society of Neuroradiology. Fardon D, Williams A, Dohring E, Murtagh FR, Rothman G, Stephen L, Sze G. Spine. 2014; 39:0.
[11] Katz. JN, Dalgas M, Stucki G, et al. Degenerative lumbar spinal stenosis: Diagnostic value of the history and physical examination. Arthritis Rheum 2005; 38(9): 36-41.
[12] Boden SD, Davis Do, Dina TS: Abnormal magnetic resonance of the lumbar spine in asymptomatic subjects: A prospective investigation. J Bone Joint Surg Am 2000; 72: 403- 408.

[13] Wiesel SW, Tsourmas N, Feffer HL. A study of computerized tomography. The incidence of positive computerized tomography scans in an asymptomatic group of patients. Spine 1994; 9(6): 549 – 551.
[14] Fritz JM, Delitto A, Welch WC, Erhard RE, Lumbar spinal stenosis: A review of current concepts in evaluation, management, and outcome measurements. Arch PhysMedRehabil 2008; 79: 70 – 78.
[15] Jonsson B, Annertz M, Sjoberg C, Stromqvist B. A prospective and consecutive study of surgically treated lumber spinal stenosis, clinical features related to radiographic finding. Spine 1997; 22(24): 232-237.
[16] Marras WS, Jorensen MJ, Granta KP, Wiand B. Female and male geometry; size and prediction of the spine loading trunk muscle derived from MRI. ClinBiomech 2010; 16(1): 38-46.
[17] Chung CT, Chou CS, Ho Y, Lee SK. Neurogenic intermittent claudicating related to spinal stenosis. Zhonghua (Taipei) 2000; 63(11): 809-815.