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PLENARY PAPERS

Reflex Effects of Vertebral Subluxations: The Peripheral Nervous System. An Update

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ABSTRACT

Background: The traditional chiropractic vertebral subluxation hypothesis proposes that vertebral misalignment cause illness, disease, or both. This hypothesis remains controversial.

Objective: To briefly review and update experimental evidence concerning reflex effects of vertebral subluxations, particularly concerning peripheral nervous system responses to vertebral subluxations.

Data Source: Information was obtained from chiropractic or scientific peer-reviewed literature concerning human or animal studies of neural responses to vertebral subluxation, vertebral displacement or movement, or both.

Conclusion: Animal models suggest that vertebral displacements and putative vertebral subluxations may modulate activity in group I to IV afferent nerves. However, it is not clear whether these afferent nerves are modulated during normal day-to-day activities of living and, if so, what segmental or whole-body reflex effects they may have. (J Manipulative Physiol Ther 2000;23:101-3)

Key Indexing Terms: Chiropractic; Vertebral Subluxation; Nervous System; Afferents; Joint Biomechanics; Muscle

INTRODUCTION

In contrast to others who manipulate the vertebral column, history records that a unique feature of the chiropractic profession is that many of the clinical activities of chiropractors have developed from a clinical hypothesis proposed by Palmer[1] concerning vertebral misalignment. Although others who manipulate the vertebral column may do so for other reasons, it is important for the chiropractic profession to determine the validity of the chiropractic vertebral subluxation hypothesis for 3 principle reasons. First, if false, it should be abandoned, and alternative hypotheses should be proposed and tested. Second, if partly correct, it should be modified according to the available valid (scientific) evidence, and the clinical activities of all healthcare providers should be modified accordingly. Third, scientific investigations of the chiropractic vertebral subluxation hypothesis may provide important clues about health and disease that can enhance the clinical activities of all healthcare providers. Therefore the objective of this invited article is to briefly review and update experimental evidence concerning reflex effects of vertebral subluxations, particularly the peripheral nervous system response to vertebral subluxations.

DISCUSSION

The traditional chiropractic vertebral subluxation hypothesis proposes that vertebral misalignment, less than a dislocation, causes nerve interference and that this causes disease or ill health.[1] Some[2-5] consider this to be an oversimplification and have endeavored to develop the original chiropractic vertebral subluxation hypothesis first proposed by Palmer.[1] Although various strategies for determining the presence of vertebral subluxations have been described in texts,[6-9] the chiropractic vertebral subluxation hypothesis remains problematic for both the clinician and the scientist. For example, when is a vertebra misaligned, and what constitutes nerve interference?

Sandoz[10] reports that before Palmer[1] proposed the chiropractic vertebral subluxation hypothesis, it was recognized that a vertebral subluxation (vertebral misalignment less than a *luxation* or dislocation) inevitably involves altered motion between the subluxated vertebra and its adjacent vertebra. The inference is that a subluxated vertebra may have a static component, a dynamic component, or both. However, the biomechanical or morphometric characteristics of a subluxated vertebra are yet to be clearly established.

There are a number of hypotheses and theoretic models concerning how vertebral subluxation may cause nerve interference. These are listed in Table 1 and reflect current experimental evidence of altered function or activity in nerve tissue. The phrase *vertebral subluxation complex* has been used by some to indicate the likely segmental tissue responses to misalignment of one vertebra with respect to its adjacent ver-

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Table 1. *A list of proposed hypotheses concerning how a vertebral subluxation may result in neurogenic dysfunction*

- The nerve compression hypothesis,
- Axoplasmic aberration hypothesis
- Neurodystrophic hypothesis
- The cord-compression hypothesis
- Somatosomatic reflex hypothesis
- Somatoautonomic reflex hypothesis
- Viscerosomatic reflex hypothesis
- Vertebrobasilar artery insufficiency hypothesis

Adapted from Leach RA. The chiropractic theories. A synopsis of scientific research. Baltimore: Williams & Wilkins; 1986. p. 3 and Mootz RD. Theoretic models of chiropractic subluxation. In: Gatterman MI, editor. Foundations of chiropractic subluxation. St. Louis: Mosby Year Book; 1995. p. 175-89.

tebrae.[2,11] For the purpose of the discussion here, a putative vertebral subluxation is considered to exist when vertebral displacement (misalignment), altered (restricted) motion, or both exist between two adjacent vertebra. These features are generally agreed to represent the *lesion* that chiropractors endeavor to identify and treat in respect to the chiropractic vertebral subluxation hypothesis.[7,8,12]

Segmental Afferent Responses to Vertebral Displacement

Yamashita et al[13] characterized afferent nerve activity arising from lumbar zygapophysial joints and paravertebral tissues of anesthetized rabbits by recording electrophysiologic activity in the dorsal rootlets innervating the lumbar vertebral column. These investigators mechanically stimulated this region by applying Von Frey hairs to determine mechanical thresholds for nerve activation or modulation. They also manually displaced the isolated articular processes in a number of directions. Most (63%) of the activity in nerve fibers with receptive fields in the joints were reported to be in nerve fibers conducting in the group III and IV range. Although a significant number (29%) had higher conduction velocities, they were typically closer to the group III range. Afferent nerve fibers with receptive fields in the paravertebral muscle and tendons were found to have higher conduction velocities, typically in the group II range. These investigators extended their studies by examining the electrophysiologic activity arising from these same joints in an isolated lumbar vertebral column preparation of the rabbit in which they could exert specific load.[14] They identified 3 types of mechanosensitive afferent nerve responses. Two groups were slowly adapting to the application of the load: one had a low (0.3-0.5 kg) mechanical threshold, and the other had a high (3.0-5.5 kg) mechanical threshold. The third group had a phasic response that was generally activated during the movement phase of the applied load, irrespective of the direction in which the load was applied. More recently, Pickar and McLain[15] used a similar strategy for recording afferent activity arising from the lumbar facet joint in the cat during manual displacement of the joint. They classified the single-fiber activity in the segmental dorsal rootlets according to conduction velocity and response to the application of Von Frey hairs. They identified group III and IV afferent activity occurring during manual displacement of the zygapophysial joint. The receptive fields of these afferent nerves included the joint being displaced and its paraspinous tissue. Interestingly, Pickar and McClain identified units that exhibited some direction sensitivity; that is, they were best activated by displacement of the articular process in a particular direction.

Table 2. *A list of reflexes evoked by mechanoreceptors in the neck*

- Cervicocollic reflex
- Tonic neck reflex
- Cervico-ocular reflex
- Cervicorespiratory reflex
- Cervicosympathetic reflex

Adapted from Wilson[24] and Bolton.[25]

The observations reported above are consistent with the mechanical response characteristics of group III and IV afferent nerves in the periphery[16] and neck region.[17] However, it is unclear whether the nerve activity elicited in the studies reported above actually occurs during a vertebral displacement in the intact animal. In this regard we have developed a strategy to examine afferent information arising during natural displacement of the intact vertebra in the neck of the cat.[18,19] Our data suggest that vertebral displacement may be signaled to the central nervous system by afferent nerves arising from deep intervertebral muscles. In particular, both the velocity and relative position of the vertebral displacement may be coded by afferent nerve activity from intervertebral muscles. Furthermore, our data suggest that afferent nerves innervating the zygapophysial joints are unlikely to make a major contribution to signaling vertebral displacement.

Reflex Responses to Vertebral Subluxation

A number of attempts have been made to develop models of putative vertebral subluxation in mammals to test the chiropractic vertebral subluxation hypothesis.[20] Notable among these are the studies by Sato and Swenson[21] and DeBoer et al.[22] These studies successfully recorded physiologic parameters in the presence of a putative vertebral subluxation or vertebral displacement. In brief, they involved the creation of transient vertebral misalignment in anesthetized rats or conscious rabbits while simultaneously recording one or more of either heart rate, blood pressure, or electrical activity in renal and adrenal nerves or gastrointestinal muscles. Their findings suggested that transient vertebral displacement may alter blood pressure, heart rate, and electrical activity in these nerves and muscles.

It remains to be determined whether the modulation of nerve activity reported above is a normal or appropriate physiologic (homeostatic) response to vertebral displacement as might occur during normal day-to-day vertebral movements. It is important to recognize that modulation of some nerve activity during vertebral displacement may be quite appropriate. For example, activation of mechanoreceptors located close to the vertebra in the neck[23] normally elicits a number of postural reflexes, as shown in Table 2.[24,25]

Future Investigations

To test the chiropractic vertebral subluxation hypothesis and identify whether the activity or behavior of the physiologic parameter being studied represents aberrant function, it is essential to establish that the response or activity noted during the vertebral subluxation is not only unique to the specific stimuli (ie, the vertebral misalignment, aberrant motion, or both between adjacent vertebra) but that it also results in (or is a precursor to) aberrant function consistent with signs or symptoms of ill health or disease. With this in mind, we proposed an in vivo model for examining the chiropractic vertebral subluxation hypothesis[26] and have developed a preparation to test the chiropractic vertebral subluxation hypothesis.[19] This work is ongoing in our laboratory.

CONCLUSION

The studies referred to here clearly identify that slow-conducting (group III and IV) afferents with receptive fields in the zygapophysial joints and paravertebral tissues can be activated by mechanical forces applied to the zygapophysial joints, para-articular tissues, or both. Some of these high (mechanical) threshold afferents (group IV) may be responsible for relaying signals that result in the sensation of pain known to arise from vertebral joints.[27] There is good evidence that displacement of vertebrae modulate nerve activity in afferent nerves innervating muscle spindles and other low (mechanical) threshold receptors, such as Golgi tendon organs in intervertebral muscles. It is also clear that some types of vertebral displacements can modulate heart rate, blood pressure, and electrical activity in renal and adrenal nerves and in gastrointestinal muscles.

However, as identified over 10 years ago,[28] without further suitable scientific investigations, the segmental reflex and whole-body consequences of the chiropractic vertebral subluxation or manipulable lesion remain theoretical and are yet to be determined.

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