

Neurodynamics of vertebrogenic somatosensory activation and Autonomic Reflexes - a review:

The introduction to a clinical series

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Abstract: Neurological factors associated with the vertebral subluxation are presented together with recognition of this clinical entity by the chiropractic, medical and osteopathic professions.

Noxious activation of somato-autonomic reflexes is an established physiological response to sensory phenomenon.

While neuro-phenomenon is recognised physiologically, it appears due recognition of the vertebrogenic origin in somatosensory physiology seems to be limited in clinical medicine.

Indexing terms: Vertebral subluxation; Neurophysiology; Somatosensory; Autonomic nervous system

Introduction

The explanation for many biological phenomena may depend on a contextual understanding. There can however be significant evidence in support of hypotheses. This series is offered in order to discuss some of the neurophysiological evidence associated with the complex vertebral subluxation concepts.

A brief overview is presented of some of the available material involving vertebrogenic pathophysiology. This series seeks to explore existing published evidence of the effects of disturbed somatic structures influencing neurological function and impacting on visceral function. This phenomenon has been designated here as a *Somato-Autonomic Visceral Complex* (SAVC). The data recognises intricacies involving the vertebral subluxation complex as a primary influence in this phenomenon, as well as being a particularly cogent portal that seeks to neutralise the noxious neural input.

... Aberrant somatosensory reflexes are seen as one of the elements involved in vertebral subluxations'



This review is aimed at presenting and discussing in particular the medical evidence that supports the chiropractic hypothesis of the vertebral subluxation. Under current available evidence, that hypothesis is offered as the most likely explanation for the phenomenon reported by patients and recorded in the literature by chiropractors, osteopaths and medical practitioners. (1, 2, 3)

For the purpose of this report a subluxation is defined as:-

A subluxation is an articular dysfunction, typically but not limited to the spine and pelvis, characterised by anatomical and neurophysiological signs and symptoms.

The manual or instrumental correction of a vertebral subluxation or other articulation is identified as an *adjustment* which emphasises its specificity.

An adjustment may be defined as:-

The physical application of a highly developed finely tuned advanced form of manual or instrument intervention directed to restore joint and neural physiology in order to ameliorate associated signs and symptoms.

The Vertebral Subluxation Complex: Beyond the mechanical

There has been a tendency to regard the *Vertebral Subluxation Complex (VSC)* primarily as elements of an articular biomechanical dysfunction with or without osseous displacement. Evolving research and clinical case reports recognise a significant integrated neural element associated with these physical and pathophysiological articular disturbances. These are essentially neuropathophysiological with identifiable signs and symptoms. The somatosensory afferent influence upon the autonomic nervous system (ANS), and consequently upon visceral physiology is now well recognised as somatovisceral reflex pathophysiology. (4)

Despite some notable exceptions, conventional allopathic clinical models have shown comparatively limited interest in any means to influence human physiology other than through medication. Meanwhile the chiropractic and osteopathic professions have focused on clinically recognised disturbances of this autonomic influence due to disrupted somatic structures, particularly from a neurophysiological and clinical perspective. (5)

The input from noxious vertebral activation may be regarded neurologically as distinctly sensitive and influential. Such input may originate from sensory elements in a range of somatic structures through to a range of spinal somatic structures, particularly the sensory-rich facets. Through somatosensory, somato-autonomic, somatovascular, and somatovisceral activation of reflexes, the influence may play a number of pathophysiological roles. For these reasons it is necessary to note that the VSC is appreciably more comprehensive than the very limited version of just a partially displaced bone as in the previous more traditional definition of a subluxation. (6, 7, 8)

In view of these considerations, it would then seem prudent, to neutralise adverse neural influence by eliminating the noxious sensory input.

A classic example of this *somato-autonomic complex* would be cervicogenic headaches which exemplify the neural involvement. Other examples would include lumbogenic sciatica and thoracogenic intercostal neuralgia along with other recognised functional vertebrogenic conditions such as dysphagia, dyspepsia and simulated conditions shadowing neural pathways. (9, 10)

This rationale for the science sustaining the subluxation concept draws primarily on the standard biological and medical sciences. This series draws heavily from these with a deliberate use of citations in order to demonstrate the strength of the evidence in the face of claims that it does not exist,

This treatise is proposed in order to submit evidence-based material upon which a rationale for a contextual model of a vertebral subluxation complex may be based. Practitioners in the manipulative sciences have noted for over a century that while managing back and neck pain that on occasion, a range of other symptoms and conditions may also appear to ameliorate. These involve activated somato-autonomic, somatosensory, somatovisceral and somatosomatic reflex signs and symptoms. Positive outcomes have led to published case reports, research and word-of-mouth referrals by patients.

Davis summarises the somatosensory disturbance in his example following whiplash when he states '*Patients with chronic whiplash syndrome may have a generalized central hyperexcitability from a loss of tonic inhibitory input (disinhibition) and/or ongoing excitatory input contributing to dorsal horn hyperexcitability. Dysfunction of the motor system may also occur, with or without pain.*' (11)

A range of everyday clinical signs and symptoms can at times indicate noxious somatosensory reflex input from aberrant somatic structures. These somatic structures such as functionally disrupted joints may be identified as subluxation complexes, or if a spinal segment, a *vertebral subluxation complex (VSC)*. These spinal complexes may be static or dynamic with an integrated afferent and efferent neural element. It should not be regarded as a purely osseous disturbance.

Manual correction or adjustment which seeks amelioration of this VSC through specific manipulation of the particular articulations has been clinically found to positively influence associated disturbance of the *autonomic nervous system*, as identified in the many case reports in chiropractic and osteopathic texts and journals. (12, 13, 14, 15, 16)

However, cases of clinical evidence explaining and supporting these observations are available in the published literature. This has been primarily garnered by the chiropractic and osteopathic professions and to a limited degree in the medical literature. (17-19)

Aberrant somatosensory reflexes are seen as one of the elements involved in vertebral subluxations. Somato-autonomic afferent reflexes have traditionally only received limited attention in clinical applications. In 1997 Sato stated that in relation to '*autonomic reflex regulation, insufficient attention has been paid to the role of somatic afferents.*' (1) Relatively limited appreciation of this aspect of neurophysiology seems to have merged into orthodox allopathic practices, except for the manipulative sciences. As such, it could be said that this statement from some 20 years ago is still current, particularly from a therapeutic point of view. (20)

Early use of the term *autonomic nervous system (ANS)* was first proposed by Langley in 1898. (2) Three years earlier Palmer rationalised the importance of this aspect of the nervous system which he subsequently called the body's automatic functions. (3) Bannister stated that the ANS influence was delivered to '*every visceral organ in the body.*' (4) Jänig et al also state that '*virtually all organs and tissues except skeletal muscle fibres receive an autonomic innervation*' and that '*innervation of most blood vessels is only by sympathetic (vasoconstrictor) axons.*' (21, 22, 23, 24)

Autonomic visceral reflexes primarily regulate the body's non-somatic structures and functions. In this neurophysiological role, these functions are regarded as homeostatic reflexes and can be activated by visceral, special senses, humoral, or somatic stimulation depending on the site, strength, or spinal level of somatic activation. (6, 7)

Sato and Swenson applied lateral pressure on rats' vertebrae and detected definitive somatovisceral reflexes affecting blood pressure, heart rate, and renal nerve activity. This simulated mechanical input tends to replicate stimulation of the spine creating noxious activation from the fixation or displacement of spinal segments. Fixations are seen by chiropractors as a frequent factor in many VSCs with the potential to affect the function of visceral structures via the

ANS. Lantz states that *'every connective tissue component of an articulation is affected by immobilisation. This immobilisation is termed by chiropractors as a fixation and comprises a central element of the vertebral subluxation complex along with segmental displacement.'* (25, 26, 27, 28, 29)

Somatic structures, particularly articular surfaces and especially vertebral articular facets are rich in mechanoreceptors. Patterson states that the spinal column is so extensively and richly innervated with mechanoreceptors *'it seems to operate as one vast proprioceptive organ.'* These sensitive receptors continually feed sensory information through the ANS to the brain in order to maintain homeostasis as well as monitor and coordinate body movement and status including both protopathic (nociception) and proprioception (position) senses. This evidence suggests that both chronic and acute noxious insults have the potential to develop somato-autonomic reflex activity and subsequently somatovisceral pathophysiology associated with the vertebral subluxation complex. (30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42)

Articulations disturbed by trauma, inflammation, hypermobility, hypomobility (vertebral impedance), stasis, aberrant movement, or micro-displacement (43) of articulations in particular lead to somatosensory activation. This can result in a barrage of neural firing from a range of different activated mechanoreceptors. These may lead to associated somato-autonomic neural reflex arcs involving innervation of organs and muscles. Under the facilitation hypothesis this hyper-stimulated irritation may then stimulate the intrinsic segmental muscles (e.g. rotators) resulting in their hypertonicity and vertebral segmental restrictions (VSC) which could further contribute to excitation of somatovisceral reflexes, and potentially organ dysfunction. (12, 13, 44)

Somatovisceral reflexes

In somatovisceral reflexes, somatic sensory input from peripheral stimuli enters the sympathetic portion of the ANS either through dorsal root ganglia, cranial nerve ganglia, or nuclei. The reflex then emerges from the lateral horn of the spinal cord, or from a cranial nerve nucleus, to a ganglion as a presynaptic efferent branch passing through as a postganglionic fibre to the target structure. The return reflex arc may then be completed via the afferent branch. Anatomically, the afferent branches of the somatovisceral reflex circuits follow similar pathways as many somatic and special senses activate autonomic responses. It may also be noted that viscerosomatic reflexes can result in irritated muscular splinting (as in muscular guarding associated with acute appendicitis) which may in turn also stimulate further contraction of the intrinsic segmental spinal muscles. (44, 45, 46, 47) This neural activation may lead to further noxious somatic irritation and stimulation of somato-autonomic reflexes as elements of the vertebral subluxation complex.

In noting that the stimulation of spinal nerves can affect visceral organs, Sato et al further define this spinal segmental reflex being *'... elicited when spinal nerves originating at specific segmental levels are stimulated. The segmental afferent nerves modulate visceral organs via autonomic efferent nerves or modulate them indirectly by affecting visceral afferent input.'* (30) As with much conventional research, Sato et al used animal subjects with appreciable correlation with medical physiology in this extensive work which cites some 750 basic scientific papers. (48, 49)

In merging the concepts of the pathophysiological and pathomechanical phenomena involving activated vertebrogenic somato-autonomic and somatovisceral reflexes, the more comprehensive term of *Somato Autonomic Visceral Complex (SAVC)* is offered as a contextual description. This serves to imply the broader significance of this mechanical and neurophysiological phenomenon, as they relate to the manipulative sciences. To normalise this physical-mechanical (somatic) disturbance, the term *Somato-autonomic Complex (SAC)* implies a physical corrective influence to certain visceral functions. (20)

Where there is a dominant spinal enablement, it is further suggested that this SAVC complex may be more accurately identified with the definitive term of Vertebral Autonomic Visceral Complex (VAVC). This would differentiate the spine from the somatic influence originating from other somatic structures initiating autonomic reflexes. This would identify VSCs as a source of influence both physiologically and therapeutically in the manual sciences.

The pathoneurophysiological impact of noxious somatic activity upon somato-autonomic reflexes should be more widely recognised clinically. In addition to innocuous physiological tone, (31) a barrage of chronic neural impulses from noxious somatic input originating from highly activated mechanoreceptors, proprioceptors, and nociceptors, may be further facilitated within a vertebral subluxation impact on autonomic functions. This may be further influenced by such initiating factors including severity, duration, type, and recurrence or persistence patterns. Stimulated receptors contained in cartilaginous facet surfaces, ligamentous, capsular, spinal musculature, and tendon tissue would activate such reflex registration. This reflex arc may also encompass and be reflected in the tone of individual muscles. (50, 51, 52, 53, 54, 55)

Examples of somato-autonomic disturbances can be clinically noted in instances of cervicogenic headaches, heart rate variability, and a range of nociceptive syndromes. Given these precedents, it is then reasonable to assert that similar reflexes involving other spinal segmental levels may impact on other internal organs as somatovisceral pathophysiology and syndromes. (56, 57, 58, 59)

Variable factors of activation could include the articular segmental level, duration, type and severity of somatic disturbance, as well as health status and age of the patient. Passatore et al noted that not only may the more severe grades of whiplash associated disorders (WADs) affect the spino-medullary regions, but lower grades may also disrupt vertebrobasilar circulation. They opined that both '*major and minor neurological symptoms*' of regions supplied by these arteries may be affected as a result of even minor trauma. (60)

Definitive evidence of a somatic impact on the autonomic nervous system was noted by Hakim and Grahame in 2004 and Durand and Daniels in 2020. (61, 62) These authors recommended wider recognition of this articular dysfunction as it has been '*overlooked by physicians*'. They found joint hypermobility in 174 hospitalised patients presenting many different autonomic-related symptoms, including:

- ▶ Presyncope - fainting, feeling faint, dizziness, light-headedness;
- ▶ Cardiorespiratory - chest pain, shortness of breath, palpitations;
- ▶ Gastrointestinal - nausea, stomach ache, diarrhoea, constipation; and
- ▶ Fatigue, joint pains, anxiety, depression, migraine, allergy, rash, nocturia, dysuria, flushing, night sweats, fever, lymph gland pain, poor sleep.

Although nerve root compression (NRC) may be an extreme example, the associated symptoms and pathology could be assessed as severe. However, in the medical literature, there seems to be relatively little consideration of degrees of NRC such as minor irritation. One can imagine a sudden leap from no compression to severe compression. Consequently it is suggested that there may also be varying degrees of nerve root compromise, from chronic or minor noxious sensory irritation to moderate input through to severe sensory bombardment, resulting from tissue damage due to structural change. (62)

These sensory and mechanical articular disturbances would be common clinical presentations for chiropractors. Such findings may also be a part of serious injury at other levels and overshadowed by the severity of the primary site(s).

In his authoritative volume on the spine, Hadley also noted a range of possible vertebrogenic symptoms related to a chronic cervical syndrome. These include sudden sharp facial or throat

pain, sensory disturbances such as vertigo, tinnitus, and diminished hearing as well as superficial vasomotor disturbances. (63)

These symptoms have the potential to impact a patient's quality of life, personal tensions, and possibly relationship stress. As such, spinogenic conditions may expose psychosocial issues which may also need to be considered clinically. (64, 65, 66)

Other clinical signs

Other clinical signs of these fixated articulations can be readily detectable and accessible to manipulative practitioners. Under this model, normalising their function would be expected in order to ameliorate associated neural reflex activity and the associated signs and symptoms. (41, 42, 43, 44, 45) In addressing these segmental fixations (subluxations), Mieritz et al found that aberrant segmental motion was smoother following spinal manipulation. (67, 68, 69, 70, 71, 72)

Clinically, localised neck and lower back pain, articular tenderness, sciatica, and headaches (as in cervicogenic headache) characteristically represent this neurological association. There can however be a number of other neurological signs and symptoms with examples such as paraesthesia, muscle weakness, altered reflexes, and dyskinesia. (73)

The published evidence from the manipulative sciences, including clinical observations, recognise the manual manipulative removal or modification of the noxious somatic input which are deemed to positively influence the variety of signs, symptoms, and pathophysiology. (17, 38, 74)

It has taken decades for some traditional allopathic theorists to formally accept that disturbed spinal segments could even exist as a vertebral subluxation, let alone be adjusted. Gradual acceptance has now been acknowledged by some as mechanical lower back and neck pain. More recently, the concept of cervicogenic headaches has become recognised as a pathophysiological condition which can be manually addressed. Currently, a similar discordant resistance persists regarding somatovisceral pathophysiology, but now recognised by some as being amenable to manual care. Such resistance is not new in conservative medicine. (75, 76, 77, 78)

The term *cervicogenic headache* has now been afforded formal recognition as a vertebrogenic condition. It is a recognised category under the 2017/18 edition of the World Health Organisation's (WHO) ICD 10 as diagnostic code R51. Further, a *cervicocranial syndrome* is allocated as code M53.0. In addition, the 2013 edition of the International Classification of Headache Disorders (ICHD-3) classifies a *Cervicogenic Headache* as code 11.2.1. This designation can now be regarded officially as a 'medical' term. Moreover, the *Subluxation complex* (vertebral) is also finally recognised and coded as item M99.1 in the 2017/18 WHO's ICD-10. (79, 80, 81)

The influence of somatovisceral and somato-autonomic reflexes are intrinsic to neurophysiology. It would seem logical for noxious spinal initiated reflexes to be the central elements which may offer a means through which it is possible to reduce the noxious input and its associated pathophysiological influence on visceral functions. For decades these principles have been applied directly in chiropractic and osteopathic spinal models of manipulative care, with the aim to improve or restore physiology at the involved level when it is indicated. This has been the rationale for removing the somatic irritant to restore or normalise the somato-autonomic reflex cycle.

Both mechanically and functionally disrupted vertebral segments have been shown to be neurologically and clinically influential and largely correctable in neutralising associated spine-related consequences, depending on the severity of involvement. The degree to which this may be a factor at the pathological level has yet to be clearly demonstrated, although both recent and early research evidence of this does exist in both human and animal subjects. (38, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91)

The axial proximity of prolific mechanoreceptors in segmental articulations, their potential for subtle, chronic, and hyper stimulation, together with their mechanical import to the spine and central processing reflex centres through the spinal cord, would tend to indicate the potential for significant neurological influence. As such, this would have potential to provide a somatic gateway to influence the ANS through manual input. (4, 92)

An irritated Autonomic Nervous System (ANS) can be associated in a wide range of disturbed physiological (pathophysiology) functions. These can be factors in such examples as inflammation, pain, immunity, endocrine production, cardiac and gastrointestinal activity. Despite awareness of this over many decades, as recently as 2014, Amiya and colleagues recognised the mechanism but acknowledged that such '*detailed mechanisms of this interrelationship have not been clearly explained.*' (93, 94, 95)

A decade before Sato's 1997 statement, (29) Wallin stated that '*If spinal reflex responses are true mass responses, i.e. if they extend also to visceral sympathetic nerves, this factor would attain greater relative importance.*' (94) Sato and colleagues raised this profile, and demonstrated how aberrant somatovisceral reflex responses can indeed impart such physiological influence. (96)

Conclusion

The prospect of manipulative care providing benefit for some spine-related conditions to some patients in a conservative minimally-interventionist manner, the potential to affect particular cases of pathophysiological visceral dysfunction, is plausible. It may also be possible as a predisposing factor or association to some more complex conditions, and should be subjected to extensive ongoing meaningful research. This should expand the chiropractic and osteopathic sources and concepts that are already available in order to more fully appreciate the neurophysiological subtleties involved in the subluxation complex.

'This chapter focuses on the description of the location, structure and function of those somatosensory receptors whose activation has been shown experimentally and clinically to have predictable effects on one or another autonomic effector organs... and make use of their potential autonomic effects for therapeutic reasons.' Sato Sato Schmidt (48) p 8



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