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Morphometric Study of Lumbosacral & Cobb Angles for Patients with Intervertebral Disc Herniation using MRI

Sara Saadeldein Albadri [1*] and Mohammed Ahmed Ali Omer [2, 3].
[1]*College of Medical Radiologic Science, AL-Ghad International College for Applied Medical Sciences*
[2]*College of Medical Radiologic Science, Sudan University of Science and Technology, Khartoum-Sudan*
[3]*Department of Radiologic Technology, College of Applied Medical Sciences, Qassim University, Buraidah-KSA, P. O. Box 6800, 51452, Saudi Arabia*

Abstract:
Background: *Biological morphometry has been considered as one of assistant skill for normal anatomy and physiology of a human systems; hence the aim of this study was to carry out a morphometric study for Lumbosacral and Cobb angles for herniated intervertebral disc patients relative to patients' morphology (age and body mass index and height) and gender.*
Material and Method*: as a retrospective study for a sample consisting of 100 patients in Sudan. The collected data imply age, gender, anatomical site of disc herniation, bulging extension, Lumbosacral and Cobb angles, and the body mass index. The analysis was based on the statistical Package for Social Science (SPSS).*
Results: *showed that: frequencies% of male & female were (45%) 45 and (55%). The common involved intervertebral discs were Lumbar 5 and Lumbar 4 with disc bulging 2.2 and 2.5 cm respectively and striking the age groups 28 – 60 years old. The height, BMI and ageing were significantly (P-value = 0.00) influencing the LS/Cobb angles and furtherly proved as risk factors for IVDH.*
Conclusion: *The study proved that IVDH is a common disease among the age group of 28 – 60 years old striking selectively L4 and L5 and leading to symptomatic disc bulging. And also, the LS and Cobb angles were associated significantly with gender, ageing, overweight and obesity which are proved as risk factors for IVDH; hence these angles could be utilized successfully from radiographs together with patient's complain to diagnose and predict the IVDH.*
Key Word*: Morphometry; Aging; Biography; Lumbosacral; Herniation; MRI.*

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I. Introduction

The body of mankind consists of many systems and organs that are so essential to it is life for servicing diverse functionalities, from delivering signals, to control pressure or even helping the body to carry weight. One of the curtail part of the body is the vertebral column which is plays major roles such as: protecting nerves along with spinal cord, and moreover carrying the body's weight. The total vertebrae of the vertebral column are divided to 7 cervical vertebrae, 12 thoracic vertebrae, lumbar vertebrae, 5 sacral vertebrae that fused after adolescence to formulate 3 to 5 fused coccygeal and are all differ in flexibility and tasks as well with their relative intervertebral discs[1]. This curtail part could be stroke by many pathologies that deteriorate it is function and or induce morphological deformity for instance: trauma, cancer (primary/secondaries), osteoporosis, kyphosis, lordosis, scoliosis and disc herniation. Many authors have considerable contribution in caring about these pathologies and their relative dysfunctionality[2-5].

Rather than the common diagnostic facilities utilized to assess and diagnose the above pathologies of vertebral column; the anatomical morphometry such as measurements in sagittal plane could reveal the pathological conditions of cervical lordosis, thoracic kyphosis, and lumbar lordosis[6-8]. However, some pathologies such as intervertebral disc herniation (IVDH) or as called a slipped plate prolapse which imply crack of the annulus fibrosis and leading to projection of the elastic core pulpous through the annulus; could induce vertebral column deformities, spinal cord compression or unbearable torment[9]. Such IVDH could be assessed successfully by morphometry. Morphometric study commonly recon on the successful and obvious obtained medical image (conventional radiographs, CT image, MRI and ultrasound). One impressive imaging modalities is the (MRI) that doesn't include ionizing radiation and is a choice for plain imaging of spine. Besides that, it is acted in the recumbent position; thus, the point estimations are thought little of contrasted with standing x-beams, because of the impacts of gravity. A few investigations have inspected the relationship in spinal arrangement between standing plain x-ray beams and prostrate MR images[10-12].

Lumbosacral point (LS) or Sacro vertebral point is clinically a significant radiographic boundary identified with the lordotic bend and is important in the administration of patients with low back issues. Its development is identified with advancement of bipedal step and erect stance. It's characterized as a point between the body of the fifth lumbar vertebra and the base of the sacrum[13]. John R. Cobb strategy was one of the primary techniques for the assessment of sagittal spinal bend. The utilization of vertebral endplate lines to develop points on sagittal radiographs is regularly named the changed Cobb technique14, and was utilized to assess cervical lordosis[15], thoracic kyphosis and lumbar lordosis[16], and to perform segmental angulations investigation[17]. A Cobb point in the scope of 10 to 20 degrees is considered as gentle scoliosis. Scoliosis seriousness is moderate when the Cobb point goes from 20 to 40 degree and when it reaches or exceeding 40 degrees, it indicates extreme scoliosis. The indexed Cobb's angle range was introduced by Tássia et al,[18] in which they showed that: the children range was (28.7°- 37.9°), (34.5^{o} - 44.8 ^{o}), (41.7o -54.1^{o}) for thoracic, Lumbar (L1-L5), and Lumbar (L1-S1) respectively. And for adolescents as (31.5o -39.2^{o}), (39.8^{o} -45.6^{o}), (51.9o -59.1^{o}) for thoracic, Lumbar (L1-L5), and Lumbar (L1-S1) respectively. And for adults as (33.7^{o} - 40.3^{o}), (**38.1^{o} -45.6^{o}**), (**54.2^{o} -61.7^{o}**) for thoracic, Lumbar (L1-L5), and Lumbar (L1-S1) respectively. And for the elderly: thoracic (37.7 ^{o} - 50.4^{o}), and lumbar L1- S1 (56.6^{o}- 65.9^{o}).

Published morphometric study showed that: lumbar plate herniation is generally having a limited correlation with aging[19], and this finding is also a mirror spread of degenerative changes[20] which start prior at the lower lumbar levels[21]. The vertebral spine presents provincial bends on sagittal plane, intended to ingest sway, diminish its longitudinal firmness, and strengthen strong capacity; by and by, it has been noticed that a few instances of low back agony and sciatica are owing to anomalous changes of the bend[22]. Lee et al,[11] exhibited that dumped spine MRI could dependably be converted into identical radiographic measures with a worthy scope of blunder in juvenile idiopathic scoliosis. Wang et al,[12] found that recumbent MRI was a substantial option in contrast to standing X-ray beams for estimating upper thoracic kyphosis in the sagittal plane. Hence, the trend of this study is to measure the Lumbosacral Angle and Cobb point in MRI for Patients with Intervertebral Disk Herniation relative to ageing, gender, Body Mass Index (BMI) and to determine the common site of IVDH.

II. Material and Methods

This is a retrospective and minimally practical study implemented on lumbar and sacral vertebrae MRI images targeting Intervertebral Disc Herniation taken at BAD Center and BMC hospitals –Khartoum – Sudan during the period from November 2014 to November 2015.

Sample size: 100 Subjects were complaining of low back pain, men and women, with ages ranging from 18 to 90 years old (45 males and 55 females) all had MRI examination for spine, all sagittal views for spine were taken disc herniation at different levels with various severity.

Study design: A retrospective study dependent on picture archiving communication system (PACs) and minimally practical study as measurement procedure to determine lumbosacral and Cobb's angles.

Exclusion criteria: The traumatic cases or any disease rather than disc herniation were excluded.

Equipment: The machine type Siemens, symphony, mastro class 1.5 Tesla and Philips & Superstar Neusoft medical system 0.35 Tesla were used in this study.

Procedure methodology: The lumbar spine was examined with the use of a **1.5 Tesla** scanner, T1 and T2 weighted images in the sagittal plane (T1 se-sag 03:28.TR 400, TE 16.0 ms. T2 Tse-sag 02:54.TR 4000, TE 118.0 ms -T1 Tirm-sag 03:09), 0.35 **Tesla** scanners (T1 Tse sag. TR 484.8, TE 11.0 ms. T2 Tse sag. TR 3752.8, TE 144.0 ms). Slice thickness was 5.5 mm. The field of view (FOV) used was 340 × 340 ml, which readily contained the lumbar spine with the last thoracic vertebra and a part of the sacrum. Measurements were taken from sagittal T2, herniated discs, lumbosacral angle and Cobb angle; Cobb angle was taken from inferior end plat of L5 to S1, and superior endplate of L1 to superior end plate of S1 respectively (Fig. 1) as applied in the obtained MRI image for the current study in Figure (2). Also, the age, gender, and body mass index for each patient have been considered.

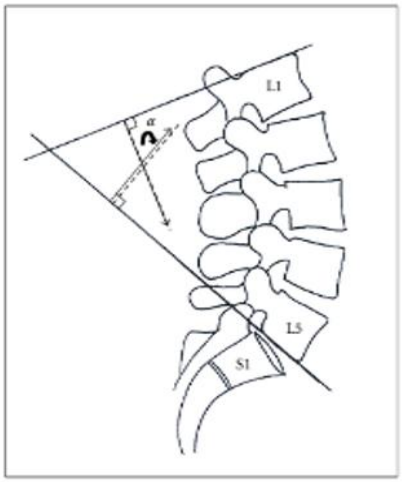

Figure 1: Measurement of lumbar lordotic angle α. Using Cobb's method, tangent lines are drawn along the superior end pated of L1 and S1. Perpendiculars to each of the lines are added to form α angle[23].

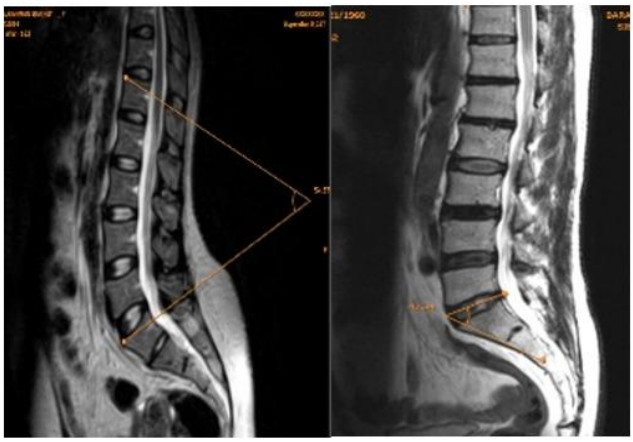

Figure 2: Measurement of lumbar lordotic angle Using Cobb's method of L1 and S1 and measurement LSA from a sagittal MRI T2 W images, the yellow lines showing the anatomical landmarks from which the angle has been derived based on John R. Cobb's technique [imaged by researchers]

Lumbar lordotic angle was measured using Cobb's angle method and applied in image (Fig. 2) T2-weighted mid-sagittal MRI images started from L1 and S1 vertebral bodies, where lines were drawn along their superior end plates, to extend past the vertebral body. Perpendiculars were then added, LSA lines were drawn along their inferior end plates of L5 to S1, the data were analyzed using Statistical comparing of two sets of comparing means were performed by ANOVA test. A p-value of less than 0.05 was considered to indicate a statistically significant difference.

Statistical analysis:

Sampling of the patients of IVDH have been categorized based on gender, age, stroke vertebra and body mass index then SPSS-16 has been used to analyze the data and the mean with standard deviation, t-test and ANOVA test were used to deduced the significance of relationship between the variables of interest.

III. Result

These results presenting morphometric statistical information of LS and Cobb angles related to Patients with Intervertebral Disc Herniation. The independent variables as gender, age, stroke vertebra and body mass index have been utilized for relationship.

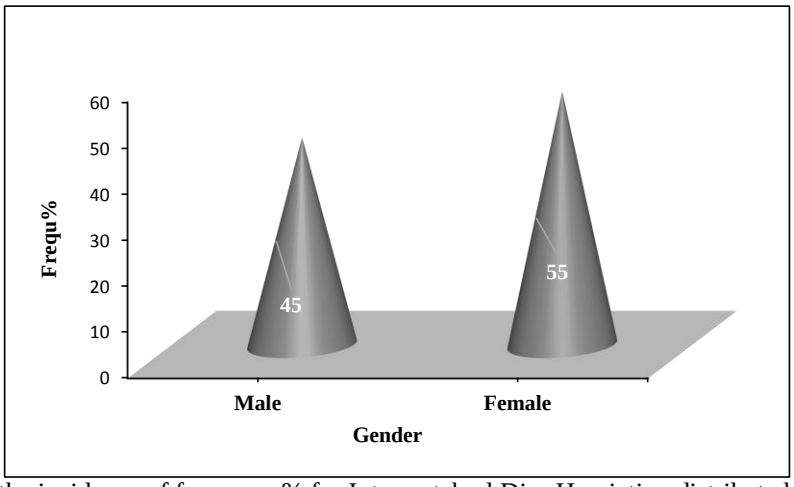

Figure 3: shows the incidence of frequency% for Intervertebral Disc Herniation distributed based on gender

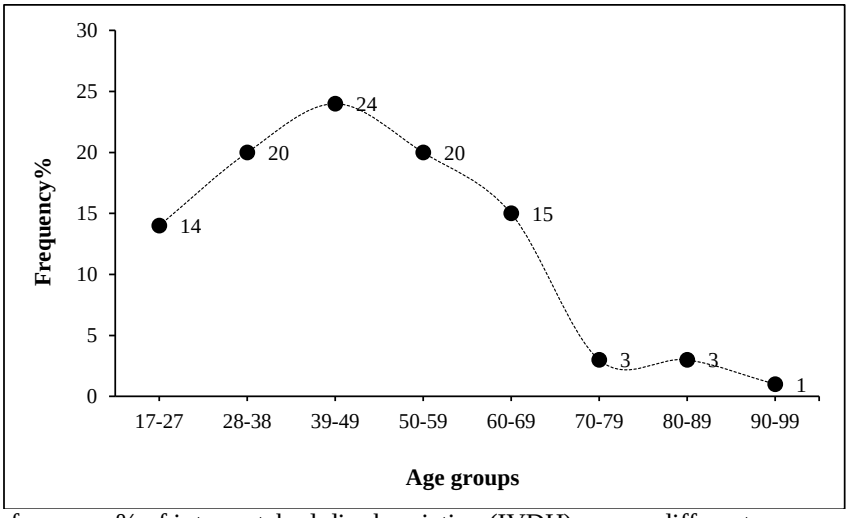

Fig. 4: shows the frequency% of intervertebral disc herniation (IVDH) among different age groups in years

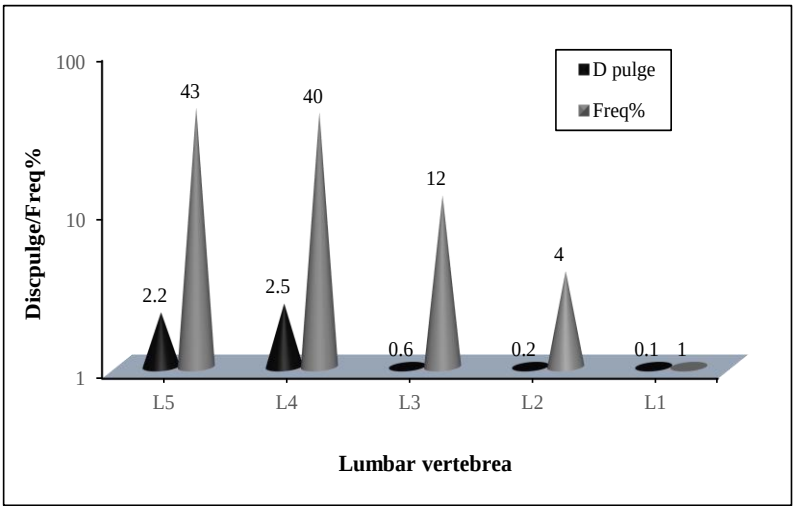

Figure 5: shows the frequency% of lumbar vertebrae (L1 – L5) stroke by IVDH and the relative disk bulging in mm

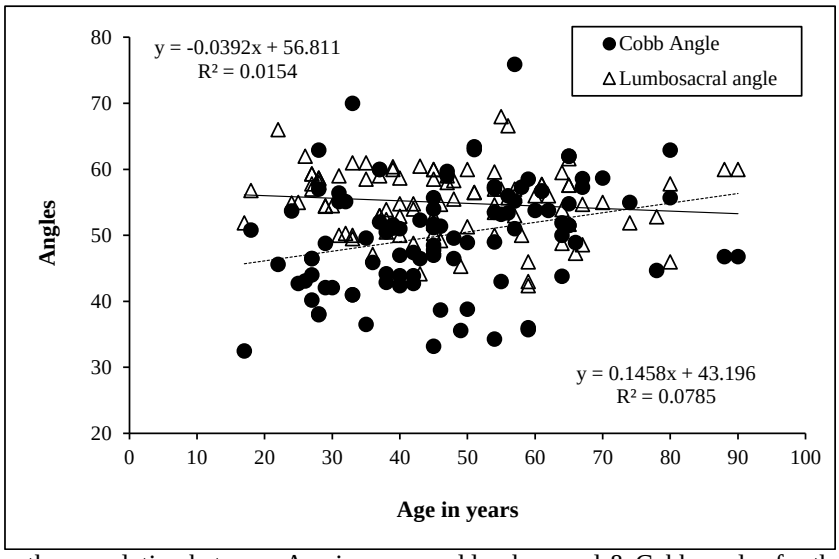

Figure 6: shows the correlation between Age in years and lumbosacral & Cobb angles for the patients with IVDH (The mean of LS angle increases as the age increase, while Cobb angle decreases slightly following ageing)

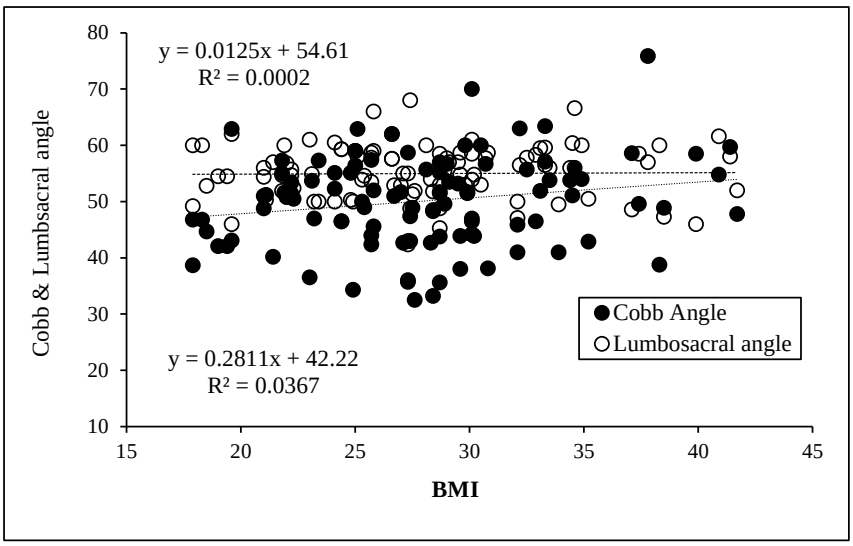

Figure 7: shows the scattered plot shows the correlation between BMI and the angles of Cobb and lumbosacral.

IV. Discussion

The intervertebral disc herniation (IVDH), has been observed among both genders, but the female showing significant stroke by IVDH where ANOVA test revealed that: p-value = 0.05. and the incidence was 55% compared with male 45% (Fig. 3). The IVDH seen in the age group of 17 years old, and it is incidence increases rapidly with ageing and peaking at age groups 39-49, with a mean age of 47.2±16.1 (male) and 47.2±15.3 (female) (Fig. 4). Such prominent incidence among female could be ascribed to the nature of daily-life activities of those living in rural areas. As has been observed that; villages' women working in farms, fetching the woods for building and fair, carrying and lifting luggage to and from market.

In comparison with this finding, Skaf et al,[23] showed similar results in which they found the disc herniation stroke L1-2, L2-3 and L3-4 with an increasing phenomenon following ageing but was so contradicted where they presented the highest frequency at the sixth decade of life. This contradiction of age groups being stroke by IVDH could be justified based on the community life style, activity, occupations, type of food and nutrient. The study also, studied the Cobb angle in patients with IVDH in view of it is distribution based on the different lumbar vertebrae (L1, L2, L3, L4 and L5), with relevant disc bulging in mm (Fig. 5). It revealed that: the common involved lumbar vertebrae with disc herniation were L5 (43%) and L4 (40%) with respective disc bulging as 2.2 mm and 2.5 mm; while L3 showed less frequency as (12%) and L2 and L1 were very rare to be stroke by disc herniation. The high incidence of IVDH at L5 and L4 could be ascribed to factors related to genesis of it and these changes could be attributed to trunk muscles imbalance, hypolordosis, intervertebral

stress distribution, and facet tropism. It is commonly accepted that trunk musculature and intra-abdominal pressure produced by muscular activity stabilize spinal structures[23]. Other study ascertaining such facts was conducted by Murray et al,[24] in which they found significant quadratic (curvilinear) correlations between Cobb angle values and Azari-Le Grande Degenerative Index scores in all groups except for younger men. Correlations were stronger for women below the age of 40 ($p = 0.042$), and women aged 40 and over ($p = 0.001$) compared to corresponding groups of men ($p > 0.05$ and $p = 0.036$ respectively). The IVDH proved to have some correlation and impact in the lumbosacral and Cobb angles; while the ageing and BMI have impact in these angles as stated by Tássia et al,[18], these facts could enhance the utilization of lumbosacral and Cobb angles morphometry in estimation and assessment of pathological evidences. In such context; the correlation between age in years versus lumbosacral & Cobb angles for the patients with IVDH has been plotted in this study. It revealed that: there was highly significant impact of ageing in LS angle (P-value = 0.00), while it had less impact in Cobb angle i.e., insignificant (P-value = 0.07) based on the selected t-test value ≤ 0.05 and in general; the mean of LS angle (50 ± 5^{o}) increases as the age increases, while the mean Cobb angle (50.1 ± 8.2^{o}) decreases slightly following ageing (Fig. 6). Such result is agreed with the study done by Tássia et al,[18]; and the observed consequences of aging impact in the LS & Cobb angles implied sever kyphosis/lordosis, pain while standing or movement, and limping and furtherly as influencing the normal position of fetal in the womb. In such context, Skaf et al,[23] showed that the Lumbar Lordotic Angle (LLA) as measured by Cobb's method has significantly correlated with age ($P = 0.0001$) and showed a tendency to decrease from the third decade onwards, to become relatively constant after the sixth decade, which is seemed to be agreed with the current result.

The standard normal LS and Cobb angles have been indexed by Tássia et al,[18]; which were equal to 60.9^{o} and 83.1^{o} in average respectively, hence the applied t-test relative to these indexed values and the factors of ageing and BMI showed significant differences (P-value = 0.03) indicating that: the disc herniation has significantly increasing these angles. Therefore, the researchers recommend that avoiding lifting of heavy weight, following the good technique in lifting luggage, avoiding overweight and obesity are of most important factors for prevention of IVDH. The other studied parameter relative LS and Cobb angles was the BMI (Fig. 7), which showed that: as the BMI increases as there were slightly increment in both LS and Cobb angles; however, t-test proved that: the impact of MBI was so highly significant (P-value = 0.001) in both LS and Cobb angles. Such fact could be ascribed to the excessive degeneration of the IVD by overload of overweight and obesity of individuals patients. The impact of overweight and obesity in IVD has been ascertained by Dino et al,[25]. The overweight and obesity have been reported as risk factors for IVDH and severity of dis bulging also, has great relationship with overweight and obesity.

IV. Conclusion

The study proved that IVDH is a common disease among the age group of 28 – 60 years old striking selectively L4 and L5 and leading to symptomatic disc bulging. And also, the LS and Cobb angles were associated significantly with gender, ageing, overweight and obesity which were proved to be some risk factors for IVDH; hence these angles could be utilized successfully even from plain radiograph together with patient's complain to diagnose and predict the IVDH.

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