

# **Cervical spine manipulation alters sensorimotor integration: A somatosensory evoked potential study**

## **Clinical Neurophysiology**

**February 2007 Feb;118(2):391-402**

Haavik-Taylor H, Murphy B

### **OBJECTIVE:**

To study the immediate sensorimotor neurophysiological effects of cervical spine manipulation using somatosensory evoked potentials (SEPs).

### **METHODS:**

Twelve subjects with a history of reoccurring neck stiffness and/or neck pain, but no acute symptoms at the time of the study were invited to participate in the study.

An additional twelve subjects participated in a passive head movement control experiment.

Spinal brainstem and cortical SEPs to median nerve stimulation were recorded before and for 30min after a single session of cervical spine manipulation, or passive head movement.

### **RESULTS:**

There was a significant decrease in the amplitude of parietal and frontal SEP components following the single session of cervical spine manipulation compared to pre-manipulation baseline values.

These changes lasted on average 20min following the manipulation intervention.

No changes were observed in the passive head movement control condition.

### **CONCLUSIONS:**

Spinal manipulation of dysfunctional cervical joints can lead to transient cortical plastic changes, as demonstrated by attenuation of cortical somatosensory evoked responses.

### **SIGNIFICANCE:**

This study suggests that cervical spine manipulation may alter cortical somatosensory processing and sensorimotor integration.

These findings may help to elucidate the mechanisms responsible for the effective relief of pain and restoration of functional ability documented following spinal manipulation treatment.

## THESE AUTHORS ALSO NOTE:

“Spinal manipulation is a commonly used conservative treatment for neck, back, and pelvic pain.”

“The effectiveness of spinal manipulation in the treatment of acute and chronic low back and neck pain has been well established by outcome-based research.” **[Very Important]**

Evidence indicates that spinal manipulation does the following:

- 1) Alters spinal cord reflex excitability.
- 2) Alters sensory processing.
- 3) Alters motor excitability.

Spinal dysfunction effects central neural processing, as follows:

- 1) Spinal dysfunction will alter afferent input to the central nervous system.
- 2) Altered afferent input to the central nervous system leads to plastic changes.
- 3) “Neural plastic changes take place both following increased and decreased afferent input.” **[Extremely Important]**
- 4) Altered afferent input from joints leads to both inhibition and facilitation of neural input to related muscles.
- 5) Both painful and **painless** joint dysfunction will inhibit surrounding muscles. **[Very Important]**

Studies show that 15 – 30 minutes of altered joint afferent input to the spinal reflex pathways “increases neural excitability that persists for several hours.”

**[Very Important]** “Once these facilitated areas are established, there may be no need for ongoing afferent input to maintain the altered output [motor] patterns.”

Altered sensory input causes rapid central plastic changes, especially after injury. **[Important]**

The altered neural processing that occurs as a consequence of joint dysfunction provides a “rationale for the effects of spinal manipulation on neural processing that have been described in the literature.” **[Very Important]**

Spinal dysfunction alters the “balance of afferent input to the central nervous system” and this altered afferent input may lead to “maladaptive neural plastic changes in the central nervous system,” and “spinal manipulation can effect this.” **[Very Important]**

The spinal manipulation in this study was applied to dysfunctional cervical joints, as determined by a "registered chiropractor."

The clinical evidence for joint dysfunction includes:

- 1) Tenderness on joint palpation.
- 2) Restricted intersegmental range of motion.
- 3) Palpable asymmetry of intervertebral muscle tension.
- 4) Abnormal or blocked joint play and end-feel.
- 5) Sensorimotor changes in the upper extremity.

"The most reliable spinal-dysfunction-indicator is tenderness with palpation of the dysfunctional joint." **[Important]**

To assess joint dysfunction, cervical range of motion also has good reliability.

In this study, cervical spinal dysfunction was defined as having both restricted intersegmental range of motion and tenderness to palpation of the restricted joint.

"The spinal manipulations carried out in this study were high velocity, low amplitude thrusts to the spine held in lateral flexion, with slight rotation and slight extension. This is a standard manipulative technique used by manipulative physicians, physiotherapists and chiropractors."

High velocity manipulation was chosen for this study because previous research has shown that only high-velocity manipulations alter reflex EMG activity and therefore would be more likely to alter afferent input to the central nervous system. **[Important]**

The non-manipulative passive head movement procedures entailed passively placing the subjects head in the same position that would be used to manipulate the cervical spine, and then returning the subjects head to the neutral position without doing a manipulation.

Immediately following the intervention (high-velocity manipulation or passive cervical set-up motion), three SEPs were recorded at 1-10 minutes, 10-20 minutes, and 20-30 minutes.

## RESULTS:

The high-velocity manipulation subjects showed significant cortical SEP amplitude attenuation at various locations.

"No changes occurred to any of the SEP components following passive head movement." **[Very Important]**

## DISCUSSION

“The major finding in this study was that a single session of spinal manipulation of dysfunctional joints resulted in attenuated cortical (parietal and frontal) evoked responses.” **[Very Important]** These changes “most likely reflect central changes.” **[Very Important]**

The length of time these central changes persisted varied between the subjects, [indicating different individuals respond differently to spinal adjusting]. **[Very Important]**

This study documents cortical brain changes as a consequence of spinal adjusting; the authors also note that sub-cortical brainstem changes may have also occurred but their study protocols were not sufficient to document them, and therefore sub-cortical brainstem changes from spinal adjusting “need further investigation.” **[Important]**

The significantly decreased cortical SEPs occurred in **all** post-manipulation measurements, indicating “enhanced active inhibition” because the “cervical manipulations could have altered the afferent information originating from the cervical spine (from joints, muscles, etc.)”

“The passive head movement SEP experiment demonstrated that no significant changes occurred following a simple movement of the subject’s head. Our results are therefore not simply due to altered input from vestibular, muscle or cutaneous afferents as a result of the chiropractor’s touch or due to the actual movement of the subjects head. This therefore suggests that the results in this study are specific to the delivery of the high-velocity, low-amplitude thrust to dysfunctional joints.” **[Extremely Important]**

The authors reiterate that the documented reduced cortical changes may be secondary to altered “subcortical loops linking the basal ganglia, thalamus, pre-motor areas and primary motor cortex” resulting from “altered afferent input following spinal manipulation.”

“Muscle afferents (probably Ia) are the most likely mediators of the central neural effects of spinal manipulation.”

The significant attenuation of the frontal SEP observed in this study suggests that spinal manipulation alters Ia afferent processing.

Studies indicate that “displacement of vertebrae is signaled to the central nervous system by afferent nerves arising from deep intervertebral muscles.”

“Both the velocity and the relative position of the vertebral displacement appeared to be encoded by afferent nerve activity from intervertebral muscles.”

“Joint dysfunction leads to bombardment of the central nervous system with Ia afferent signaling from surrounding intervertebral muscles.”

Spinal manipulation reduces excessive afferent signals from adjacent intervertebral muscles which improves altered afferent input to the central nervous system. This changes the way the central nervous system “responds to any subsequent input.” **[Very Important]**

Episodes of acute pain following injury induce plastic changes in the sensorimotor system, prolonging the episode of pain and playing a roll in establishing chronic neck pain conditions. **[Very Important]** “The reduced cortical SEP amplitudes observed in this study following spinal manipulation may reflect a normalization of such injury/pain-induced central plastic changes, which may reflect one mechanism for the improvement of functional ability reported following spinal manipulation.” **[Extremely Important]**

“Spinal manipulation of dysfunctional joints may modify transmission of neuronal circuitries not only at a spinal level but at a cortical level, and possibly also deeper brain structures such as the basal ganglia.” **[Very Important]**

#### KEY POINTS FROM DAN MURPHY

- 1) “Spinal manipulation is a commonly used conservative treatment for neck, back, and pelvic pain.”
- 2) “The effectiveness of spinal manipulation in the treatment of acute and chronic low back and neck pain has been well established by outcome-based research.”
- 3) Spinal dysfunction will alter afferent input to the central nervous system.
- 4) Altered afferent input to the central nervous system leads to plastic changes in the central nervous system. **[Very Important]**
- 5) “Neural plastic changes take place both following increased and decreased afferent input.” **[Extremely Important]**
- 6) Both painful and **painless** joint dysfunction will inhibit surrounding muscles.
- 7) Joint dysfunction causes afferent driven increases in neural excitability (facilitation) to muscles that can persist even after the initiating afferent abnormality is corrected. **[This suggests that a muscle afferent problem can persist even after the joint component of the sUBLUXATION is corrected. The chronic component of the sUBLUXATION may be plastic changes that cause long-term alteration of muscle afferentation.]** This article clearly supports that the joint component, the muscle component, and the neurological component of the sUBLUXATION complex are influenced by traditional joint-cavitation spinal adjusting.

8) The altered neural processing that occurs as a consequence of joint dysfunction provides a "rationale for the effects of spinal manipulation on neural processing that have been described in the literature." **[Very Important]**

9) Spinal dysfunction alters the "balance of afferent input to the central nervous system" and this altered afferent input may lead to "maladaptive neural plastic changes in the central nervous system," and "spinal manipulation can effect this." **[Very Important]**

10) The clinical evidence for joint dysfunction that requires manipulation includes:

- A)) Tenderness on joint palpation.
- B)) Restricted intersegmental range of motion.
- C)) Palpable asymmetry of intervertebral muscle tension.
- D)) Abnormal or blocked joint play and end-feel.
- E)) Sensorimotor changes in the upper extremity.

**[I recall the teachings of Richard Stonebrink, DC, in the orthopedic diplomate program 25 years ago, the importance of "always documenting (in our daily records) the evidence that the patient had a manipulatable spinal lesion (subluxation)." His evidence was identical to these. Dr. Stonebrink would stress that such documentation would "always make the case unique to chiropractic" and consequently make the chiropractor the only expert in the case.]**

11) The most reliable spinal-dysfunction-indicators are tenderness with palpation of the dysfunctional joint, and alterations of segmental range of motion.

12) High velocity, low amplitude thrust spinal manipulation with the head held in lateral flexion, with slight rotation and slight extension "is a standard manipulative technique used by manipulative physicians, physiotherapists and chiropractors."

13) High velocity manipulation alters reflex EMG activity and alters afferent input to the central nervous system. **[Important]**

14) High-velocity manipulation causes significant cortical SEP amplitude attenuation in at least the frontal and parietal cortexes.

15) Passive head movements do not cause changes in cortical firing.

16) "A single session of spinal manipulation of dysfunctional joints resulted in attenuated cortical (parietal and frontal) evoked responses." These changes "most likely reflect central changes." **[Very Important]**

17) The cortical function of different individuals responded differently to spinal adjusting. **[This indicates that other variables other than the adjustment itself can influence the cortical responses in a given individual]**

18) The significantly decreased somatosensory cortical SEP occurred in **all** post-manipulation measurements, indicating “enhanced active inhibition” because the “cervical manipulations could have altered the afferent information originating from the cervical spine (from joints, muscles, etc.)”

19) “The passive head movement SEP experiment demonstrated that no significant changes occurred following a simple movement of the subject’s head. Our results are therefore not simply due to altered input from vestibular, muscle or cutaneous afferents as a result of the chiropractor’s touch or due to the actual movement of the subjects head. This therefore suggests that the results in this study are specific to the delivery of the high-velocity, low-amplitude thrust to dysfunctional joints.” **[Extremely Important]**

20) “Displacement of vertebrae is signaled to the central nervous system by afferent nerves arising from deep intervertebral muscles,” and this is improved with adjusting the adjacent dysfunctional joint.

21) “Joint dysfunction leads to bombardment of the central nervous system with Ia afferent signaling from surrounding intervertebral muscles.” Spinal manipulation reduces excessive afferent signals from adjacent intervertebral muscles which improves altered afferent input to the central nervous system. This changes the way the central nervous system “responds to any subsequent input.”

22) Episodes of acute pain following injury induce plastic changes in the sensorimotor system, prolonging the episode of pain and playing a roll in establishing chronic neck pain conditions. **[Very Important]** “The reduced cortical SEP amplitudes observed in this study following spinal manipulation may reflect a normalization of such injury/pain-induced central plastic changes, which may reflect one mechanism for the improvement of functional ability reported following spinal manipulation.” **[Extremely Important]**

23) “Spinal manipulation of dysfunctional joints may modify transmission of neuronal circuitries not only at a spinal level but at a cortical level, and possibly also deeper brain structures such as the basal ganglia.” **[Very Important]**

24) Cervical spine manipulation alters cortical [brain] somatosensory processing and sensorimotor integration.

25) These findings may help to elucidate the mechanisms responsible for the effective relief of pain and restoration of functional ability documented following spinal manipulation treatment.

#### COMMENT BY DAN MURPHY

One of the central themes of the neurology diplomate program taught by Ted Carrick DC is that chiropractic spinal adjusting influences the cortical brain, creating plastic changes. This article very much supports that perspective.