Correlation of Lumbar-Hip Kinematics Between Trunk Flexion and Other Functional Tasks

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Abstract

Objective: The purpose of this study was to explore the relationship between the kinematic profiles of flexion of the upper lumbar and lower lumbar (LL) spine and hip and 3 sagittally dominant functional tasks (lifting, stand-to-sit, and sit-to-stand).
Methods: Fifty-three participants were recruited for this study. Four sensors were attached to the skin over the S1, L3, T12, and lateral thigh. Relative angles between adjacent sensors were used to quantify the motion for the hip, LL, and upper lumbar spine. Pearson correlation coefficients were used to explore the relationship between the movements and more functional tasks. One-way analysis of variance was used to determine the significance of differences between the variables.
Results: Flexion resulted in a greater or similar range of motion (ROM) to the other tasks investigated for both spinal regions but less ROM for the hip. Strong correlations for ROM are reported between forward flexion tasks and lifting for the LL spine (r = 0.83) and all regions during stand-to-sit and sit-to-stand (r = 0.70-0.73). No tasks were strongly correlated for velocity (r = 0.03-0.55).
Conclusion: Strong correlations were only evident for the LL spine ROM between lifting and flexion; all other tasks afforded moderate or weak correlations. This study suggests that sagittal tasks use different lumbar-hip kinematics and place different demands on the lumbar spine and hip. (J Manipulative Physiol Ther 2015;38:442-447)
Key Indexing Terms: *Flexion; Lifting; Sitting; Standing; Lumbar; Hip; Correlation; Function; Tasks*

Clinical evaluation of the lumbar-hip complex is commonplace in musculoskeletal therapies such as physical medicine/rehabilitation, chiropractic, osteopathic, and physiotherapy clinics.[1,2] Traditional texts advocate the assessment of motion in the cardinal planes. The evaluation of the behavior of the spine and hip during spinal motions such as flexion/extension is a potential test used to observe lumbar impairments.[3-5] Clinicians use the results of motion tests such as forward flexion to aid in the clinical reasoning process when attempting to determine treatment and rehabilitation options.

Disorders of the lumbar-hip complex have been shown to affect lumbar spine and hip range of motion (ROM) as well as the interaction between these 2 anatomical regions.[5-7] Moreover, disorders of the lumbar-hip complex have a demonstrably significant effect on movement velocity, both at the hip and at the lumbar spine.[8-13] This has been determined for cardinal ROM (lumbar flexion/extension) and in more functional movements such as lifting an object from the floor, a commonly reported daily activity.[11] Moreover, sit-to-stand and stand-to-sit are common activities of daily living, which are reportedly completed approximately 60 times a day in certain working populations.[14] These activities are also known to be affected by the presence of disorders of the lumbar-hip complex. This suggests that disorders of the lumbar-hip complex may affect functional tasks as well as the cardinal movements often used in the clinic.

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Paper submitted May 22, 2014; in revised form November 26, 2014; accepted May 8, 2015.
0161-4754

http://dx.doi.org/10.1016/j.jmpt.2015.05.001

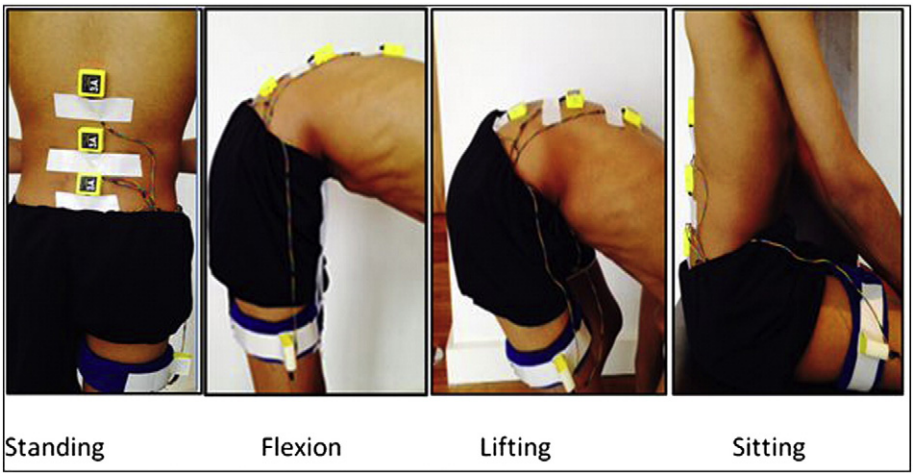

Fig 1. *Schematic represents the location of 4 sensors on spinous processes of T12, L3, and S1 and on the lateral aspect of the thigh midway between the lateral epicondyle and greater trochanter on the iliotibial band.*

Currently, it is not well understood to what degree the cardinal motions, such as forward flexion, are related to more functional tasks. It is possible that there is no relationship between forward flexion and other sagittally dominant functional tasks, such as lifting, stand-to-sit, or sit-to-stand. If there were no relationship, using forward flexion as a basis for exploring sagittal movement behavior would be flawed, potentially leading to erroneous clinical judgements and reasoning. However, it may be that forward flexion is closely related to other sagittal tasks, making the assessment of many tasks within the clinic unnecessary. Therefore, a better understanding of the relationship between forward flexion and sagittal tasks may aid in the interpretation of clinical assessment and treatment decision making.

The assessment of the spine usually involves the completion of movements in the cardinal planes, and the relationship between these cardinal motions and functional tasks such as lifting, stand-to-sit, and sit-to-stand has yet to be established. Therefore, the purpose of this study was to explore the relationship between the kinematic profiles of trunk flexion and 3 sagittally dominant functional tasks (lifting, stand-to-sit, and sit-to-stand). The kinematic profile for the anatomical regions of upper lumbar (UL) and lower lumbar (LL) spine and hip will be used to determine correlations and differences.

Methods

Subjects

Fifty-three subjects were recruited from Cardiff University (age, 29.4 ± 6.5 years; mass, 75.3 ± 16.4 kg; height, 1.69 ± 0.15 m). None of the participants had a history of spinal pain or reported any disorder of the cervical, thoracic, or lumbar spine or the hip. Participants were screened to be free from neurologic conditions, vestibular disturbances, inflammatory joint disease, and a history of spinal surgery. This study was approved by the Cardiff School of Engineering Ethics Committee. Participants were recruited via email advertisement to staff and postgraduate students; thus, our cohort was a convenience-based sample. All participants provided written informed consent.

Instrumentation

A string of 4 accelerometers (3A Sensors; THETAmetrix, Waterlooville, UK) was used to measure the kinematics of the lumbar spine and hip. Each sensor footprint was 24 mm^2 and was connected to a laptop computer via universal serial bus cable. Each sensor provides absolute orientation (tilt) with respect to gravity. Such a system has been shown previously to have excellent repeated-measures reliability relating to spinal motion analysis, with the intraclass correlation coefficient ranging from 0.88 to 0.99 and a standard error of measurement ranging from 0.4° to 5.2°.[15] The accuracy of such a system has been established in a preliminary study and shown to offer root mean square errors of 0.70% to 1.39% compared with a precision angle measurement table (THETAmetrix).

Procedure

Subjects were asked to perform a warm-up exercise, which included flexion, extension, and rotation of the trunk. Four sensors were placed firmly on the skin using double-sided hypoallergenic tape over the spinous processes of T12, L3, and S1 as well as the lateral aspect of the right thigh midway between the lateral epicondyle and greater trochanter on the iliotibial band (Fig 1). Participants were permitted 1 trial of the movements before data collection to familiarize themselves with the procedure and moving with the sensors attached. Participants stood barefoot on assigned markers and focused on a wall marker set at a height of 2 m with arms relaxed by their side. Movements included forward bending, lifting an