Global Spine Journal

Movement Frequency of the Thoracic Spine—Implications for Thoracic Disk Degeneration

D. M. Perriman[1], J. M. Scarvell[2], A. R. Hughes[3], C. J. Lueck[3], T. M. Neeman[4], B. Ashman[5], P. N. Smith[6]

[1]Trauma and Orthopaedic Research Unit, Australian National University
[2]Faculty of Health, University of Canberra, Canberra, Australia
[3]Neurology Department, Canberra Hospital, Canberra, Australia
[4]Statistical Consulting Unit, Australian National University, Canberra, Australia
[5]Department of Orthopaedics
[6]Trauma and Orthopaedic Research Unit, Canberra Hospital, Canberra, Australia

Introduction

While there are many causes which are understood to lead to disk degeneration, loss of nutrition of the disk is the final common pathway[1]. Disk nutrition is fundamentally influenced by dynamic compression frequency[2] which corresponds to the frequency at which the spinal segments move in a normal day. The effect of reduced movement is seen in disks adjacent to fused or immobilized segments which have been reported to degenerate at an increased rate[3]. Finite element modeling has predicted that after 200 cycles of dynamic compression at 0.1 Hz, even disks with impermeable end-plates would have a 33% increase in oxygen concentration in the nucleus, a 22% increase in the annulus fibrosis, and a significant decrease in lactate concentration, especially in the annulus[2]. However, it is not possible to relate these predictions to humans because normal values of spine movement frequency have not previously been reported. In the thoracic spine, disk degeneration has been reported to be strongly associated with hyperkyphosis[4]. Given that disk degeneration is related to reduced movement frequency, it is possible that hyperkyphosis and altered movement frequency are interrelated. The aim of this study was to ascertain how often normal adults move their thoracic spine and whether there is a relationship between movement frequency and the degree of thoracic kyphosis.

Materials and Methods

Total 56 subjects of age 62.4 ± 11.1 years participated in this study. Movement frequency of the mid-thoracic spine was measured with a flexible electrogoniometer in both the sagittal and coronal planes for 6 hours. Outcome measures included the frequency of spinal movement >5 during the whole 6-hour period as well as during walking and driving. The relationship between movement frequency and age, gender, and kyphotic angle in both movement planes was assessed.

Results

Thoracic spine movement frequencies were very low. Sagittal plane frequency was approximately half that in the coronal plane (5.21 ± 0.32 cycles/h vs 10.44 ± 2.88 cycles/hr; walking 6.13 ± 0.58 cycles/hr vs. 15.35 ± 1.13 cycles/h; and driving 2.98 ± 0.41 cycles/hr and 5.58 ± 0.71 cycles/hr). Age was not correlated with movement frequency. Females had higher movement frequencies than males in both planes, but only significantly so in the sagittal plane (5.6 ± 0.4 cycles/h 4.4 ± 0.4 cycles/h, $p = 0.04$). Decreased kyphosis was negatively correlated with 6-hour sagittal frequency (−0.44, $p = 0.0008$) but not with coronal frequency.

Conclusion

This is the first time that the frequency of thoracic spine movement has been reported in man. The results show that thoracic spine movement frequency is very low, especially in males. The highest frequency recorded was 25 times lower than the 0.1 Hz suggested to be beneficial to disk health. Sagittal movement frequency was approximately half that measured in the coronal plane. This finding increases our understanding of spine kinematics and is potentially valuable to thoracic disk implant designers because it reveals the actual ratio of flexion and extension frequency to combined side-flexion/rotation movement frequency. Finally, increased thoracic kyphosis angle, but not age, was found to be correlated with decreased movement frequency. The implication of this finding is that kyphotic posture itself may result in decreased disk nutrition with resultant degenerative disk disease. Further investigation would elucidate this finding.

DOI: 10.1055/s-0032-1319919 ISSN: 2192-5682

I confirm having declared any potential conflict of interest for all authors listed on this abstract
Yes

Disclosure of Interest
None declared

Urban, JP, Smith S, Fairbank JC, Nutrition of the intervertebral disk. Spine (Phila Pa 1976) 2004;29(23):2700–2709

Huang CY, Gu WY. Effects of mechanical compression on metabolism and distribution of oxygen and lactate in intervertebral disk. Journal of Biomechanics 2008;41(6):1184–1196

Stokes IA Iatridis JC. Mechanical conditions that accelerate intervertebral disk degeneration: overload versus immobilization. Spine (Phila Pa 1976) 2004; 29(23):2724–2732

Schneider DL et al. Kyphosis does not equal vertebral fractures: the Rancho Bernardo study. Journal of Rheumatology 2004;31(4): 747–752