ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 11, Issue, 08, pp.6260-6262, August, 2019

DOI: https://doi.org/10.24941/ijcr.36318.08.2019

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

ANALYSIS OF THE INFLUENCE OF POSITION ON THE LOADINGS OF THE LUMBAR SPINE

***Shujie Tang**

School of Chinese Medicine, Jinan University, Guangzhou city, Guangdong province, 510632, China

ARTICLE INFO

Article History:
Received 28th May, 2019
Received in revised form
24th June, 2019
Accepted 19th July, 2019
Published online 31st August, 2019

Key Words:
Loadings, Position,
the Lumbar Spine,
Compression Force,
Shear Force.

**Corresponding author:*
Shujie Tang

ABSTRACT

Objective: To evaluate the influence of position on lumbar loadings. **Methods:** Ten healthy participants were recruited for the study. A motion analysis system was used to collect kinematic data, a force platform measured ground reaction force, and spherical reflective markers were attached into the upper, low extremities and trunk of each participant during lumbar flexion, extension, left bending and left axial rotation. The marker's data and ground reaction force data were input to Open Sim and the compression and shear force in each segment of the lumbar spine was calculated. **Results:** In each position, the compression force and shear force from L1-L2, L2-L3, L3-L4 to L4-L5 increased gradually, but compared with L4-5 segment, the values in L5-S1 segment were decreased. In each segment, there were significant differences in compression and shear forces among flexion, extension, left lateral bending and left axial rotation ($p<0.05$). The compression forces presented with the largest values in flexion, followed by lateral bending, extension, and left axial rotation, and the shear force presented with the largest value in flexion, followed by left axial rotation, extension and left lateral bending. **Conclusion:** In the lumbar spine L4-5 and L5-S1 segment support more loadings than other segments, especially during flexion and axial rotation.

***Citation: Shujie Tang,* 2019.** "Analysis of the influence of position on the loadings of the lumbar spine", *International Journal of Current Research*, 11, (08), 6260-6262.

INTRODUCTION

Low back pain is one of the most common causes of absenteeism and disability in industrialized societies (Tang, 2016), which exerts a large burden on the health care system, so its treatment has been paid high attention to in the world. Most of low back pain result from lumbar inter vertebral disc degeneration, in which many factors may affect the progress of degeneration, but biomechanical factor plays an important role (Tang, 2011). Some studies demonstrated that increased intra discal pressures in the nucleus pulpous and shear stresses in the annulus fibrosus as well as mobility of lumbar segment may accelerate catabolism, increase apoptotic cells and cell death, lead to proteoglycan degradation and increased matrixmetalloproteinase-3 production in the intervertebral disc and cartilage end plate, resulting in accelerated disc degeneration ultimately (Tang, 2011). In another words, the increased loadings in the lumbar spine may adversely affect the lumbar intervertebral disc degeneration. However, how does the position of the lumbar spine influence its loadings? Based on the finite element or conventional experimental studies, many authors ever analyzed the issues, but few elucidated in flexion, extension, lateral bending and axial rotation, which position lead to the highest loading on the lumbar spine. In addition, the abovementioned studies didn't consider the biomechanical effect of muscles around the lumbar spine. As a result, the conclusions of these studies may be different from the real conditions of the lumbar spine.

OpenSim is a freely available, open-source musculoskeletal modeling software that allow susers to develop and analyzed ynamic simulations of human movement (Raabe, 2016). Many studies related to human lumbar spine has been carried out using Opensim (Beaucage-Gauvreau, 2019; Raabe, 2018; Kim, 2017). In addition, simulation of the muscles surrounding the lumbar spine is also conducted in Opensim. Subsequently, the outcomes obtained from this software may be more close to the real biomechanics of the human lumbar spine. Therefore, in the current study we evaluated the influence of position on the loadings of the lumbar spine using Open sim software, and we believe this study may help spine surgeons analyze the injury mechanism of human lumbar spine and prevent the occurrence of low back pain correctly.

MATERIALS AND METHODS

Ten healthy participants including six males and four females were recruited for the current study. Participants who had a history of low back pain were excluded. All participants signed an informed consent form, and the study was approved by the Ethics Committee of University of Jinan. A motion analysis system was used to collect kinematic data during lumbar flexion, extension, left bending and left axial rotation, anda force platform was employed to measure ground reaction force. 54 spherical reflective markers were attached into the upper, low extremities and trunk of each participant.

Table 1. The compression force in each segment of the lumbar spine

	Compressionforce (N)				
	L1-L2	L2-L3	L3-L4	L4-L5	L5-S1
Flexion	3704(653)	3928(668)	4180(691)	4479(712)	4350(702)
Extension	2201(231)	2489(253)	2538(267)	2853(381)	2699(362)
Left lateral bending	2891(198)	2995(201)	3217(278)	3569(296)	3417(301)
Left axial rotation	1345(76)	1486(98)	1502(110)	1689(129)	1638(118)

Table 2. The shear force in each segment of the lumbar spine

	Shear force(N)				
	L1-L2	L2-L3	L3-L4	L4-L5	L5-S1
Flexion	197(64)	236(67)	258(71)	302(81)	289(79)
Extension	186(42)	221(48)	229(51)	283(62)	266(59)
Left lateral bending	167(34)	183(39)	205(43)	278(61)	245(56)
Left axial rotation	191(35)	209(43)	257(46)	285(57)	271(54)

The marker's data and ground reaction force data were input to OpenSim, then a subject-specific model was created by scaling the musculoskeletal model according to the size of body segments of a subject. After scaling, inverse kinematics and dynamics were carried out to calculate the joint angles and moments at each joint of the lumbar spine. Lumbar spinal loading including compression force and shear force in each segment of the lumbar spine was calculated by solving the dynamics equations based on the muscle forces, gravity and joint moment.

The statistics was performed using SPSS 22.0 software. Analysis of variance (ANOVA) was carried out to compare the difference of the compression force and shear force between different lumbar segments, as well as different subjects. A p value less than 0.05 was regarded as significant difference.

RESULTS

The compression and shear force in each segment of the lumbar spine show in Table 1and 2. In terms of the flexion, the compression force and shear force from L1-L2, L2-L3, L3-L4 to L4-L5 increased gradually, but compared with L4-5 segment, the values in L5-S1 segment were decreased. The values of compression and shear forces in extension, left lateral bending, and left axial rotation presented with the similar trend. In the lumbar segments, L4-5 presented with the largest value, followed by L5-S1, L3-L4, L2-L3, and L1-L2 in compression or shear force. In addition, there were significant differences in compression and shear forces in each segment among flexion, extension, left lateral bending and left axial rotation ($p<0.05$). The compression forces presented with the largest values in flexion, followed by lateral bending, extension, and left axial rotation, and the shear force presented with the largest value in flexion, followed by left axial rotation, extension and left lateral bending.

DISCUSSION

We found in this study the values of compression and shear forces in extension, left lateral bending, and left axial rotation presented with a similar trend, and L4-5 presented with the largest value, followed by L5-S1, L3-L4, L2-L3, and L1-L2 in compression or shear force. The outcome can be used to explain the clinical phenomenon, in clinics most of the low back pain, such as lumbar disc herniation, occurred in L4-5 or L5-S1 segment (Kim et al., 2019; Mu et al., 2019), because these two segments support more compression and shear forces, which accelerate the degeneration of the lumbar intervertebral disc, and lead to a series of low back pain. Moreover, in this study we found there were significant differences in compression and shear forces in each segment among flexion, extension, left lateral bending and left axial rotation. The compression forces presented with the largest values in flexion, followed by lateral bending, extension, and left axial rotation, and the shear force presented with the largest value in flexion, followed by left axial rotation, extension and left lateral bending. The outcome elucidated that the two positions, flexion and axial rotation, presented with the largest compression and shear forces during the movement of human lumbar spine. Subsequently, we can conclude that people who often perform the two positions may be liable to suffering low back pain. In short, we conclude that L4-5 and L5-S1 segment support more compression and shear forces than other segments, especially during the movement of flexion and axial rotation. However, the current study has its limitation. We only studied the position of flexion, extension, lateral bending and axial rotation, but in fact in many cases the movement of human lumbar spine are complicated, for a instance, many movements are the combination of flexion, extension, lateral bending and axial rotation, but we didn't study these combined movements in the current study. Hence, more study should be carried out in the future.

Acknowledgement

This study was supported by Science and Technology Projects of Guangdong Province, China (No. 2017A020215102）and Medical scientific research foundation of Guangdong Province, China (No.A2016036).

REFERENCES

Beaucage-Gauvreau E., Robertson WSP., Brandon SCE., Fraser R., Freeman BJC., Graham RB., Thewlis D., Jones CF., 2019. Validation of an OpenSim full-body model with detailed lumbar spine for estimating lower lumbar spine loads during symmetric and asymmetric lifting tasks. Computer methods in biomechanics and biomedical engineering., 22:451-464.

Kim H., Jung HJ., Kim M., Koh SE., Lee IS. 2019. Does Adequate Lumbar Segmental Motion Reflect Recovery

Process in Acute Lumbar Disc Herniation? *Annals of rehabilitation medicine., M43*:38-44.

Kim HK, Zhang Y. Estimation of lumbar spinal loading and trunk muscle forces during asymmetric lifting tasks: application of whole-body musculoskeletal modelling in OpenSim. Ergonomics 2017;60:563-576.

Mu W, Shang Y, Zhang C, Tang S. 2019. Analysis of the depression and anxiety status and related risk factors in patients with lumbar disc herniation. *Pakistan journal of medical sciences.,* 35:658-662.

Raabe ME, Chaudhari AMW. 2018. Biomechanical consequences of running with deep core muscle weakness. *Journal of biomechanics.,* 67:98-105.

Raabe ME., Chaudhari AMW. 2016. An investigation of jogging biomechanics using the full-body lumbar spine model: Model development and validation. *Journal of biomechanics.,* 49:1238-1243.

Tang S., Qian X., Zhang Y., Liu Y. 2016. Treating low back pain resulted from lumbar degenerative instability using Chinese Tuina combined with core stability exercises: A randomized controlled trial. *Complementary therapies in medicine.,* 25:45-50.

Tang S., Rebholz BJ. 2011. Does anterior lumbar interbody fusion promote adjacent degeneration in degenerative disc disease? A finite element study. *Journal of orthopaedic science: official journal of the Japanese Orthopaedic Association.,* 16:221-228.

****