Dr. Chestnut's Research Review

 February 2022

Altered Central Integration of Dual Somatosensory Input After Cervical Spine Manipulation

Haavik & Murphy (2010) Altered Central Integration of Dual Somatosensory Input After Cervical Spine Manipulation. Journal of Manipulative and Physiological Therapeutics 33 (3) 178-188.

Unfortunately, this study, like so many, looks at the acute effects of one adjustment/SMT. Although this can provide some important information on acute neurophysiological effects, it cannot provide any information on whether these effects elicit clinically meaningful changes in neurophysiology that elicit clinically meaningful outcomes.

Remember, measuring the effects of one bout of exercise is completely misleading. One bout of exercise causes tissue damage, inflammation, increased cortisol levels, decreased immune function, and discomfort and reduced mobility and reduced ability to perform activities of daily living. However, regular exercise has the OPPOSITE effects! Further, one bout of exercise has no clinically meaningful benefits but regular exercise most certainly does.

Basic science evidence is important, but for it to be useful to practitioners, it must be followed up with studies that determine if the basic science changes are clinically meaningful and can be elicited in clinical practice. It is not scientifically valid to take the results of a basic science study, which importantly can demonstrate biological plausibility for clinical outcomes, as evidence of the ability to elicit clinical outcomes.

Having said all that, these studies are enormously valuable when interpreted properly and built upon with studies that provide clinical evidence and clinically meaningful information for practitioners.

ABSTRACT

Objective: The aim of the current study was to investigate changes in the intrinsic inhibitory interactions within the somatosensory system subsequent to a session of spinal manipulation of dysfunctional cervical joints.

Method: Dual peripheral nerve stimulation somatosensory evoked potential (SEP) ratio technique was used in 13 subjects with a history of reoccurring neck stiffness and/or neck pain but no acute symptoms at the time of the study. Somatosensory evoked potentials were recorded after median and ulnar nerve stimulation at the wrist (1 millisecond square wave pulse, 2.47 Hz, 1 × motor threshold). The SEP ratios were calculated for the N9, N11, N13, P14-18, N20-P25, and P22-N30 peak complexes from SEP amplitudes obtained from simultaneous median and ulnar (MU) stimulation divided by the arithmetic sum of SEPs obtained from individual stimulation of the median (M) and ulnar (U) nerves.

Results: There was a significant decrease in the MU/M + U ratio for the cortical P22-N30 SEP component after chiropractic manipulation of the cervical spine. The P22-N30 cortical ratio change appears to be due to an increased ability to suppress the dual input as there was also a significant decrease in the amplitude of the MU recordings for the same cortical SEP peak (P22-N30) after the manipulations. No changes were observed after a control intervention.

Conclusion: This study suggests that cervical spine manipulation may alter cortical integration of dual somatosensory input. These findings may help to elucidate the mechanisms responsible for the effective relief of pain and restoration of functional ability documented after spinal manipulation treatment.

FULL REVIEW

BACKGROUND

"The effectiveness of spinal manipulation for improving spinal function and relieving acute and chronic low back and neck pain has been well established by outcome-based research. However, the mechanism(s) responsible for the effective relief of pain and restoration of functional ability after spinal manipulation are not well understood, as there is limited evidence to date regarding the neurophysiologic effects of spinal manipulation."

I find it ironic that the critics of chiropractic first disputed the clinical outcomes and patient satisfaction levels of patients receiving chiropractic adjustments. Then, when the evidence for clinical outcomes was produced, which far surpassed the level of evidence for usual medical care or physiotherapy, the argument became that it was necessary to prove HOW chiropractic worked. This is a question seldomly seen as important for usual medical care interventions, the only important question has, for decades, been IF any given medical intervention can elicit clinically meaningful outcomes, not HOW.

And, even more ironically, there has never been ANY valid information that usual medical care or physiotherapy produced clinically meaningful outcomes, they could not even answer the IF question!

"There is a growing body of evidence suggesting that the presence of spinal dysfunction of various kinds has an effect on central neural processing. For example, several authors have suggested that spinal dysfunction may lead to altered afferent input to the central nervous system (CNS). It is well documented in the literature that altered afferent input to the CNS leads to plastic changes in the way that it responds to any subsequent input; thus, it is possible that the presence of spinal dysfunction also leads to central neural plastic changes.

Restricted motion, scar tissue adhesions, inflammation, reduced proprioception into the sensory cortex, reduced sensori-motor integration, reduced motor control, reduced strength, coordination, and balance, increased chance of injury, reduced ability to perform activities of daily living, reduced quality of life. And, as you will soon read, increased pain and discomfort. This has not even considered the effects of increased nociception.

What this research elucidates is that chronic VSC/motion unit dysfunction, elicits chronic neuroplastic changes in the brain that can create symptoms and/or persist independently of symptoms.

"Several recent studies indicate that spinal manipulation of dysfunctional cervical joints leads to alterations in central processing and sensorimotor integration. One of these studies [Haavik and Murphy 2007 – See Nov 2021 Research Review] demonstrated that spinal manipulation of dysfunctional cervical joints alters cortical processing and sensorimotor integration for at least 20 to 30 minutes after the manipulations, as reflected by altered N20 and N30 somatosensory evoked potential (SEP) peak amplitudes. The N20 SEP peak reflects processing of peripheral information at the level of the primary somatosensory cortex. The N30 SEP peak reflects central sensorimotor integration processing involving primary sensory cortex, primary motor cortex, premotor cortex, and deeper brain structures such as the basal ganglia."

"One possible mechanism responsible for altering the amplitude of the cortical N20 and N30 SEP components after spinal manipulation is altered reciprocal sensory inhibition, that is, the filtering of afferent information by the somatosensory system. Reciprocal sensory inhibition enhances the contrast between stimuli, so that information from adjacent body parts is perceived and processed separately."

Reciprocal sensory inhibition allows the brain to better distinguish information coming from adjacent body parts which allows for better sensory perception which allows for better motor control. Your brain "sees" your body via proprioception and reciprocal sensory inhibition allows your brain to "see" your different body parts more clearly and thus to control them more accurately.

"This study sought to investigate whether spinal manipulation alters the intrinsic inhibitory interactions within the somatosensory system by comparing the amplitudes of SEP peaks obtained by stimulating 2 nerves simultaneously with the amplitude obtained from the arithmetic sum of the SEPs elicited by stimulating the same 2 nerves separately."

This study measured whether SMT improved the communication between body and brain. WOW!

METHODS

"Thirteen subjects (8 women, 5 men), aged 18 to 40 (mean age, 28.0 ± 6.3 years), with no history of neurologic disorders participated in this study."

"The subjects were required to have a history of reoccurring neck problems. However, at the time of the experiment, all subjects were required to be pain-free. This was done to assess the potential effects of joint manipulation delivered to dysfunctional joints in the absence of acute pain, as acute pain on its own is known to induce a significant reduction of the postcentral N20-P25 SEP complex and a significant increase of the N18 wave."

Asymptomatic subjects with clinical indicators of segmental joint dysfunction/segmental motion unit dysfunction/VSC.

"The stimulating electrodes (cathode proximal) were placed over the median and ulnar nerve at the wrist of the dominant arm."

"At motor threshold, the sensation of transcutaneous electrical stimulation is usually described as a slight "buzzing" sensation accompanied by the sensation of the low level involuntary contractions of the muscles innervated by the stimulated nerve. Motor threshold was defined as the lowest intensity that produced a visible muscle contraction of the abductor pollicis brevis muscle for median nerve stimulation or abductor digiti minimi muscle for ulnar nerve stimulation. The stimulated arm was splinted to ensure stable stimulating conditions throughout the experiment. During the recording periods, the subjects were asked to close their eyes, sit as still and quietly as possible, and the lights in the room were turned off."

"Recording electrodes were placed on the ipsilateral Erb's point, over the C6 spinous process (Cv6), and 2 cm posterior to contralateral, central, and frontal scalp sites C3/4 and F3/4, which will be referred to as Cc' and Fc', respectively."

"The subjects were asked to attend 2 sessions. They were screened for the presence of joint dysfunction by a registered doctor of chiropractic. As the most reliable spinal dysfunction indicators relating to the cervical spine are tenderness on palpation of the dysfunctional joint and passive intervertebral and global motion of the cervical spine, spinal dysfunction was for this study defined as the presence of both restricted intersegmental range of motion and tenderness to palpation of the joint at at least one cervical spine segment."

Again, here is a peer-reviewed published description of the most reliable spinal dysfunction/VSC clinical indicators being segmental restriction and tenderness (allodynia). The clinical indicator for SMT is NOT pain, NOT orthopedic tests, NOT patient history, but palpatory spinal exam findings!

"After assessment of joint dysfunction, 3 baseline SEP trials were carried out in a randomized order: 1 after stimulation of the median nerve individually (M), 1 after stimulation of the ulnar nerve individually (U), and 1 trial after simultaneous stimulation of both nerves (MU). These 3 recordings were repeated immediately after either a control intervention or after the spinal manipulation intervention (high-velocity, low-amplitude)."

"The passive head movement intervention involved the subject's head being passively laterally flexed and slightly extended and rotated to a position in which the chiropractor would normally manipulate that person's cervical spine and then returning the subject's head back to neutral position. This was repeated to both the left and the right. However, the experimenter was particularly careful not to put pressure on any individual cervical segment. Loading a joint, as is done before spinal manipulation, has been shown to alter paraspinal proprioceptive firing in anesthetized cats and was therefore carefully avoided by ending the movement before end-range-of-motion when passively moving the subjects' heads. No spinal manipulation was performed during any passive head movement experiment."

"The passive head movement control experiment was not intended to act as a sham manipulation but to act as a physiologic control for possible changes occurring due to the cutaneous, muscular, or vestibular input that would occur with the type of passive head movement involved in preparing a subject/patient for a cervical manipulation."

The control was used so that any claim that the changes elicited were simply from moving the head rather than from the thrust manipulation aimed at the dysfunctional joint (VSC) could be dismissed.

MAIN OUTCOMES/RESULTS

"For the cortical P22-N30 MU/M + U peak ratio, there was a significant interactive effect of the factors "TIME" and "INTERVENTION. The one-way repeated measure ANOVA revealed a significant effect of the factor "TIME" for the manipulation intervention data."

"This change [after manipulation] represented on average a 17% decrease for the P22-N30 SEP ratio postmanipulation."

"There were no significant changes after the passive head movement intervention."

"The individual median nerve P22-N30 SEP peak amplitude also decreased significantly after the cervical manipulations. This represented an 18% decrease in amplitude of the averaged median nerve P22-N30 SEP peak amplitude."

"For the MU data, the P22-N30 SEP component decreased significantly after the cervical spine manipulations. This represented a 24% decrease in amplitude of the averaged MU P22-N30 SEP peak amplitude."

"The frontal P22-N30 normalized MU amplitude was significantly decreased after the manipulation intervention and is marked with an asterisk. This indicates that the changes in the P22- N30 ratio are due to a surround-like inhibition and not merely due to an increase in either the individual median and/or ulnar nerve SEP peaks."

DISCUSSION AND CLINICAL IMPORTANCE

"The major finding in this study was that a single session of spinal manipulation of dysfunctional cervical joints resulted in improved suppression of SEPs, evoked by dual upper limb nerve stimulation, at the cortical level of the lemniscal pathway. More specifically, the improved suppression of dual input was evident for the frontal P22- N30 SEP component."

To simplify and summarize, SMT of a chronic dysfunctional motion unit segment (deficient proprioceptive input into CNS) elicited a proprioceptive volley into the CNS which, since sufficient proprioception is required for proper sensorimotor function, improved the function of the sensorimotor system via improved suppression of dual input/reciprocal sensory inhibition. In other words SMT improved the communication between body and brain by improving the delivery and accuracy of processing of sensory (proprioceptive) information.

As a reminder, reciprocal sensory inhibition allows the brain to better distinguish information coming from adjacent body parts which allows for better sensory perception which allows for better motor control. Your brain "sees" your body via proprioception and reciprocal sensory inhibition allows your brain to "see" your different body parts more clearly and thus to control them more accurately.

"This study extends previous work [2007 study by same authors I reviewed in Nov 2021 Research Review] that has demonstrated attenuated parietal N20 and frontal N30 SEP components, reflecting altered cortical processing, for 20 to 30 minutes postmanipulation."

"The current study findings suggest that the initial changes that occur after spinal manipulation occur at the cortical level. This is in agreement with previous research. The peripheral N9 peak, representing the afferent volley in the brachial plexus, was maintained stable in this experiment. The changes observed in this study therefore most likely reflect central changes."

No changes in peripheral signals so changes almost certainly occurring in brain cortex (sensory-motor cortex).

"The changes observed in the current study only occurred for the frontal N30 component of the SEP peaks. Although some authors suggest this peak is generated in the postcentral cortical regions (ie, S1), most evidence suggests that this peak is related to a complex cortical and subcortical loop linking the basal ganglia, thalamus, premotor areas, and primary motor cortex. The frontal N30 peak is therefore thought to reflect sensorimotor integration."

"The decreased frontal N30 SEP peak ratio observed in the current study therefore suggests that there may be an increase in surround inhibition or filtering of sensory information from the upper limb occurring somewhere in these cortical and subcortical loops linking the basal ganglia, thalamus, premotor areas, and primary motor cortex for at least 20 minutes immediately after spinal manipulation.

"Impaired surround inhibition before spinal manipulation may account for this finding."

In other words, joint dysfunction/VSC may be resulting in impaired surround inhibition!

"The SEP ratio changes appear to be due to an increased inhibition of the dual peripheral input, as the MU data significantly decreased for this SEP component after the manipulation intervention."

"The passive head movement SEP experiment demonstrated that no significant changes occurred after a simple movement of the subject's head. The results after manipulation are therefore not simply due to altered input from vestibular, muscle, or cutaneous afferents as a result of the doctor of chiropractic's touch or due to the actual movement of the subjects head. This therefore strengthens the argument that the results in this study are more likely specific to the delivery of the high-velocity, low-amplitude thrust to the dysfunctional joints."

Actually, this is not quite accurate. What is accurate is that the results are likely due to the delivery of the high-velocity, low-amplitude thrust of the adjustment/SMT, whether this is specific to the identified dysfunctional joints cannot be determined by this study design. To determine this would have been easy – just have one group that received adjustment/SMT of joints not identified as dysfunctional!!

CONCLUSION

"Episodes of acute pain, such as after an injury, may initially induce plastic changes in the sensorimotor system. These changes could include dysfunctional motor control of spinal joint segments, that is, the manipulable lesion that chiropractic physicians and other manipulative therapists treat."

"Pain alone, without deafferentation, has been shown to induce increased SEP peak amplitudes and increased somatosensory evoked magnetic fields. Sensorimotor disturbances are known to persist beyond acute episode of pain, and these disturbances are thought to play a defining role in the clinical picture and chronicity of different chronic neck pain conditions."

The brain changes elicited from acute VSC/segmental motion unit dysfunction persist beyond the acute episode of pain and these brain changes in sensori-motor integration and motor control further create sensori-motor changes that manifest as chronic VSC, often without symptoms or 'beyond the resolution of symptoms'.

Clinically what this means is that asymptomatic VSC/segmental motion unit dysfunction is common, can only be <u>detected</u> with palpatory spinal examination, and can only be <u>determined as resolved</u> with palpatory spinal examination.

This is PRECISELY why I created the Spinal Health Assessment (SHA) and Report to allow chiropractors to have an evidence-based, VSC/segmental motion unit dysfunction centric practice!

"Therefore, the reduced frontal N30 SEP peak ratio observed in the current study after spinal manipulation may reflect an improvement of plastic changes induced by previous injury and may reflect one mechanism for the improvement of functional ability reported after spinal manipulation."

"Tinazzi et al argued that the increased central dual SEP peak ratios represented reduced surround inhibition in the patients with dystonia and that their findings suggest that the inhibitory integration of mainly

proprioceptive afferent inputs coming from adjacent body parts is abnormal in patients with dystonia. Furthermore, they argue that the inefficient integration of dual input was most likely due to altered surround inhibition and could in turn lead to abnormal motor output, contributing to the motor impairment present in dystonia. Motor impairments are also present in chronic neck pain patients. Impairment of deep cervical neck flexors and significant postural disturbances during walking and standing has been demonstrated in both insidious-onset and trauma-induced chronic neck pain conditions."

Chronic neck pain patients are very likely chronic VSC/segmental motion unit patients!

"Altered sensitivity of proprioceptors within the neck muscles has been suggested to be related to the postural disturbances seen in these patients. It is therefore possible that this leads to altered or inefficient integration of dual input in this patient group also, resulting in the above mentioned motor impairments. There is also evidence to suggest that muscle impairment occurs early in the history of onset of neck pain and that this muscle impairment does not automatically resolve even when neck pain symptoms improve."

"Some authors have therefore suggested that the deficits in proprioception and motor control, rather than neck pain itself, may be the main factors defining the clinical picture and chronicity of different chronic neck pain conditions. These deficits in proprioception and motor control may be partly due to spinal dysfunction causing either inhibition or facilitation of neural input to the muscles surrounding the spine."

"However, the central sensorimotor plastic changes that occur with spinal dysfunction may also lead to abnormalities in the way the CNS processes incoming information from more distal regions, such as the upper limb. The altered frontal P22-N30 SEP peak ratio after spinal manipulation may reflect an improvement of such maladaptive plastic changes in the current study population, who all had reoccurring neck problems, but were not in acute pain at the time they participated in this study."

Treating pain does NOT treat or resolve VSC, BUT treating/correcting VSC can resolve pain while it also resolves the sensori-motor issues.

I would be most grateful if you see enough value in these Research Reviews to recommend them to a colleague.

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Talk to you next month.

Dr. C.