Lumbar Kinematic Analysis of Lateral Bending

University of Minnesota
Usculoskeletal Biomechanics Research Laboratory

Jessica Swanson, Virginia Schwanke, Arin Ellingson, David Nuckley

College of Science & Engineering
University of Minnesota

Introduction

80% of the world's adult population will be affected by low back pain (LBP) in their lifetime[1]. Acute LBP is labeled as an episode of pain in the lower back lasting for at least twenty four hours[2]. Despite its prevalence and technological advancements, LBP is still difficult to diagnose because the cause of restricted movement is not well understood.

In our experiment, we are focusing on the kinematic movements of individuals without low back pain as they specifically perform a lateral bending exercise, in order to analyze the kinematics of a simple every day exercise.

Figure 1: Pictorial representation of lumbar spine LBP[3].

Hypotheses

1. In individuals without low back pain, their lumbar spine range of motion will be symmetrical for left and right lateral bending.
2. In individuals without low back pain, males will display a greater lumbar spine range of motion than females.

Methods

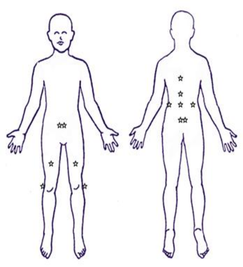

Figure 2: Representation of 13 anatomical markers placed on each participant to gather data points.

Vicon 3-D Imaging

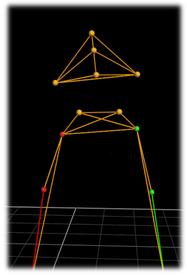

Figure 3: Example of digitalized participant when using Vicon imaging system.

23 volunteers (11 males, 12 females) assisted in this experiment. Each participant had 13 3-D reflective markers placed on anatomical landmarks shown in **Figure 2** to create rigid bodies representing the torso and pelvic girdle. Participants performed seven simple lumbar exercises that were then analyzed by a Vicon MX-F40NIR imaging system (Vicon Motioning Systems, Centennial, CO). Lateral bending data were analyzed via paired-t tests and ANOVA with an alpha acceptance of <0.05.

Results

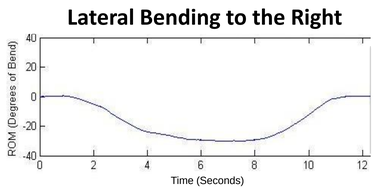

Figure 4: Angle of bend during right lateral bending

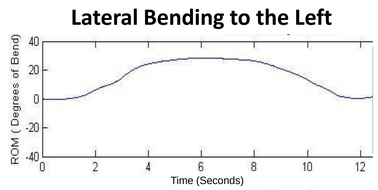

Figure 5: Angle of bend during left lateral bending

Figures 4 & 5 display the smoothed, uninterrupted pattern of the angles created between the trunk and the thigh during the lateral bend to the right and left, respectively.

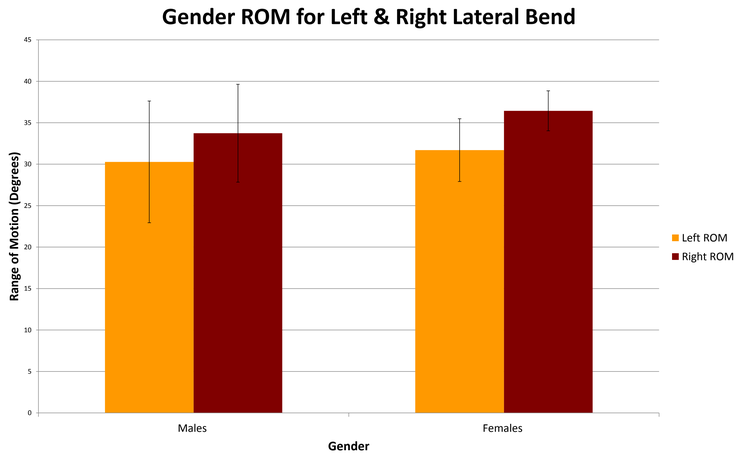

Figure 6: Gender ROM averages for left and right lateral bend. There was no statistical difference between males and females for left or right bending(Left:p=0.09, m_{males} = 33.74±3.79 degrees, $m_{females}$ = 36.44±2.41 degrees, Right: p=0.66, m_{males} = 30.28±7.34 degrees, $m_{females}$ 31.70±5.90 degrees).

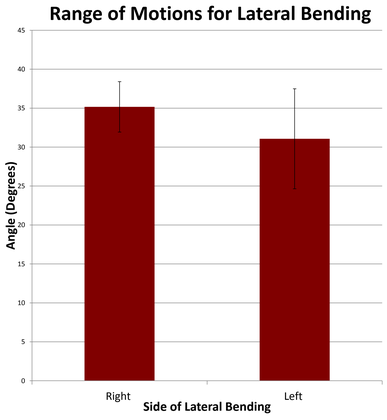

Figure 7: Range of motion for all participants during right and left lateral bending. There was a significantly larger angle made when bending to the right, (p=0.03, **m_R = 35.17±3.24, m_L = 31.07±6.41**).

- There was a significantly larger angle when bending to the right compared to the left (p=0.03)
- Females showed a strong trend toward asymmetry (p=0.07)
- Males displayed greater symmetry than females (p=0.33)
- Left bend: ROM not statistically different between males and females (p=0.66)
- Right bend: Positive trend that females had a greater ROM than males, however not statistically significant (p=0.09)

Discussion

- Since there was a significant difference between the degree of bend to the right and to the left (p=0.03), we conclude that the range of motion is not symmetrical for our subjects, thus rejecting our original hypothesis.
- It was predicted that males would have a greater degree of bend, but this hypothesis was rejected for both the right and left lateral bends, (p_R=0.09, p_L=0.66).
- In future studies, it would be interesting to see if handedness is correlated with greater range of motion for lateral bending.

Broader Impact

In the future, we hope to complete a similar experiment with LBP individuals to pinpoint areas of affected range of motion and possibly smoothness of motion. Comparing these differences could lead to a clearer picture of how LBP affects the kinematics of the lower back. With a greater understanding of the kinematics of the lower back for healthy and pain-afflicted individuals, we hope to ultimately develop a protocol of distinctive movements that could be used when diagnosing LBP.

References

1. Devo, R., & Tsui-Wu, Y. (1987). Descriptive Epidemiology of Low-back Pain and its Related Medical Care in the United States. *SPINE, 12*(3), 264-268. Retrieved October 2012
2. Griffin, D. W., Harmon, D. C., & Kennedy, N. M. (2012). Do patients with chronic low back pain have an altered level and/or pattern of physical activity compared to healthy individuals? A systematic review of the literature. *Physiotherapy*, *98*(1), 13–23. doi:10.1016/j.physio.2011.04.350
3. Photo. *innova-pain.com*. 2010. February 2013. http://www.innova-pain.com/low-back-pain-st-george-ut/

Acknowledgements

I would like to thank the University of Minnesota's Undergraduate Research Opportunities Program (UROP) for funding this research.