

The Reflex Effects of Subluxation: The Autonomic Nervous System

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Editor's note: This paper by Dr. Budgell is slated for publication in the February 2000 issue of the *Journal of Manipulative and Physiological Therapeutics (JMPT)*, an issue dedicated to the 1999 World Chiropractic Congress in Auckland, New Zealand that took place in May of this year. (See "Report from the World Chiropractic Congress," DC June 28).

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There is no shortage of theories to explain the role of the subluxation in disease and the effect of the adjustment in relieving symptomatology. The autonomic nervous system has often been invoked in constructing mechanisms to account for the effects of spinal dysfunction. Recent investigations justify the attention which has been focused on this component of the nervous system.

To discuss the reflex effects of the subluxation on the autonomic nervous system, it is necessary first to characterize the subluxation. The chiropractic subluxation has been defined in terms which are useful philosophically and politically. However, this entity has not been described in terms which are of assistance to the physiologist. Nonetheless, our clinical experience tells us that the manipulable lesion is often painful and displays some biomechanical abnormality, such as restricted or aberrant motion. We could therefore study the effects of nociceptive or mechanical stimulation as a way of investigating a portion of the spectrum of effects of the subluxation on autonomic nervous system function.

The modern physiological investigations of the impact of somatosensory input on autonomic functions have been reviewed in a very comprehensive monograph by Sato, Sato and Schmidt.¹ Of the approximately 750 basic scientific papers which they cited, however, only three made reference to spinal stimulation. In the past, therefore, we have been compelled to look at the effects of, for example, limb joint or skin stimulation, and extrapolated them to the spine.

In the 15 years since Rand Swenson's first study,² the chiropractic profession has generated approximately a half-dozen basic scientific papers specifically investigating the effects of spinal stimulation on autonomic or visceral function. This is a minuscule amount in terms of what needs to be done, but we can already see results which could help guide the clinician in assessment and management.

It would be useful to review those few physiological investigations of spinovisceral function which have been published. However, to place them in perspective, it is first necessary to take a look at the earlier history of experimentation which led to the familiar model of the somatoautonomic reflex.

The Cannon Model of the Somatoautonomic Reflex

The term "autonomic" was first applied to the sympathetic and parasympathetic nervous systems by Langley around the turn of the century. Experimentation of that era frequently used noxious stimulation (the better to elicit consistent results), applied to limb tissues (which were easily accessible) to elicit changes in heart rate and blood pressure (which were easily measured). Most experimental models have utilized anesthetized animals in order to eliminate the influence of emotional factors. These aspects of experimental design have been essential to successful investigation of somatoautonomic phenomena and led to the development of a model of autonomic response to noxious stimulation generally attributed to Walter Cannon and characterized as "fight or flight."

The essential elements of the model were that noxious stimulation applied to any tissue would elicit a generalized response mediated by the brain. This model runs counter to the professed collective experience of the chiropractic profession, which maintains that aberrant stimulation at a particular level of the spine is likely to elicit a segmentally organized response which may manifest itself in dysfunction within organs receiving autonomic innervation at that level.

Revision of the Cannon Model

In early investigations, it had frequently been observed that transection of the cervical spinal cord eliminated somatosympathetic reflex discharges. Consequently, it was assumed by Cannon and others that these reflexes were mediated at the supraspinal level. Later, however, Beacham and Perl were able to demonstrate somatosympathetic reflex discharges of spinal origin.^{3,4} Since then, many investigators have confirmed the existence of spinal and supraspinal reflex centers.

Kimura et al.⁵ demonstrated that in CNS-intact anesthetized rats, noxious mechanical stimulation of the skin elicits significant responses in heart rate. Pinching virtually anywhere produced some response. However, there was a segmental tendency, with the strongest responses coming approximately equally from stimulation of the hindpaws or forepaws. In spinalized animals, the segmental tendency was altered but exaggerated. Thus, in spinalized animals, forepaw stimulation still gave a significant but relatively weak response, while stimulation in the thoracolumbar region produced much-enhanced reflexes. Furthermore, and quite interestingly, stimulation on the right side gave a significantly greater response than stimulation on the left side. In contrast then to the Cannon model, there is clear evidence of spinal reflex centers which mediate segmentally organized responses.

In general, it has been found that natural stimulation of nociceptors or electrical stimulation sufficient to recruit unmyelinated C-fibers have been most effective in eliciting consistent somatoautonomic reflex responses.⁶ Reflex effects have been demonstrated throughout the cardiovascular system, in the digestive system, urinary system, endocrine system and immune system.¹ In anesthetized animals, innocuous stimulation produces weak, inconsistent responses or no reflex at all. In particular, it has generally been shown that stimulation of group Ia fibers (from muscle spindles) or group Ib fibers (from Golgi tendon organs) has virtually no effect on autonomic nervous system activity or visceral function.⁷

For example, in anesthetized cats, it has been shown that movement of the knee joint within its normal physiological range has no effect on blood pressure or heart rate.⁸ However, forced movement beyond the normal physiological range produces significant increases in these parameters. Furthermore, in the acutely inflamed joint, these responses are greatly exaggerated. In fact, in the inflamed joint, even movement within the normal range produces reflex increases in blood pressure and heart rate. Similar observations abound: noxious stimulation elicits clear and

consistent autonomic responses; innocuous stimulation elicits weak and inconsistent responses (or none at all). These observations appear to run counter to the experience of chiropractors who maintain that dysfunction of the spine need not be painful in order to elicit visceral dysfunction.

Basic physiological studies involving stimulation of peripheral tissues in anesthetized animals therefore provide only partial support for the view that spinal dysfunction may impact autonomic function. Segmentally organized spinal reflexes have been demonstrated, but only consistently in response to noxious stimulation.

Spinovisceral Reflexes

While the limbs and peripheral joints are easily accessible, relatively little work has been conducted on spinal and paraspinal tissues. It is not unreasonable to think that axial tissues may differ in innervation from more peripheral tissues, or that sensory input from axial tissues might elicit distinct reflex responses. A single study conducted by Dr. Rand Swenson² investigated the effects of mechanical stimulation of the spine on blood pressure, heart rate and renal sympathetic nerve activity. The application of lateral stress to the lower lumbar or lower thoracic spine produced changes in the monitored parameters; these changes outlasted the length of stimulation. The results were clearly shown to be the result of activation of spinal afferents. However, it is unclear whether the forces applied from 0.5 to 3.0 kg should be characterized as noxious or innocuous.

More recent studies conducted in Dr. Akio Sato's lab have employed noxious chemical stimulation of interspinous tissues in anesthetized rats. The virtue of this system is that the algescic used, capsaicin, causes a well-characterized response within a subset of polymodal nociceptors so that mechanical stimulation is removed as a consideration. The stimulation is pure and relatively long-lasting pain, as might be encountered in clinical syndromes of spinal pain. Such stimulation has been shown to produce a profound increase in systemic blood pressure and a matching increase in sciatic nerve blood flow.⁹

However, although blood pressure remained elevated for perhaps 20 minutes or more, sciatic nerve blood flow quickly dropped below pre-stimulus levels and remained there for approximately 20 minutes before normalizing. This suggests that noxious chemical stimulation of the interspinous tissues evokes two competing reflexes: (I) an increase in systemic blood pressure, which initially leads to a passive increase in sciatic nerve blood flow; and (II) constriction of the sciatic vasa nervorum, resulting in a decrease in sciatic nerve blood flow. It would appear that with the long-lasting noxious spinal stimulation of capsaicin injection, the reflex constriction of the vasa nervorum becomes fully manifested and overpowers the effect of systemically increased blood pressure.

A related study has examined adrenal nerve activity and catecholamine secretion in response to capsaicin injection of thoracic and lumbar interspinous tissues.¹⁰ In both CNS-intact and spinalized animals, noxious stimulation of the interspinous tissues normally leads to increases in adrenal sympathetic nerve activity and catecholamine secretion. It was possible to confirm both supraspinal and spinal reflex responses to stimulation of A and C fibers, and there was a relatively greater response to thoracic stimulation in the spinalized animal. In this regard, it should be noted that the bulk of preganglionic sympathetic neurons serving the adrenal gland in the rat are located between the T7 and T10 level of the spinal cord.

A further study of spinovisceral reflexes reported responses of bladder motility to noxious spinal stimulation.¹¹ Previous studies had shown that the resting bladder could be stimulated to contract

by noxious stimulation of the perineal skin. Noxious stimulation of other areas was ineffective. This suggests that the reflex depended upon stimulation within the territory of afferent fibers which enter the cord at the level of parasympathetic outflow to the bladder.

The more recent study, however, showed that stimulation at either the thoracic or lumbar level could produce a brisk response in bladder tone. This response was mediated at the supraspinal level, and the efferent limb of the reflex was within the pelvic nerves which provide parasympathetic innervation to the bladder. In contrast to the adrenal studies, when the reflex is mediated principally at the supraspinal level, there is not a clear segmental organization.

A study just completed has examined responses of gastric motility to capsaicin injection of thoracic and lumbar interspinous tissues. Noxious chemical stimulation of the interspinous tissues was associated with arrest of peristaltic movement and a sharp decline in gastric muscle tone. The decrease in gastric tone was significantly greater in response to thoracic (as opposed to lumbar) stimulation, was unaffected by bilateral vagotomy, and was preserved in spinalized animals. This is the clearest demonstration to date of a segmentally organized, spinally mediated visceral response to noxious stimulation of spinal tissues.

To summarize the results of these animal studies, we may say that autonomically mediated reflex responses to noxious stimulation of spinal tissues have been clearly demonstrated. Where parasympathetic influences dominate, a segmental organization has not been apparent. Where sympathetic mediation has been significant, it has been possible to demonstrate the existence of spinal reflex centres, and to some degree, at least, a measure of segmental organization.

Certain findings cited are consistent with the observations of chiropractic clinicians concerning the effects of spinal dysfunction on visceral disorders. On the other hand, the bulk of the positive data obtained were elicited with noxious stimulation. There is still little (if any) support for the contention that painless spinal dysfunction can affect organ function. This is scarcely surprising considering that all of the basic physiological work cited was performed in anesthetized animals.

However, we now have tantalizing new evidence suggesting that muscle spindles in cervical paraspinal muscles may in fact be capable of eliciting somatoautonomic reflexes.¹² Additionally, there is recent evidence from studies in conscious humans that innocuous somatic stimulation of the neck may influence cardiovascular function.¹³ Additional and similarly well-conceived studies of basic physiology and clinical phenomena will be needed to construct a scientifically robust explanation for the promising observations of practitioners of spinal manipulation.

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OCTOBER 1999