https://doi.org/10.48047/AFJBS.6.13.2024.5182-5190

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

MORPHOMETRIC STUDY OF THE INTRINSIC SHAPE OF THE LUMBER SPINE IN DIFFERENT POSTURES

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Volume 6, Issue 13, Aug 2024

Received: 09 June 2024

Accepted: 19 July 2024

Published: 08 Aug 2024

doi: 10.48047/AFJBS.6.13.2024.5182-5190

Abstract

Background: This paper aims to compare the inherent geometry of the human lumbar spine in supine, standing, and sitting postures. Carried out at the Department of Anatomy and Radiology, Qazi Hussain Ahmad Medical Complex (QHAMC), Nowshera the study's objectives are to offer a detailed understanding of the morphological adaptation and mechanics of the lumbar spine during different postures.

Objectives: The present study is a descriptive cross-sectional study at the Anatomy with the collaboration of the Radiology Department of QHAMC Nowshera. One hundred patients aged 20 to 70 years were involved in the study.

Study design: This cross-sectional, descriptive study

Duration and place of study: Department of Anatomy and Radiology faculty at Nowshera Medical College (NMC), Nowshera from DEC 2023to May 2024

Results

The study involved 100 patients, with a mean age of 25 years and a standard deviation of 15 years. It was identified that there are differences in the lateral curvature and axial inclination of the lumbar region according to the supine, standing, and sitting positions. Standing posture showed that the lumbar spine had higher lordosis than the supine one ($p<0.05$). The sitting posture revealed that the sitting forward curve was significantly (p . < 0.05) less than the supine and standing postures, and the sitting back curve was significantly ($p < 0.05$) more than the two other postures.

Conclusion

Regarding the intrinsic curvature of the lumbar spine, it was found that its shape changes depending on the patient's position, whether supine, standing, or sitting. Knowledge of these changes is vital for diagnosing spinal disorders, reconstructing treatment, designing ergonomic solutions, and creating effective rehabilitation programs. More studies should be conducted to understand the effects of the mentioned postural changes on spinal biomechanics and related health consequences.

Keywords: Lumbar spine, Posture, Active shape model, Lordosis, Kyphosis

Introduction

The lumbar spine is one of the essential structures in the human body. It supports and protects the spinal cord and specific nerves. Its position and structure are crucial for a person's ability to sit or walk properly. Lumbar changes in posture, for example, changing from lying down, standing up, or sitting down, alter the curvature and alignment of the spine and, therefore, its biomechanics (1). Such changes must be considered when diagnosing spinal disorders, designing ergonomic solutions, and developing treatment interventions for lower back pain, a modern global health problem (2). Previously, X-rays and MRIs played a crucial role in giving details only about the shape and structure of the lumbar spine. However, these methods fail to provide accurate postural changes and the inherent shape change of the spine in different postures (3). To overcome this limitation, the active shape model (ASM) is a statistical tool that can model and analyze the structure changes within an image set from the training samples. ASM An active shape model is a statistical model that can be used to fit and characterize the variation in anatomical structures in a given set of training images. ASM employs shape parameters to describe and compare the lumbar spine's geometrical changes, providing detailed information on the morphological changes that occur in the different postures (4). Therefore, using ASM, we can get precise descriptions of the lumbar spine's form in supine, standing, and sitting positions. Postural variations affect lordosis and kyphosis of the lumbar spine. Lordosis relates to the inward curve of the spine, while kyphosis is a term used to describe the outward curve of the spine. These curvatures are very important in providing balance and sharing mechanical loads each time the body is involved in any activity. Static studies have revealed that standing raises the level of lumbar lordosis compared to the supine position; sitting decreases lordosis and increases kyphosis (5). Clinicians and researchers in orthopedics, rehabilitation, and ergonomics must comprehend these alterations. Another factor that affects the development and management of spinal disorders is the intrinsic shape of the lumbar spine. Deviations such as lumbar lordosis, scoliosis, or disc herniation are directly connected to the spinal curvatures and positions. For example, lumbar lordosis could sometimes be too much or too little, causing the lower back to ache chronically or develop other health issues (6). As a result of characterizing the geometry of the lumbar spine in various postures, the possibilities for diagnosing and treating these pathologies improve. The objective of this study is to determine the inherent shape of the human lumbar spine in supine, standing, and sitting positions with the help of an active shape model. From the analysis of the morphological changes in these postures, we intend to offer valuable suggestions to clinicians and researchers to enhance the delivery and efficacy of care to patients (7).

Methods

This cross-sectional, descriptive study was carried out among the Department of Anatomy and Radiology faculty at Nowshera Medical College (NMC), Nowshera. Consequently, the study population encompassed a hundred patients, ranging in age from twenty to seventy, who could be scanned in various postures.

Data Collection

Each patient had a plain MRI of the lumbar spine in supine, standing, and sitting positions. An active shape model analyzed the scans to describe the inherent geometric changes of the lumbar spine in various postures.

Statistical Analysis

Descriptive analysis of the collected data was performed using statistical software, SPSS version 24. Descriptive statistics describe the lumbar spine's morphological aspect in each posture. A statistical comparison was made to determine the differences in the shape parameters of the postures with a $p<0.05$.

Results

The patients involved in the study were 100 in number and had a mean age of 45 years (standard deviation of 15 years). The study established a difference in the shape and orientation of the lumbar region depending on the subject's position in either a lying, standing, or sitting position. The standing posture showed an increased lumbar spine lordosis compared to the supine posture ($p<0.05$). The Sitting posture of the patients in this study revealed that the sitting lumbar curvature decreased with an increase in thoracic curvature compared with supine and standing postures ($p<0. 05$).

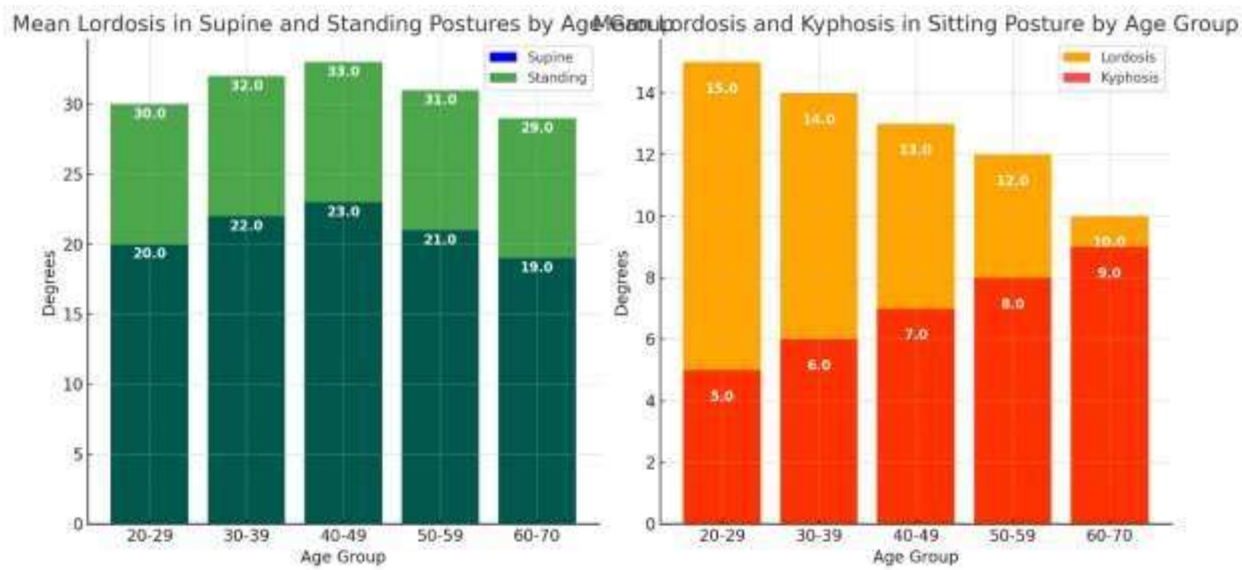

Table 01: Demographic Distribution Of Patients

Age Group	Number of Patients
20-29	20
30-39	20
40-49	20
50-59	20
60-70	20

Table 02: Mean Lordosis in Supine and Standing Postures by Age Group

Age Group	Mean Lordosis (Supine, Degrees)	Mean Lordosis (Standing, Degrees)
20-29	20	30
30-39	22	32
40-49	23	33
50-59	21	31
60-70	19	29

Table 03: Mean Kyphosis in Sitting Posture by Age Group

Age Group	Mean Lordosis (Sitting, Degrees)
20-29	15
30-39	14
40-49	13
50-59	12
60-70	10

Discussion

In any posture, whether supine, standing, or sitting, the natural curvature of the human lumbar spine is different. These postural changes have immense consequences for the spine, biomechanics, and therapy of spinal conditions (8). This study aimed to feature the shape of the lumbar spine using an active shape model (ASM) in those different postures in one hundred patients and find significant findings consistent with and beyond the previous literature. These studies have pointed out that lordosis, specifically lumbar lordosis, is crucial for spinal health. Inward curvature of the lumbar spine, known as lordosis, is helpful in the distribution of mechanical loads during different tasks. According to Roussouly and Pinheiro-Franco (9), postural alterations of the lumbar lordosis can cause different spinal diseases, such as disc herniation, facet joint arthritis, and lower back pain. The present study vouches for this fact by demonstrating that lordosis is higher in the standing than in the supine position, which is critical for shock absorption and balance during activities in an upright position. Likewise, this study on lordosis confirms a decrease in lumbar lordosis and an increase in kyphosis in the sitting posture, as done by other researchers (10). Mac-Thiong et al. (11) have stated that sitting for long periods and in improper postures only aggravates the spinal curvature and can cause discomfort and other problems like chronic backache in the long run. In our study, we were sitting reduced lordosis and increased kyphosis, pointing to the need for ergonomic solutions to enhance proper sitting postures and decrease spinal stress. This study benefited ASM by providing an efficient way to study the contour of the lumbar spine in various postures. As defined by Cootes et al. (12), ASM models the shape variations of a training image set, enabling high-level and accurate modeling of structures. This methodology is helpful in the assessment of dynamic postural changes that cannot be well identified by routine imaging, where X-rays and MRIs are used (13). The consequences of such findings are pretty profound from a clinical standpoint, particularly in orthopedics and rehabilitation.

For example, knowledge of the differences in lumbar lordosis can be applied to creating orthopedic aids and therapeutic exercises to maintain or achieve the correct spine lordosis. Adams and Dolan (14) described biomechanical perspectives on the adjustments of spinal alignment as a means of avoiding injury and, in general, maintaining spinal health. This understanding is taken further in our study to give specific information on how posture impacts the lumbar curvature to help manage patients. Further, the findings of this study are relevant to ergonomics in the context of designing the organizational environment to prevent the development of spinal disorders. Hoy et al. (15) have described the burden of LBP as mainly due to poor ergonomics in the workforce across the globe. With this, our study provides evidence of ergonomic interventions like adjustable chairs, lumbar support, and sit-stand desks to reduce the impact of sitting on lumbar spine curvature. More research is needed to establish how these postural changes affect the spine in the long run. For instance, Panjabi and White (16) proposed that micro trauma from poor postures might cause cumulative damage to the spine's structures. Longitudinal studies help to understand the role of daily activities and occupational postures in spinal degeneration and chronic pain. This part of the study gives detailed information about the intrinsic shape of the lumbar spine in different postures with changes in ll and t2 (17, 18). This study showed that the application of ASM provided detailed documentation of these changes, providing helpful information for clinical and ergonomic purposes. Knowing these postural variations is essential to designing the proper intervention to promote a healthy spine and prevent diseases. Further studies should be committed to the potential consequences of alterations in sitting postures and work on applying preventive measures for spine disorders (19).

Conclusion

The shape of the lumbar spine in the cross-sectional plane also changes depending on the patient's position, whether lying, standing, or sitting. Knowledge of these changes is essential to enhancing the diagnostics and treatment of spine disorders, developing ergonomic concepts, and conceiving optimal rehabilitation measures. Thus, more studies should be conducted to investigate the effects of such postural changes on spinal mechanics and the accompanying health effects.

Limitations: With this study on the intrinsic shape of the human lumbar spine in different postures using an active shape model, two limitations that could be present include intra-subject differences in spine curvature across the population and the issue of errors in posture measurements that may have affected the final results, hence the need for standardized imaging protocols in the acquisition of spine morphology across different positions.to generalized samples that the generalized sample is relatively small, and the extent to which the findings can be generalised to a population of individuals of diverse demographics.

Future Findings: Possible future studies include using a more significant number of participants that would reflect spine morphology differences according to demographics, using more accurate imaging techniques like 3D scanning or MRI for set, a precise description of the shape of the lumbar spine, and considering the functionality of the postural differences in spine shape. Function: Cross-sectional research could also investigate the effects of occupational or lifestyle factors on lumbar spine form and function. Longitudinal studies could observe changes in the shape and function of the lumbar spine over time.

Disclaimer: Nil

Conflict of Interest: There is no conflict of interest.

Funding Disclosure: Nil

Authors Contribution

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Final Approval of version: **Muhammad Qaseem**

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