Motor Neuron Excitability Attenuation as a Sequel to Lumbosacral Manipulation in Subacute Low Back Pain Patients and Asymptomatic Adults: A Cross-Sectional H-Reflex Study

J. Donald Dishman, DC, MSc,[a] Jeanmarie R. Burke, PhD,[b] and Paul Dougherty, DC[b]

Abstract

Objective: The purpose of the study was to compare a time series of tibial nerve H-reflex trials between patients with subacute low back pain (LBP) and asymptomatic adults using pre and post high-velocity, low-amplitude (HVLA) spinal manipulation (SM) and control procedures.

Methods: Asymptomatic adults (n = 66) and patients with subacute LBP (n = 45) were randomized into 3 lumbosacral procedures: side-posture positioning, joint preloading with no thrust, and HVLA SM. A time series of 40 H_{max}/M_{max} ratios at a rate of 0.1 Hz were recorded in blocks of 10 trials at baseline and after the lumbosacral procedures at time points corresponding to immediately after, 5 minutes after, and 10 minutes after the procedure. Descriptive time series analysis techniques included time plots, outlier detection, and autocorrelation functions. A mixed analysis of variance model (group × procedure × time) was used to compare the effects of lumbosacral procedures on H_{max}/M_{max} ratios between the patients with subacute LBP and asymptomatic participants.

Results: The time series analysis and the significant lumbosacral × time interaction term ($P < .05$) indicated that inhibition of the H_{max}/M_{max} ratios at the 10-second postlumbosacral procedure time point was greatest after the HVLA SM procedure. The effects of lumbosacral procedures on H_{max}/M_{max} ratios were similar between patients with subacute LBP and asymptomatic participants.

Conclusions: Although nonspecific effects of movement or position artifacts on the H_{max}/M_{max} ratio were present, a reliable and valid attenuation of the H_{max}/M_{max} ratio occurred as a specific aspect of HVLA SM in both asymptomatic adults and patients with subacute LBP. (J Manipulative Physiol Ther 2018;xx:1-xxx)

Key Indexing Terms: *Low Back Pain, Mechanical; Lumbar Manipulation; H-Reflex; Gastrocnemius Muscle*

Introduction

A time series of tibial nerve H-reflex trials or pre-post H/M recruitment curves has revealed an inhibition of the Ia afferent-alpha motoneuron pathway that was dependent upon the delivery of a high-velocity, low-amplitude (HVLA) spinal manipulation (SM) to the lumbosacral spine.[1,2] The effects of postural perturbations after various methods of lumbosacral spine manipulation, the stimulus-response segmental relationship between the lumbosacral spine and the gastrocnemius muscle (GM), and H-reflex methodological considerations have been rigorously addressed in previous research to document the validity and reliability of H-reflex responses after HVLA SM.[1,3-7] However, only one of these tibial nerve H-reflex studies conducted to date included a patient sample.[8] Although the report by Suter et al[8] dissents on the attenuation of H-reflex responses in asymptomatic participants after HVLA SM, attenuation of the H-reflex response after HVLA SM occurred in patients with nonspecific low back pain (LBP). Their side-posture testing position, the soleus as the test muscle, and sacroiliac joint manipulation are experimental design deviations that would need to be rigorously addressed to provide an explanation for this dissenting report. A factorial experimental design is necessary to compare various postural orientations, triceps surae muscle

[a] Clinical Neurosciences Institute, Palmer College of Chiropractic Florida, Port Orange, Florida.

[b] Research Department, New York Chiropractic College, Seneca Falls, New York.

Corresponding author: Jeanmarie R. Burke, PhD, Research Department, New York Chiropractic College, 2360 State Route 89, Seneca Falls, NY 13148. Tel.: +1 315 568 3869.
(e-mail: *jburke@nycc.edu*).

Paper submitted June 15, 2017; in revised form October 26, 2017; accepted October 26, 2017.

0161-4754

https://doi.org/10.1016/j.jmpt.2017.10.015

recording sites for H-reflex measurements, and methods of lumbosacral SM. As support for this recommendation, a previous study by Murphy et al[9] on sacroiliac joint manipulation using a prone H-reflex testing position reported an attenuation of the H-reflex response from the soleus muscle after the HVLA SM procedure in asymptomatic participants.

Inhibition of the Ia afferent-alpha motoneuron pathway as a unique stimulus-response to HVLA SM does not provide insights on the mechanisms that underlie the effectiveness of spinal manipulative therapy (SMT) in a clinical setting. However, surface electromyographic (EMG) recordings from the erector spinae muscles revealed that HVLA SM thrusts to lumbosacral spine evoked reflex responses in asymptomatic participants and patients with chronic LBP.[10,11] In addition to inhibition of the Ia afferent-alpha motoneuron pathway, other neurophysiological outcome measures (eg, facilitation of motor-evoked potentials after single-pulse transcranial magnetic stimulation,[12-14] increased V/M_{max} ratios,[2] modulation of motor-evoked potentials after paired-pulse transcranial magnetic stimulation,[15,16] and modulation of somatosensory-evoked potentials[17]) are evidence of unique stimulus-response effects of HVLA SM thrusts on neural pathways, including corticospinal, intracortical, and cerebellar. There are also unique stimulus-response patterns of afferent discharges to manipulative-like thrusts in animal models.[18-21] These data provide evidence that identifying a neurophysiological test as an indicator of "successful" delivery of an HVLA SM thrust may be promising as a translational tool for large-scale clinical research involving SM.[1,22]

The purpose of this study was to compare a time series of tibial nerve H-reflex trials between patients with subacute LBP and asymptomatic adults, pre-post HVLA SM, and control procedures. If results in patients with subacute LBP are similar to those in previous studies on asymptomatic adults, then the current study would provide further evidence that inhibition of the Ia afferent-alpha motoneuron pathway may be a neurophysiological indicator of a "successful" HVLA SM treatment.[1,2,8] The primary hypothesis was that inhibition of the Ia afferent-alpha motoneuron pathway would be greater after an HVLA SM thrust compared with SM control procedures of side-posture positioning and joint preloading with no thrust in both asymptomatic adults and patients with subacute LBP. The exploratory hypothesis was that the degree of inhibition of the Ia afferent-alpha motoneuron pathway after an HVLA SM thrust would be similar between asymptomatic adults and patients with subacute LBP. The rationale for the exploratory hypothesis was that an HVLA SM thrust evokes force, direction, and velocity-dependent afferent discharges from various mechanoreceptors that inhibit the Ia afferent-alpha motoneuron pathway regardless of the "resting" state of the lumbar musculoskeletal system (eg, hypertonicity of muscles or hypomobility of joints). From a therapeutic perspective, and beyond the scope of the current study, inhibition of the Ia afferent-alpha motoneuron pathway after an HVLA SM thrust may be a potential mechanistic response to reduce hypertonicity of lumbar muscles in subacute LBP patients—that is, reset the gain of the motoneuron pool to reduce hypertonicity.

Methods

Participants

A convenience sample of 66 healthy volunteers and 45 patients with subacute LBP participated in the study (Table 1). The healthy volunteers were first- and second-year chiropractic students who were recruited using campus advertisements and class announcements. Healthy volunteers who self-reported LBP within the past 12 weeks or had a history of spinal trauma, herniated nucleus pulposus, peripheral neuropathy, radiculopathy, or any other medical conditions were excluded from participation. Physical examination findings of neurologic abnormalities or hypertonicity of the lumbosacral musculature also excluded healthy volunteers from participation. The patients with acute LBP were referrals from a single private practice chiropractic office located in a suburb of Rochester, New York. The multidisciplinary practice included chiropractic practices, acupuncture, massage, exercise rehabilitation, and nutrition. The 2 referring chiropractors had over 20 years of clinical experience with a large patient volume.

Inclusion and Exclusion Criteria for Patients. Patients who were experiencing LBP that was confined to the lumbosacral region without any evidence of radicular pain into the lower extremities were identified as experiencing subacute LBP that was mechanical in origin. These patients met the inclusion criteria and were selected for this study. All patients fell into the category of subacute LBP, which was defined as a period of pain that did not exceed 12 weeks before enrollment in the study. All patients with subacute LBP who were referred to the study had previously undergone a routine series of plain-film radiographs to rule out fracture, dislocation, luxation, or osseous pathology. Upon neurologic screening by the clinician, there was no evidence of herniated lumbar intervertebral discs, cauda equina syndrome, canal stenosis, bowel or bladder dysfunction, peripheral neuropathy, or focal lumbosacral radiculopathy. In addition, a palpation examination performed by the clinician revealed exacerbation of pain upon deep palpation of the lumbar erector spinae musculature. Specifically, there was both a subjective response of increased pain by the patient and a palpation finding by the clinician of increased or hypertonic musculature. These palpation findings of taut and tender muscle fibers were consistent with pain-induced muscle spasm. During the patient history, any self-reported lumbar surgery or minimally invasive procedures, such as epidural steroid injections to treat LBP or metabolic disease that may lead to central or peripheral neurologic deficits including multiple