Effects of 12 Weeks of Chiropractic Care on Central Integration of Dual Somatosensory Input in Chronic Pain Patients: A Preliminary Study

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Abstract

Objective: The purpose of this preliminary study was to assess whether the dual somatosensory evoked potential (SEP) technique is sensitive enough to measure changes in cortical intrinsic inhibitory interactions in patients with chronic neck or upper extremity pain and, if so, whether changes are associated with changes in pain scores.

Methods: The dual peripheral nerve stimulation SEP ratio technique was used for 6 subjects with a history of chronic neck or upper limb pain. SEPs were recorded after left or right median and ulnar nerve stimulation at the wrist. SEP ratios were calculated for the N9, N13, P14-18, N20-P25, and P22-N30 peak complexes from SEP amplitudes obtained from simultaneous median and ulnar stimulation divided by the arithmetic sum of SEPs obtained from individual stimulation of the median and ulnar nerves. Outcome measures of SEP ratios and subjects' visual analog scale rating of pains were recorded at baseline, after a 2-week usual care control period, and after 12 weeks of multimodal chiropractic care (chiropractic spinal manipulation and 1 or more of the following: exercises, peripheral joint adjustments/manipulation, soft tissue therapy, and pain education).

Results: A significant decrease in the median and ulnar to median plus ulnar ratio and the median and ulnar amplitude for the cortical P22-N30 SEP component was observed after 12 weeks of chiropractic care, with no changes after the control period. There was a significant decrease in visual analog scale scores (both for current pain and for pain last week).

Conclusion: The dual SEP ratio technique appears to be sensitive enough to measure changes in cortical intrinsic inhibitory interactions in patients with chronic neck pain. The observations in 6 subjects revealed that 12 weeks of chiropractic care improved suppression of SEPs evoked by dual upper limb nerve stimulation at the level of the motor cortex, premotor areas, and/or subcortical areas such as basal ganglia and/or thalamus. It is possible that these findings explain one of the mechanisms by which chiropractic care improves function and reduces pain for chronic pain patients. (J Manipulative Physiol Ther 2017;40:127-138)

Key Indexing Terms: *Somatosensory Evoked Potentials; Spinal Manipulation; Sensory Gating; Neuroplasticity; Transcutaneous Nerve Stimulation*

Introduction

Spinal manipulation is known to result in clinical improvements in spinal function and reduction of both acute and chronic low back and neck pain.[1-7] However, the mechanism(s) responsible for the restoration of function and relief of pain after manipulative care are not well understood. We have yet to fully understand the neurophysiological mechanisms responsible for such clinical improvements after spinal manipulation of any kind. It is of interest to us whether chiropractic care can induce changes in various aspects of central nervous system (CNS) functioning, including alterations in reflex excitability,[8-12] sensory processing,[13] and motor control.[12]

A recent study used the dual somatosensory evoked potential (SEP) ratio technique to further explore these CNS alterations following chiropractic adjustment/manipulation.[14,15] This experimental technique has previously been used by Tinazzi et al.,[16] who found that dystonic subjects exhibited an abnormality in the intrinsic inhibitory interactions within the somatosensory system. The technique can be used to measure central integration of dual somatosensory input.[16] This can be achieved by comparing the amplitudes of SEP peaks obtained

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by stimulating the median and ulnar nerves simultaneously (MU) with the amplitude obtained from the arithmetic sum of the SEPs elicited by stimulating the same nerves separately (M + U). The ratio of MU to M + U indicates the central interaction between afferent inputs from these 2 peripheral nerves and, thus, reflects the degree to which the CNS filters or gates excessive somatosensory afferent information.[17-21]

Previous research has indicated that healthy individuals have smaller central MU SEP amplitudes (ie, SEP amplitudes following MU) compared with the M + U amplitudes (ie, SEP amplitude calculated as the arithmetic sum of the individual median and ulnar SEPs).[16,22] However, in conditions such as dystonia[16] and Huntington's disease,[23] increased central SEP ratios have been observed. The increased SEP ratios suggest that these individuals receive distorted and excessive (ie, not spatially filtered) afferent input from their affected limb or limbs, which may potentially cause their motor system to transform these afferent inputs into abnormal "unhealthy" motor outputs. Sensorimotor disturbances are also known to persist beyond acute episodes of pain,[24,25] and such sensorimotor disturbances are thought to play a defining role in the clinical picture and chronicity of different chronic pain conditions.[26] We therefore hypothesized that patients with chronic pain may also have increased central dual SEP ratios.

Our previous studies using the SEP ratio technique examined the effects of cervical spine chiropractic manipulation (also known as chiropractic adjustments) and a period of repetitive muscular contractions.[14,22] This work demonstrated that the dual-peripheral-nerve-stimulation SEP technique may be used as a sensitive measure of sensorimotor integration (SMI). The experiment involved recording SEPs before and after the subjects performed a repetitive thumb abduction task for 20 minutes. The results suggest that the cortical system becomes less able to suppress the dual input after 20 minutes of repetitive thumb abduction.[22] These SEP changes were unrelated to peripheral factors, as the N9 responses remained stable. The N9 SEP peak reflects the afferent signal over the brachial plexus[27] before it enters the CNS, and thus can be used to ensure that the incoming signal is consistent before and after an intervention. Furthermore, these experiments demonstrated that the subjects' N30 SEP peak ratios decreased significantly after a single chiropractic manipulation of the cervical spine. As the N30 SEP peak is thought to reflect early cortical SMI,[28] the authors argued that their results suggest that the subject's SMI networks' ability to suppress the dual input after the adjustment was increased.[14] The N30 SEP peak ratios remained decreased even after repeating the 20-minute repetitive thumb abduction task. This suggested that the treatment effects appear to have altered the way in which each subject's CNS responded to the repetitive thumb typing task.[14]

Using dual somatosensory input and comparing the SEP ratios are more robust against the variations in placement of recording and stimulating electrodes that can affect SEP amplitudes when measuring SEP data evoked from stimulation of a single peripheral nerve. As it measures the degree of central surround-like inhibition of somatosensory input, it is less affected by the recording and stimulating setup, thus allowing more reliable measures over time and enabling us to compare across subjects. Thus, it may be a useful tool to measure long-term central neurophysiological changes that may occur with chiropractic care.

The purpose of this preliminary study was to assess whether the dual SEP technique is sensitive enough to measure changes in cortical intrinsic inhibitory interactions in patients with chronic neck pain after a 12-week period of chiropractic care and, if so, whether any such changes related to changes in symptomatology.

Methods

Subjects

Six subjects (1 woman and 5 men), aged 24 to 50 (mean age, 36.2 ± 12.8 years) with a history of chronic recurring neck or upper limb symptoms (ie, >3 months in duration and severe enough for the subject to have sought previous treatment for this symptom). The upper limb symptoms were assessed according to the Southampton examination schedule for the diagnosis of musculoskeletal disorders of the upper limb,[29] which has been reported to have good interperson reliability.[30]Inclusion criteria were age 18 through 50 years and a history of pain longer than 3 months. Subjects were excluded if they had a history of neurologic disorders such as epilepsy, multiple sclerosis, dystonia, and abnormal peripheral nerve function. Subjects were recruited from acquaintances of staff and students at the New Zealand College of Chiropractic and University of Auckland through word of mouth during the period from December 2006 to December 2007. Five of the subjects were deemed to be right-handed (mean laterality quotient, 75.5%; range, 64.7%-85.7%) and one left-handed (laterality quotient, 66.0%), using the Edinburgh handedness questionnaire.[31]

All subjects were screened for possible contraindications to treatment or the presence of diseases or disorders that may require medical management (eg, history of previous fractures; high blood pressure; and metabolic, inflammatory, or neoplastic disease). Subjects were also excluded if they had less than 3 months of neck or upper limb symptoms (or both), had received treatment for this condition, or had been prescribed pain medication within the previous 6 weeks. All screening examinations and assessment sessions were conducted by a chiropractor. Written informed consent was obtained from all participants by the same chiropractor (H.H.), and the local ethics