The Effect of Chronic Pain Intensity on Sit-to-Stand Strategy in Patients With Herniated Lumbar Disks

Tomasz Sipko, PhD, PT,[a] Edmund Glibowski, PT,[b] Katarzyna Barczyk-Pawelec, PhD, PT,[c] and Michał Kuczyński, PhD[a, d]

Abstract

Objective: Recurrent symptoms of low back pain and its transition to a chronic state are associated with specific motor strategies used by people to avoid pain. The aim of the study was to determine the impact of chronic pain intensity on sit-to-stand (STS) strategy in chronic low back pain (CLBP) patients with herniated disks.

Method: Vertical ground reaction forces (counter, peak, and postpeak rebound) and their respective times of occurrence were measured on 2 Kistler force plates. Thirty-two healthy persons served as a control group. People with CLBP (n = 40) were divided into 2 subgroups according to the reported pain intensity at rest as measured by the numeric pain rating scale (NRS): low pain (NRS ≤ 3) and high pain (HP; NRS > 3).

Results: Both CLBP subgroups achieved shorter time to counter force but longer time to postpeak rebound force ($P < .01$). The time to peak force was extended in HP on the right side ($P < .01$). HP presented lower peak force on the right and lower postpeak rebound force on the left side ($P < .001$) compared with controls.

Conclusion: Patients with CLBP were characterized by an individual, compensatory STS movement strategy with shorter preparation and longer stabilization times. Avoidance behavior in STS execution was presented in HP individuals only, indicating that intensity of chronic pain was a significant factor in decreasing ground reaction peak force and increasing time to peak force. (J Manipulative Physiol Ther 2016;xx:1-7)

Key Indexing Terms: *Posture; Movement; Chronic Pain*

The *sit-to-stand* (STS) *movement* is defined as moving the body's center of mass (COM) upward from a sitting position to a standing position without loss of balance.[1] The sequence of the STS movement is marked by 4 distinct phases: (1) flexion momentum and preparation, (2) momentum transfer, (3) extension, and (4) stabilization.[2–4] In healthy individuals, the duration of these phases is comparable, as are the time course and magnitude of forces exerted on ground. During this common maneuver, the momentum-transfer strategy is most frequently applied, as it is based on a tradeoff between stability and force requirements as well as the coordination and strength between inferior and superior parts of the body.[5]

This strategy does not require excessive lower extremity force because the body is already in motion as it begins to lift. However, individuals with motor deficits may exhibit a distinct departure from the former STS pattern stemming from the need to use compensatory strategies to overcome neural and/or muscular deterioration. For example, the zero-momentum strategy provides an alternative, as it ensures greater stability but requires sufficient trunk flexion to bring the COM well within the base of support of the feet before liftoff. This, however, requires the generation of larger lower-extremity forces to vertically lift the body.

Despite being a simple functional task for healthy individuals, the STS has been widely adopted as a clinical test to evaluate motor deficits in adults with pathological conditions such as chronic low back pain (CLBP).[6] In the assessment of clinical risk factors for CLBP, particular attention has been placed on everyday activities of daily living including lifting, prolonged sitting, and bending.[7] It has been shown that the recurrent symptoms of CLBP and

[a] Associate Professor, Faculty of Physiotherapy, Academy of Physical Education, Wroclaw, Poland.
[b] Master, Faculty of Physiotherapy, Academy of Physical Education, Wroclaw, Poland.
[c] Adjunct, Faculty of Physiotherapy, Academy of Physical Education, Wroclaw, Poland.
[d] Professor, University of Technology, Opole, Poland.
Submit requests for reprints to: Tomasz Sipko, PhD, PT, Professor, Academy of Physical Education, Faculty of Physiotherapy, Al. Ignacego Jana Paderewskiego 35, 51-612 Wrocław, Poland. (e-mail: *tsipko@wp.pl*).
Paper submitted September 16, 2015; in revised form January 7, 2016; accepted January 18, 2016.
0161-4754

http://dx.doi.org/10.1016/j.jmpt.2016.02.014

its transition to a chronic state are associated with specific motor strategies used by patients to avoid pain.[8–10] Such changes in the postural control of dynamic tasks may significantly modify the biomechanical constraints imposed on movement and lead to further changes in motor strategies, affecting rate and force dynamics of the STS movement. Based on earlier work assessing postural control in subjects with CLBP,[11,12] we believe that the intensity of chronic pain should be considered an important strategy-related determinant of the STS. Although several authors have demonstrated altered STS strategies due to experimental[13] or chronic pain,[8] little is known as to the extent that these strategies may be further modified by the level of chronic pain.

Therefore, the purpose of this study was to determine the impact of chronic pain intensity on the STS strategy of both feet in CLBP patients. We hypothesized that patients with high chronic pain use a compensatory movement strategy and present avoidance behavior in STS execution via diminished performance, reduced peak ground reaction forces, and prolonged completion times of characteristic STS events.

Methods

Participants

Forty people with CLBP aged 30 to 65 years undergoing noninvasive treatment in a health clinic participated in the study. Inclusion criteria encompassed individuals with CLBP caused by an underlying herniated disk and experiencing persistent or recurrent chronic pain for at least 3 months. This condition was verified by magnetic resonance imaging and the straight leg raise (SLR) test as well as by the administration of a pain and health status questionnaire. Exclusion criteria included the presence of any neurological disease, orthopedic condition, surgical treatment of the herniated disk (indicated in the health questionnaire), and stenosis of the spinal canal (via magnetic resonance imaging).

The straight leg angle was measured on the left and right side to determine the involvement of neural tissue mechanosensitivity. The test procedure entailed placing the participant in the supine position. The physiotherapist passively raised the extremity generating hip flexion with knee extension until significant resistance was detected or the participant reported a reproduction of pain in the involved extremity, whichever occurred first. At this point, the examiner asked an independent observer to record the presented angle by goniometry to determine the range of motion of the SLR.[14] A reproduction of the symptom in the test at an angle less than 50° was interpreted as a positive SLR outcome, suggesting increased sciatic tension.[14,15]

The level of resting pain on the day of investigation was determined on the basis of the numeric rating scale (NRS) by self-reporting the current intensity of pain from 0 to 10.[16] The CLBP group was stratified in terms of pain intensity into 2 subgroups: low pain (LP; NRS = 0-3) and high pain (HP; NRS = 4-10). These cutoff points were suggested by Corbeil et al[17] and Sipko and Kuczyński,[12] as weak pain was found to minimally affect postural control but moderate and extreme pain may lead to a gradual deterioration in postural stability. Both subgroups of CLBP had a similar distribution of irradiated leg pain and pain during activities of daily living, described in detail in previous studies.[10,12] Body mass index (BMI) was calculated and classified according to standard World Health Organization criteria as underweight (<18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (25.0-29.9 kg/m^2), obese class I (30.0-34.9 kg/m^2), and obese class II/III (≥ 35.0 kg/m^2).[18]

A convenience sample of 32 volunteers, who were not involved in any regular physical activity, was recruited from the authors' institution and served as a control group (CON). The inclusion criteria encompassed asymptomatic subjects (NRS = 0) aged 30-65 years with no history of CLBP. The exclusion criteria were as follows: neurological disease; orthopedic problems of the spine, hip, knee, or foot; low back pain at the time of testing; or any indication of poor physical or mental state on the day of examination.

All participants provided their informed consent before enrollment in the study, and the study procedures received the approval of the Ethics Committee of the Academy of Physical Education in Wrocław, Poland.

Experimental Protocol

Sit-to-stand assessment began with the participant assuming a comfortable erect stance on 2 force plates (Kistler, Type 9286) in front of a standard chair (46-cm seat height) with the feet hip-width apart and the arms crossed across the chest. The participant was instructed to assume a comfortable unsupported sitting position from which they were to immediately start the STS maneuver when given a visual signal. The STS task was repeated twice to calculate test-retest reliability.[19] Force platform measures in the 3 dimensions were recorded for each participant. The resulting plot displayed 4 distinct events in the time course of vertical ground reaction forces. These events, in order of occurrence following the initiation signal, were as follows: initial force at seat unloading (FzT_0), counter force (FzT_1) at the beginning of the upward acceleration, peak force (FzT_2) achieved after seat-off, and postpeak rebound force (FzT_3) which transitions into the final stabilization phase.[2] To eliminate the effect of body weight on ground reaction forces, the results were normalized [(Fz/body weight) × 100%]. Event times were analyzed using actual times (real times of raw force recordings) of the consecutive force events following the initiation signal (T_1, time to counter force; T_2, time to peak force; T_3, time to postpeak rebound force) (Fig 1).[2] The bilaterally measured