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

Part 11 The vertebral (somatic) autonomic influence upon other organs and functions

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Abstract: The basis of a vertebrogenic somato-autonomic-visceral triad comprises a biomechanical alteration to a vertebra's normal physiological state, activation of its sensory receptors leading to noxious stimulation of somatoautonomic reflexes. It is opined that these key pathophysiological elements may culminate in signs and symptoms indicating dysfunction or pathophysiology of anatomical structures innervated from that segmental level. An evidence base of this biological phenomenon is drawn from research by neurophysiologists, clinical reports by medical doctors in published literature, and acknowledged by patients demand.

This paper presents a summary of studies involving visceral responses as well as clinical narratives related to these somatic vertebral aberrations. The physiology behind the premises of somatovisceral effects is primarily available on PubMed. However adoption of this *clinical* model for patient health and welfare, are predominantly limited to the professions of chiropractic, osteopathy with some from Continental European medicine.

Indexing terms: Vertebral subluxation; autonomic influence; chiropractic; Heart Rate Variability.

Introduction

The Somato Autonomic Visceral Complex (SAVC) phenomenon comprises an integrated relationship between somatosensory physiologic disturbance, the parasympathetic and sympathetic nervous systems, and the innervated structure(s). Its impact concerns the neurophysiological disturbance of segment-specific related organs, somatic or other structures neurologically impacted from a vertebral subluxation. (1, 2, 3, 4, 5)

The concept of these biomechanical lesions has been recognised in the chiropractic and osteopathic literature for over a century, and more recently recognised in the medical literature. (6, 7, 8)

The clinical application of a manipulative correction of this lesion is directed at moderating this biological phenomenon. It seeks to ameliorate the noxious sensory articular input of this somatovisceral construct thereby neutralising the associated noxious autonomic reflexes (pathophysiology) of somatic origin. (9, 10, 11, 12, 13, 14, 15, 16)

> *….the term vertebral subluxation relates to the dysfunction with or without displacement of a spinal segment. Subluxation complex relates to generated neural changes (vertebrogenic) to afferent reflexes – autonomic dysfunction'*

Budgell and Sato state that '*it is apparent that somatic stimulation is capable of causing widespread and, at times, profound visceral responses, both in the short and long term. The most consistent and potent reflexes are induced by noxious stimulation or the activation of unmyelinated afferent fibres*.' (17)

In this discourse, the term vertebral subluxation relates to the dysfunction with or without displacement of a spinal segment. Subluxation complex relates to generated neural changes (vertebrogenic) to afferent reflexes – autonomic dysfunction. The affected innervated structure may then be affected be it visceral dysfunction or further somatic dysfunction or both. Under a spinal model of this entity, an acronym, the VAVC (vertebral autonomic visceral complex), could also be applied in order to more directly attribute a contribution from a vertebrogenic factor (pathophysiology). (18, 19, 20, 21, 22, 23)

The recognised physiological rationale and clinical evidence concerning somatovisceral dysfunction of an internal organ, due to vertebro-autonomic disturbance is well recognised. However, there is less research evidence of it being a precipitating factor in frank tissue pathology. Noted exceptions to this are the historical studies conducted by Cleveland (chiropractic) and Burns (osteopathy). Both their studies used rabbits as subjects for their research on the relationship between spinal subluxations and visceral pathology. (24, 25)

While other articulations may also subluxate, the richly innervated sensory vertebral segments and especially their articulations, appear to provide the most sensitive, common and potent influential activation of autonomic reflexes from noxious stimuli.

A number of hypotheses have been proposed in seeking to interpret the documented positive clinical outcomes under this subluxation construct. One major hypothesis by Nansel and Szlazak in 1995 suggested that due to the afferent convergence of noxious sensory input, many visceral signs and symptoms may simulate actual conditions. (26) This model essentially reflected the integration of somatic (especially vertebrogenic sensory articular input) with visceral sensory pathways, and is supported by the research of Sato et al. (27) A similar neurophysiological model is that proposed by Pickar. (15) The hypotheses involve reflex neural outputs which acknowledge the principle of somato-sensory-autonomic integration. (4, 28, 29, 30, 31)

The term vertebral subluxation complex (VSC) is offered as clarity to cover all characteristics of the hypotheses from changes in anatomical displacement, articular dysfunction, neural dysfunction, vascular dysfunction, somatic dysfunction, visceral dysfunction and associated clinical findings. This suggests that the complex can be much more than a mechanical displacement and associated segmental pain.

Neuroscientists at the *Department of the Autonomic Nervous System* at the *Tokyo Metropolitan Institute of Gerontolog*y in Japan have assiduously investigated this somatosensory topic. (1) The effect of noxious somatosensory activation somato-autonomic and somatovisceral reflexes are covered in their extensively referenced volume:-

- Somatosensory modulation of the cardiovascular system, (p 115-165)
- Somatosensory modulation of the digestive system, (p.166-188)
- Somatosensory modulation of the urinary system, (p189-212)
- Somatosensory modulation of the sudomotor system (p213-219)
- Somatosensory modulation of the hormonal system, [adrenal, pancreas, pituitary] (p 219-252)
- Somatosensory modulation of the immune system (p253-256).

As with other health professions, there has been significant research using animal subjects. Vernon reviewed 18 animal studies while Henderson summarised some 34 animal studies since 1975, these included 31 studies on the subluxation, and 3 on adjustment of the subluxation. (32, 33, 34, 35, 36)

Budgell and Sato explain that '*A great deal of basic research on somato-autonomic reflex regulation of visceral function has been carried out in anesthetized animals, particularly cats and rats. These animal models have been useful in revealing the underlying neural mechanisms in the absence of emotional influences. Because of the limitations of anaesthesia, most of these studies have necessarily addressed acute effects*.' (37)

In relation to somatovisceral reflexes, Victor and colleagues demonstrated that stimulation of muscular mechanoreceptors and group III afferents contributed to activation of renal sympathetic outflow in cat research subjects. (38, 39)

The classical concept of the *Dorsal Root Ganglion* (DRG) as merely an assembly of afferent pathways of sensory neurons has been challenged by Lu. Evidence (in animal subjects) demonstrating somatovisceral and bilateral activation indicates that the DRG is more a '*laterally displayed portion of the spinal cord*'. Anatomically, this may have the potential to facilitate autonomic influence on visceral and somatic structures. (40)

Typical examples of dysfunctional vertebrogenic conditions would be the somato-autonomic symptoms associated with cervicogenic headaches. (See Part 9 of this series). Conditions such as vertebrogenic sciatica and other referred pain syndromes acknowledge the phenomena of more complex somato-neural integration. This form of sensory activation may be classified as somato-somatic, somato-autonomic, or somatovisceral reflexes. (41, 42, 43, 44, 45)

The effect upon an organ from somatic stimulation (somatovisceral) may also lead to a rebound of further firing of sensory viscerosomatic and viscero-visceral reflex arcs. (46, 47, 48, 49)

Over two decades ago, Budgell declared that '*Recent neuroscience research supports a neurophysiologic rationale for the concept that aberrant stimulation of spinal or paraspinal structures may lead to segmentally organized reflex responses of the autonomic nervous system, which in turn may alter visceral function*.' It should logically follow that removal of that aberrant stimulation should tend to neutralise the reflex responses and subsequently normalise associated effects on visceral function. (2, 50)

Recently Shaballout et al suggested that segmental lateralisation symptoms of visceral disease may be useful diagnostic signs and were characterised by three classic signs of superficial hyperalgesia (Head zones), muscle resistance, and mydriasis. Static vertebral assessment rather than motion palpation was apparently preferred by them. (51)

In essence, as chronic pain and other aberrant sensory input can activate ANS reflexes, the sensory disturbances associated with subluxated articulations demonstrate a potential contribution to somatosensory pathophysiology of neurologically targeted structures. (1, 50, 52, 53, 54, 55, 56, 57, 58, 59)

Somatovascular/smooth muscle

The role of smooth muscle under the influence of the ANS integration is recognised. As with neural distribution, there is potential for it to affect vascular distribution to a range of internal structures including dermis, mucosa, sphincters, and bladders through the circulation. Schmorl and Junghanns recognised a somatic origin for a range of conditions that appear to be related to the vertebrogenic influence on autonomic or vascular routes. (23, 60, 61, 62, 63)

The evidence indicates that as with neural activation, vascular changes or a combination of both may alter the homeostatic state of a target structure, the physiology of that target may be altered. (64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84)

Other factors to be considered on the subject of the role of smooth muscle in somatovascular disturbance can be: (61)

- Somatosensory activation of autonomic vascular reflexes
- The severity and duration of these reflexes
- Vascular tone
- Angiosomes
- Vasomotor influence
- Capillaries
- Intrinsic chemical factors
- Vascular dysfunction
- Thermography

Cardiovascular

Under a somatic-autonomic-visceral triad, key elements of the cardiovascular system are readily accessible for monitoring. As a result, a number of neurophysiological studies have assessed aspects of cardiac physiology that are subjected to the influence of spinal manipulation. (54, 62, 73, 85, 86)

Vertebrogenic autonomic influenced physiological cardiac changes could be regarded as somatovisceral conditions which may be recognised clinically. Two of the more readily identified and accessible clinical signs are changes to heart rate variability and blood pressure. Both of these have been used in studies to monitor ANS-influenced changes associated with vertebral adjustments, as well as a more general manipulation procedure. (87, 88, 89, 90, 91, 92, 93)

The plethora of evidence exploring a vertebrogenic somatocardiac phenomenon, typifies the connection between somatic (a *Vertebral Subluxation Complex*, VSC) and visceral dysfunction via autonomic reflex activity, a *Somato-autonomic Visceral* (SAV) *Triad*. Budgell stated that '*... even innocuous mechanical stimulation of the cervical spine can induce statistically significant decreases in blood pressure.*' (2) He also noted that in inflamed joints 'movement within the normal range produces reflex increases in blood pressure and heart rate.' (50, 86, 87, 94, 95, 96, 97, 98, 99, 100)

Boiardi and colleagues noted the existence of autonomic dysfunction of the parasympathetic nervous system with cluster headaches (CH). This coincided with impairment of sympathetic cardiovascular reflexes with migraine patients. (100). To investigate autonomic nervous system involvement in CHs and migraines, they compared the cardiovascular reflex responses of common migraine and CH subjects with a group of controls. A battery of five well-codified autonomic tests was monitored.

- deep breathing test,
- lying to standing test,
- Valsalva manoeuvre,
- postural hypotension test,
- blood pressure response to sustained handgrip (SHG).

The authors concluded that the data confirmed an autonomic dysfunction in cluster headaches which mainly affected the parasympathetic system. Evidence of an impairment of sympathetic cardiovascular reflex regulation was found in their common migraine group. (101, 102)

In a further study, Avnon and colleagues stated that control of the ANS from the brain is asymmetrical, with the left hemisphere mainly affecting the parasympathetic nervous system (PNS). In migraineurs, they noted parasympathetic differences depending on whether the patient experienced left or right-sided migraines. One difference being that bradycardia was more pronounced in left-sided migraineurs. They stated '*that unilateral left-side migraineurs have increased parasympathetic activation in response to pain compared with right-side migraineurs*'. (103, 104)

In a somewhat similar vein, Sato and colleagues found the heart rate response to mechanical pinching in rat subjects was different depending on whether the stimulus was applied from the left or the right side of the subject's neck. (105, 106)

In a randomised, controlled, cross-over study, Win and colleagues noted that manipulation of the upper cervical spine stimulated the PNS, while the lower cervical spine stimulated the *sympathetic nervous system* (SNS). In general, the PNS was dominant in subjects with neck pain who underwent both upper and lower cervical adjustments. They found further, that the manipulation of normotensive volunteers could positively influence blood pressure and heart rate variability. (88)

Heart Rate Variability (HRV)

See Table 1

By activating sympathetic tone from mechanoreceptors in the calf muscles of male Wistar rats, Watanbe and Hotta noted heart rate and blood pressure changes through somatic '*mechanical pressure stimulation of skeletal muscles*'. (130)

Using osteopathic manipulative therapy, Ruffini and colleagues noted changes while monitoring heart rate variability (HRV). They found that osteopathic manipulative therapy can influence ANS activity by increasing parasympathetic function and decreasing sympathetic activity. They compared cardiac response with sham therapy and a control group. In 2020, Carnevali et al extensively reviewed the literature on the rationale for the influence of the autonomic nervous system on HRV. Other studies note a connection between neck pain and a cardiac influence. (87, 109, 110, 111, 119, 124, 131, 132, 133, 134, 135, 136)

Another somatovisceral study by Roy and colleagues in 2009 found that the removal of spinal pain in the lumbar spine was also shown to influence heart rate variability (HRV). Yilmaz et al found that pelvic pain altered HRV and blood pressure which also suggested an autonomic nervous system response to a noxious somatic stimulation. (137, 138)

Blood pressure

See Table 2

A synopsis of papers has been listed in the accompanying table. It presents investigations and outcomes of studies of spinal manipulation and blood pressure. The volume of literature indicates support for the finding that somatovisceral factors may influence BP. The table outlines manipulative studies from medical, osteopathic, and physical therapy, as well as chiropractic sources. (139, 140, 141, 142, 143)

In relation to an articulo-cardiac reflex, Sato et al state that '*noxious joint movement led to pronounced excitation of the inferior cardiac sympathetic nerve units accompanied by increases in blood pressure*.' (144) This finding provides further grounds supporting the rationale for the removal of such somatic noxious elements when present, in order to positively influence … (to p. 7)

Table 1: Heart Rate Variability

LEAD AUTHOR(S)	STIMULUS/ INTERVENTION	JOURNAL Format	YEAR (& Ref)	OUTCOME
Bakken AG, Axén I, et al	Spinal Manip Ther. Multidiscip	Trials Proposed RCT	2019 (107)	HRV/Pain Research design
Borges BLA, Bortolazzo GL	Osteopathic Manip Ther	J Bodywork Movement Ther. Systemic review	2017 (108)	Parasympathetic Response noted
Budgell B, Hirano F	Innocuous Mech. 25 subjects	Auton Neurosci Random crossover	2001 (96)	Significant response
Budgell B Igarashi Y	SMT Chiropr Single case	J Neuromusculokel Sys Case study	2001 (109)	Bradycardia, Upper cervical
Carnevali L, et al	OMT	Front Neurosci Review	2020 (110)	Justification for further research
Eingom AM, Muhs GJ	SMT Chiropr Autonomic tone	J Manipulative Phy Th. Review	1999 (111)	Assessing HRV technique
Giles PD, Hensel K, et al	Suboccipital decompression	J Altern Compl Med Case study 19 subjects	2013 (112)	OMT, RCT Upper cervical
Haas A, Russell D	Chiropractic Adjustments	Chiropr J Aust Retrospect case series	2017 (113)	Adjustments, Improved HRV
Hart J	Chiropractic Adjustments	Int J Statistics Med Res Single case study	2020 (114)	Positive indications
Hart J	Chiropractic adjustments	Int J Neurol 16 subjects, case study	2019 (115)	Improved HRV
Hart J	Chiropractic adjustments	J Contemp Chiropr Case study, 38 subjects	2019 (116)	HRV to indicate necessity of care
Henley CE,et al.	Osteopathic Man Ther, myofascial	Osteop Med Prim Care 17 subjects repeat meas	2008 (117)	Autonomic OMT, HRV
Igarashii Y Budgell B	SMT Chiropr	Chiropr J Aust Case study	2000 (118)	Upper cervical thoracic, HRV
Kent C	HRV monitor	Research Reviews Neuroscience	2017 (119)	Autonomic function review
Kessinger RC, et a	Upper Cervical Adjustments	J Upper Cerv Chiro Res 3-case report	2013 (120)	HRV, ANS Skin temperature
Polus BI Budgell B.	Chiropr Thoracic manipulation	JMPT. Crossover RCT. 28 subjects	2006 (121)	ANS, HVLA HRV
Reis MAS, Durigan JL et al	Thoracic glide One Tx, Phyioth	Rehab Res Pract Comparative study,	2014 (122)	Fibromyalgia, ANS, HRV ↓
Roy RA, Boucher JP et al	Chiropr, lumbar adjustment	JMPT RCT 51 subjects	2009 (123)	HRV modulation with ↓ LB pain

Table 1 conc: Heart Rate Variability

LEAD AUTHOR(S)	STIMULUS/ INTERVENTION	JOURNAL Format	YEAR (& Ref)	OUTCOME
Ruffini N, et al	Osteopathic Manual Therapy	Front Neurosci. Case Report. 66 subjects	2015 (124)	RCT, HRV
Sato A, Sato Y, Schmidt RF	Somatosensory modulation	Text. Research, rat subjects	1997 (125)	Laboratory research
Shafiq H, et al McGregor C	Cervical manipulation	Eng Med Biol Soc 10 subjects	2014 (126)	Significant interaction
Swenson DM	SMT Chiropr	J Acad Chiropr Orthop Literature review	2011 (127)	Sympathovagal ANS, HRV
Toro-Velasco C et al	Manual therapy	JMPT 8 subjects	2009 (128)	Crossover study HRV index ↑
Ward J, et al	Anterior thoracic adjustment	JMPT 36 subjects	2013 (129)	No change
Watanabe N Hotta H	Mechanical Pressr Calf muscles.	Frontiers Neuroscience Rat subjects	2017 (130)	Responses in HRV & BP
Win NN, et al Jorgensen AMS	Upper & low cerv. Chiro SMT	J Chiropr Med. 20 subjects	2015 (88)	RCCT crossover BP, HRV,
Zhang J, Dean D et al	Chiropractic adjustments	JMPT. 960 subjects	2006 (131)	Pain VAS↓ HRV P < .05
Zwaaftink KG	SMT General	Masters Thesis Neurovegetative responses	2017 (132)	Literature review

(From p. 5) … hypertension in appropriate candidates. Manual or instrumental segmental adjustment would then seem a logical means to neutralise the noxious input from mechanically disturbed articular structures. In support of such a modification, Sato et al. proposed that '*decreases in blood pressure and renal nerve activity during manipulation of the spine are thought to be supraspinal reflexes*' in the rat subjects. (144) Additional studies by these researchers supported their earlier findings. (145, 146)

Sato et al also noted '*changes in adrenal nerve activity induced by thoracic spine stimulation'* (147) as well as '*clear and consistent decreases in blood pressure and renal nerve activity*' with stimulation of T10-T13 or lumbar L2-L5. (147)

This extensive research by Sato and colleagues on the somatosensory-autonomic association was acknowledged further by Schmidt. In this tribute Schmidt notes the studies of the excitatory or inhibitory influence of segmental and non-segmental effects '*depending on the visceral organ involved.'* These may be dependent on the organ's condition or the modality of activation. He opines that '*These findings on the pathways and modes of operation of somatoautonomic reflexes now provide a scientific basis to the application of all kinds of physical treatments to affect diseases*.' (148)

Table 2: Blood pressure

AUTHOR(S)	STIMULUS/ INTERVENTION	JOURNAL	YEAR	OUTCOME
Bakris G, et al Dickholtz M	C1 adjustments 50 subjects	J Human Hypertension	2007 (149)	C1 adjustment, BP↓, DBPC pilot study
Balogun JA Abereoje OK, et	Cervical traction	Physioth Canada	1990 (150)	Limited effect 20 healthy subjects
Cao WH, Sato A et al	Somatosensory Regulation. Rats	Japanese J Physiol	1992 (151)	↑ hippocampal Blood flow
Cerritelli F Carinci F, et al	OMT	J Bodywork Movement Ther	2011 (152)	Reduced systolic BP 63 subjects
Crawford J, Hickson G, et al	Chiropractic, diet SMT, exercise	JMPT	1986 (153)	Advisory management review
Dimmick KR Young MF, et al	Chiropractic Adjustments from left/right compare	JMPT 35 subjects Matched pairs	2006 (154)	↓ systolic BP
Driscoll MD Hall MJ	Chiropr SMT	JMPT Case study	2000 (155)	Arterial tonometry Monitoring overview
Driscoll MD	Chiropr SMT Instrument study	JMPT	1997 (156)	PNS/SNS, Resp., BP ECG, tonometry
Fazalbhoy A, Birznicks I, et al	Tonic pain	Exp Physiol 12 subjects	2012 (54)	BP, Heart rate SNS
Fedin AI, Kakorin S, et al	Manual therapy	Kardiologiya	1991 (157)	Cervical chondrosis ↓ BP,
Fichera AP Celander DR	OMT 57 subjects	J Am Osteop Assoc	1969 (158)	OMT, autonomic tone, BP, fibrinolytic system
Fujimoto T, Budgell B, et al	Innocuous mechanical input	J Autonom Nerv Syst	1999 (159)	BP, HRV,tonometry monitored
Gera C, Malik M, et al	Manual Therapies Systematic rev.	Hong Kong Physioth J	2020 (160)	↓ systolic & ↓ diastolic BP, meta-analysis
Goertz CM Salsbury S et al	Chiropr SMT	JMPT 51 Subjects	2016 (161)	BP, Upper cervical adjustments
He Z-B, Lv Y-K, et al	SMT	J Cervicodynia Lumbodynia	2011 (162)	Case study 60 cases Hypertension. C1/C2
He Z-B Lv Y-K, et al	C1/C2 VSC 130 rat subjects	BioMed Res International	2017 (91)	C1/C2 subluxation Hypertension in rats
Holt J, Beck R, Sexton R	Chiropractic adjustments reflex effects	Chiropractic J Australia 70 subjects	2010 (163)	↓ systolic BP. Spinal region not relevant
Jackson R	Cervical syndrome	Textbook	1966 (164)	Cervical trauma & BP.
Kessenger RC Moe C	Upper cervical adjustment	J Upper Cerv. Chiropr Research	2015 (165)	Single case report Single adjustment

Table 2 conc: Blood pressure

AUTHOR(S)	STIMULUS/ INTERVENTION	JOURNAL	YEAR	OUTCOME
Knutson GA	Upper cervical adjustment	JMPT 40 new patients	2001 (77)	C1 vectored BP ↓
Liu H Ploumis A	Cause/effect hypothesis	Hypothesis	2012 (90)	Cervical spondylotic myelopathy
Mangum K, Partna L, et al	Chiropractic SMT	JMPT	2012 (166)	Insufficient evidence Review
McKnight ME DeBoer KF et al	Chiropractic SMT	JMPT 75 subjects	1988 (167)	Gonstead BP ↓
McMasters KL Wang J, et al	Chiropractic SMT	J Chiropr Med 24 subjects	2013 (168)	BP ↓ group comparison
Nansel D, Jansen R, et al	Chiropr cervical, One adjustment	JMPT	1991 (169)	BP. Heart rate, NAD, Plasma catecholamine
Pastellides AN	Cervical and Thoracic SMT	Dissertation Durban Univ.	2009 (170)	Review
Plaugher G Bachman TR	Chiropractic specific	JMPT. Single case report	1993 (171)	BP ↓, GP ↓ medication over 2 months
Reis DJ, et al Morrison S, et al	Suboccipital Physioth.	Hypertension Rat subjects	1988 (172)	Reflex role in Arterial BP
Sato A, Sato Y, Schmidt RF	Joint mobilisation inflammed knee	Neurosci Letters Physiology	1984 (173)	↑ in BP with noxious Somatic. Cat subjects
Saeki Y, Sato A, Sato Y, et al	Cortical cerebral blood flow in rats	Japanese J Physiol	1990 (146)	Cervical sympathetic trunk stimulation
Spiegel AJ, et al Capobianco JD	Osteopathic MM	Heart Dis	2003 (174)	Review
Torns S	Atlas adjustment 42 subjects	J Upper Cerv Chiropr Res	2012 (175)	↓ hyper BP ↑ hypo BP
Torns S	Atlas adjustment 20 subjects	J Upper Cerv Chiropr Res	2014 (176)	↓ BP
Van Dyke V, Russell D, et al	Chiropractic care & adjustments	Ann Vertebral Sublux Res	2015 (177)	↓ BP Single case report
Ward J, Tyer K, Coats J, et al	Upper thoracic SMT	J Man Manip Th 56 subjects	2015 (178)	Anterior T1-T4 Minimal change
Ward J, Tyer K, Coats J, et al	C1 adjustment RCT	Clin Chiropr 48 subjects	2012 (179)	No effect on normotensive
Watanabe N Polus B	Single impulse mechanical	Chiropr J Aust 11 subjects	2007 (180)	Upper cervical & cardiac influence
Welch A, Boone R	Chiropractic. Cerv or Thor adj.	J Chiropr Med 40 subjects	2008 (181)	ANS monitored via HRV and BP ↓
Yates G, et al Lamping D	Chiropractic SMT	JMPT 21 patients	1988 (182)	RCT, Activator BP ↓
Yung EY, Oh C, et al	P-A pressure to cervical spine C6	Musculoskeletal Sci Pract,	2017 (183)	BP ↓ 44 subjects

Angina and Pseudoangina

Simulation of angina of somatic origin was recognised by Nachlas in 1934, and Carnett acknowledged simulated gall bladder disease in 1927, and simulated appendicitis in 1934. (184, 185, 186) It has been postulated that pseudo anatomical pains and symptoms may originate in the spine. (187, 188, 189) Murtagh uses the term masquerade in relation to spinal dysfunction in cases identified to be triggering angina and other symptoms. (190)

Chest pain of somatic origin can present a very similar pattern to that of cardiac origin. Unless recognised, this pseudo condition may result in delays, expensive diagnostic investigative procedures, and interventions, as well as requiring patients' daily routine changes. (191, 192, 193, 194)

At times, pseudo-angina may be taken as a true heart condition. The cervical spine has been nominated as the origin of the symptom in some studies, and the thoracic spine by others. The overlap of musculoskeletal involvement as a somatic factor with cardiac visceral symptoms again tends to highlight the integration of spinal factors in the somato-autonomic-visceral system. (192, 195, 196, 197)

The example of somato-visceral integration is referred pain, as in angina pectoris involving a vertebrosomatic factor. This may masquerade as a cardiac condition which appears to activate similar sensory pathways. Accurate diagnosis is critical in such conditions so that the appropriate regimen can be followed. (190, 192, 198, 199)

In 2007, in a retrospective study of 4,223 patients, Simonenko and colleagues adopted the term '*vertebrogenous cardiomyalgia*'. The subjects of the 7-year study were examined for heartache between 1998 and 2005. The patients were divided into three groups. Group I exhibited isolated *'vertebrogenous cardiomyalgia*', Group II were patients with coronary heart disease, and Group III suffered from both conditions. Their findings assisted with significant differential diagnostic criteria for patients with chest pain. (197, 200, 201, 202, 203, 204, 205, 206)

Parallels of somatovisceral and viscerosomatic reflexes were noted by Stochkendahl and Christensen in 2010. They nominated cervical angina and segmental dysfunction of the cervical and thoracic spine as amongst several simulated vertebrogenic and other musculoskeletal conditions. (207)

A 2017 physiotherapy study monitoring systolic blood pressure employing manipulation of C6 with the patient prone, noted '*a significant reduction in systolic blood pressure, while the placebo group had an increase in systolic blood pressure*.' There were no significant differences in heart rate or diastolic blood pressure. (208)

Gastrointestinal

The brain and visceral function are mediated through the autonomic nervous system (ANS). ANS somatosensory reflexes can be influenced by physically disrupted or disturbed vertebral segments or by other somatic structures. In order to neutralise somatovisceral reflexes, it would then seem appropriate to identify and physically remove the somatic elements initiating that autonomic irritation resulting in gastric dysfunction where applicable. Again, there can be other causes of gastric dysfunction apart from the SAVC. (209, 210, 211, 212, 213, 214, 215, 216)

In an example of somatovisceral reflexes involving peristalsis, Koizumi and colleagues found that in anaesthetised rats, a '*strong mechanical stimuli which was applied to the abdominal skin always inhibited motility of the small intestine.*' This was found to be a propriospinal reflex and involved a somatic factor of a *cutaneo-intestinal* reflex. (217) Interestingly, if the stimulus was applied to a range of sites on the rats' upper bodies, it had the opposite effect. Earlier research had shown that a bilateral vagotomy did not affect gastric inhibition, suggesting the splanchnic nerve was not the primary influence. (217, 218)

In 2009, Manabe et al and others indicated that no single shared etiological factor has been associated with irritable bowel syndrome (IBS). However they recognise an abnormal brain-gut interaction of this functional disorder where the ANS acts as a mediator. Adeyemi et al found further ANS association with IBS patients who also exhibited changes in heart rate variability. (219, 220. 221, 222)

In 2000, somatovisceral influence upon viscera was also noted by Qu who concluded that the cause of irritable bowel syndrome was '*Unstable thoracolumbar vertebrae*' and further that through manipulation of these vertebrae it was '*simple and effective*' to correct the neural and vascular elements in '*treating this disease.*'

After successfully treating 82 patients with thoracolumbar manipulation, his advocacy for this form of management for this condition appears effective. Further studies also appear to recognise a spinal somatovisceral association of particular gastrointestinal conditions with further somatovisceral papers having been published using traditional Chinese spinal orthopaedic manipulation. (223, 224, 225, 226)

A study by Bertilson et al in 2014 concluded that '*Patients with IBS have significantly more findings in the physical examination indicating nerve involvement from spine T7-L1 than people without gastrointestinal disorder*.' We note that this association may involve somatovisceral or perhaps viscerosomatic reflexes. (227)

As a further acknowledgement of a spinal-somatic influence on gastrointestinal function, a comprehensive 2018 review by Fornai et al emphasised the central neural role of the autonomic nervous system under vagal, spinal thoracolumbar, and spinal lumbosacral input as a modulating factor of gastric mucosa. (228, 229)

Vertebrogenic dysphagia

The vertebrogenic aetiology in relation to dysphagia was discussed by Vaňásková et al. Their paper was initially published in 2007 and updated as a book chapter in 2012. The title, '*Swallowing disorders related to vertebrogenic dysfunction*', basically conveys the concept in itself. However, the authors go further by noting '*the relationship between clinical disability of locomotor system and functional dysphagia*'. The authors also note that despite '*approximately 60% of patients with functional bowel disorders, relatively little research has examined vertebrovisceral functional relationships.'* They conclude '*Swallowing disorders can be due not only to structural changes, but frequently to dysfunction of the spinal column and its musculature.*'(230, 231)

To focus further on visceral dysfunction, Pope and Henderson each discussed the motor disorders of the oesophagus as neurological based conditions. A recent paper by Stone et al on whiplash-associated dysphagia and dysphonia recognised limited existing literature on these conditions and an enigmatic aetiology. (232) Gastrointestinal dysfunction is the topic of a number of medical papers with clinical management having traditionally been either pharmaceutical or surgical regimens, (233, 234, 235, 236, 237, 238) while a biomechanical vertebrogenic factor does not appear to have been considered.

Dyspepsia

In a similar vein regarding dysfunction, in 1991 Waldron et al noted that gastric hypomobility delayed small bowel transit and was a likely factor in non-ulcer dyspepsia and possibly other disorders of gastrointestinal function. While this study did not specify somato-autonomic considerations, some forms of the condition would provide a promising and interesting research topic under a vertebrogenic model. (239, 240)

Further evidence of a somatovisceral element in functional dyspepsia has been widely reported. The chiropractic and osteopathic journal indexes record a number of papers related to somatovisceral and vertebrogenic clinical observations and research. These have been augmented by European medical literature. (67, 99, 237, 241, 242, 243, 244, 245, 247, 247, 248) (See also Part 6 of this series)

Infantile colic

Apart from the many chiropractic studies and clinical experiences on infantile colic, there are also a number of medical and chiropractic papers supporting the spinal manipulative management of the condition. (249, 250, 251, 252, 253, 254, 255, 256)

A 2009 medical textbook on integrative medicine edited by May Loo, MD, opens with the observation by Spicer that 'In spite of its prevalence, colic remains mysterious and puzzling to paediatric healthcare professionals … it is difficult to define, both in terms of aetiology and symptomatology.' The section on chiropractic care of colic then states '*The success of chiropractic management of colic is substantial enough to suggest that colic may be a neurologically based condition of spinal origin.*' (249)

A recent (2017) review by Carnes et al in *BMJ Open* concluded that the authors '*… found moderate favourable evidence for reduction in crying time in infants receiving manual therapy.*' (257)

The *University of Maryland* website noted that under the heading chiropractic while '*there is only preliminary scientific evidence that chiropractic may lessen crying in colicky babies, chiropractors frequently treat colic with a form of gentle spinal manipulation specially designed for infants. Usually treatment requires 3 to 4 visits over a 2 week period*'. The Mayo clinic website also lists parents reporting that chiropractic manipulation has been noted as '*soothing crying babies*', one of the symptoms of colic. (258, 259)

A medical study on colic by Yao et al in 2016 was most supportive of chiropractic care, it concluded that '*based on the above literature, it can be concluded that manual chiropractic therapy is the most successful option for the management of paediatric musculoskeletal health of infants. In addition, few adverse effects have been reported, and these are negligible in comparison to the beneficial accounts of manual therapy.*' (260)

As a reflection on the demand for patients seeking care by noting patients' expectations and values, O'Connor stated that '*patients are recognised as the best experts for judging values.*' (261)

In 2004, Hipperson reported on two case studies of infantile colic under chiropractic care, where both cases resulted in complete resolution. The author also noted indications that the cases may have been related to birth trauma. (262)

Of 'political' interest, in 2019 the *Safer Care Victoria* included 'infantile colic' in a study by the Cochrane Australia. However the study did not refer to or cite an earlier Cochrane study from 2012, even though the 2019 study reviewed the same papers that had been covered in the 2012 study. The two studies were not in complete agreement. (263, 264)

Of note, the 2019-20 *Safer Care Victoria* review of spinal manipulation of infants in its preliminary findings found an extremely high patient and parent satisfaction level of 96.7%. Further, that they found no evidence of serious adverse events to children receiving chiropractic manipulative care from 21,874 submissions, plus a 98% of respondents indicated that the care helped their children. (https://accp.asn.au/scv)

Dysmenorrhoea

Schmorl and Junghanns recognise a somatic origin for some lower pelvic pains. They note the medical use of such terms as gynecologic vertebral syndrome and spondylogenic pelvicopathy.

They suggest that such conditions may be related to the vertebrogenic influence on autonomic or vascular routes. (265, 266) Similarly, in his medical text, Lewit also recognised a spinal factor in some cases of dysmenorrhea. (267)

A Masters thesis relating to the somatovisceral clinical implications of the SAVC was published in 2002. Symptoms associated with visceral dysfunction were addressed at that time by Rampersad. Her conclusion stated that SMT was '*one of the most effective treatment protocols … in the battle against pain associated with primary dysmenorrhoea … when patients are treated within a specific time frame of the female reproductive cycle.*' The integration of the neural registration of pain in visceral dysfunction and the spine, exemplifies the possibility of VSC complex in some cases. This was the basis of the study offered by Polus et al, and Genders et al in 1996 and 2003 respectively. For symptomatic dysmenorrhea to respond to vertebral manipulation it would seem unlikely that the neural influence would restrict itself to just the one neurological element of pain so that visceral function may also be influenced. (268, 269, 270, 271)

As with a number of conditions, it seems that spinal manipulation by chiropractors, osteopaths, physiotherapists, or doctors of physical medicine, may be beneficial for some patients. As with all clinicians, it is a matter of determining which patients may have a vertebrogenic factor underlying their condition. (272, 273)

Asthma and other respiratory conditions

As with infantile colic, a percentage of asthma patients also seem to be resistant to conventional regimens, particularly if their clinical outcome is unsuccessful. It is natural then that patients who are aware of other choices for care, perhaps via internet research or by word-of-mouth recommendations would seek other options for a trial of conservative care which may have benefitted other patients about whom they have knowledge.

In his text on spinal manipulative management under the heading of functional disturbances, the once head of the *Physical Medicine Department* of a Paris hospital lists such conditions as constipation, certain digestive pains, asthma, facial pain, *Basedow's disease*, mastodynia, palpitations, pseudo-ulcers, and *Barrés Syndrome* (274) as conditions that have responded to spinal manipulation. (274) Also, Schmorl and Junghanns reviewed a rather extensive and varied list of conditions in their textbook under '*Spondylogenic Symptoms and Syndromes in The Human Spine in Health and Disease'.* (23) Lewit nominates similar visceral conditions under vertebrovisceral correlations in a further European medical text, '*The Manipulative Therapy in Rehabilitation of the Locomotor System.*' (275)

In his medical text (275, p283) on spinal manipulation, Lewit states quite clearly that 'S*evere incoordination of respiratory movement may produce dyspnoea, while chronic asthma with emphysema will produce rigidity of the thorax*.' He states further that '*… Koberle (1975) found blockage of the segments T7-T10. In a group of 30 asthmatics, Sachse (1975) found taut trapezius in 23 patients, a taut pectoralis in 15 and a weak lower trapezius in 15 ...*' He then states that '*The mobilisation of the ribs and of blocked segments of the thoracic spine, and training of correct breathing, will thus be the logical treatment for patients with respiratory disorders, particularly those with obstructive respiratory disease*.' (275) [It can be noted that a vertebral blockage is a synonym for the chiropractic term - vertebral subluxation.]

In a reference to respiratory difficulties Biedermann also states that the '*Mechanical dyspnea syndrome is frequently the result of a (traumatic) blockage of one or more thoracic vertebrae and the costovertebral joints in the vicinity … These blockages are more important in children with internal breathing problems like asthma or obstructive bronchitis, as they tend to worsen an already precarious situation, certainly if combined with a kyphotic posture*.' (276)

Other medical papers that incorporate a biomechanical-neurophysiological or somatovisceral subluxation model in addressing respiratory conditions essentially support the manual model of management. (277, 288)

The following case series study by Dougherty et al. offered preliminary evidence that SMT may have the potential to benefit lung function in chronic obstructive airways disease (COPD) patients who are older than 65 years of age. (289)

As reported in *Australian Doctor* in 2013, during the previous 12 months 37% of asthmatic patients were already seeking care outside the conventional model. This referred to a Canadian research study which found that more than one-third of asthma patients use complementary and alternative medicines to try to control their symptoms. As there are 2.7 million asthmatics in Australia, on this basis some 900,000 patients could be seeking alternative care, and the anecdotal evidence for chiropractic would seem a reasonable option for a trial of manipulative care. There would seem to be a need and a demand for further choices for other models of care for asthmatics other than a pharmaceutical approach. (290, 291, 292)

In 2012, the *National Asthma Council of Australia* booklet titled '*Asthma and Complementary Therapies: An information paper for health professionals*' noted in relation to chiropractic (page 14) that, '*There is anecdotal evidence of efficacy*.' (293)

Contrary to the 2012 document, the current (2021) *National Asthma Council* handbook claims that '*Chiropractic spinal manipulation has not been shown to improve asthma in sham manipulation-controlled randomised clinical trials*'. (294) It cites the same two references used in 1998 (295) and 1995 (296) but has ignored papers on both the positive medical manipulative and the chiropractic management of asthma. Given the papers cited in this document, the *Asthma Council* appears to have been distinctly and negatively selective. This is hardly justifiable or fair for those asthmatics who continue to suffer. Other papers listed in a summary by Painter are more supportive of chiropractic care of patients who generally have not responded to the usual medical regimen. (297) [Ed note: Indicative of interference by political medicine]

The 1995 paper by Nielsen, Bronfort et al, concluded '*Objective lung function did not change during the study, but over the course of the study, non-specific bronchial hyperreactivity (n-BR) improved by 36% (P = 0.01) and patient-rated asthma severity decreased by 34% (P = 0.0002) compared with the baseline values*.' (296)

In 2001, a subsequent paper by one of the authors, Bronfort, found '*After 3 months of combining chiropractic SMT with optimal medical management for paediatric asthma, the children rated their quality of life substantially higher and their asthma severity substantially lower*.' (298)

In addition, a later paper by Balon stated '*certain clinical circumstances may warrant a therapeutic trial in patients with asthma*', it then urged further collaborative research. (299)

Clinically, evidence suggests that there appears to be support for chiropractic care which may involve breathing exercises, general exercises, dietary advice, allergy advice as well as vertebral adjustive care in vertebrogenic forms of asthma. Asthmatic patients who have turned to chiropractic would seem to indicate a degree of satisfaction with outcomes. (300, 301, 302, 303)

Autonomic Nervous System (ANS)

Association with biochemistry, somatoautonomics, humoral changes & immune function

Studies regarding a somato-autonomic factor and its influence of other biochemical changes have been undertaken by Sato et al under the heading somatosensory modulation of hormonal secretion. (304) Research on spinal manipulation on this topic has been summarised by Gatterman (305), Leach (306), King (307), and others. (308, 309, 310, 311, 312)

The biochemical changes associated with inflammation, including those of musculoskeletal mechanical origin, have been monitored in patients under chiropractic care (312, 313, 315, 315, 316, 317, 318, 319) or by somatosensory activation. (320, 321) This included monitoring cytokines, tumour necrosis factor-α and interleukin-1ß as well as others.

Neural reflexogenic somato-hormonal secretion responses have not been an extensive topic of research, at least until Sato and colleagues explored the hypothesis in rats, (304) their research investigated somatic stimulation under three themes:-

- adrenal medullary and pancreatic hormones;
- the hypothalamo-anterior pituitary hormone system; and
- the posterior pituitary hormone system.

In their study, they found that somatic afferent activation from vertebral joint stimulation registered in the same region of the brain that integrates hormonal secretions. Somatosensory stimulation at the thoracolumbar region of rats (particularly T13) was also found to increase adrenal sympathetic nerve activity and decrease blood pressure in the specimens through the somato-adrenal medullary reflex. (304 (Sato) pp 220, 231,235) The authors concluded that in the rat, noxious somatic mechanical stimulation of the skin can also stimulate adrenal sympathetic nerve supply leading to an increase in adrenaline and noradrenaline production from the adrenal medulla. (304, p. 224)

In 2012, Bolton and Budgell reviewed a further possible association between spinal manipulation, and autonomic and visceral reflexes. They summarised evidence demonstrating a potential mediating influence upon cellular and humoral neural mechanisms, but at that time they recognised that more neurobiological research on the topic was required. (322)

In a controlled 2006 study, Teodorczyk-Injevan and colleagues assessed changes in a range of serum inflammatory factors indicating a positive somatic influence associated with spinal manipulation. (319) A second study in 2008 found that in immunoassays '*in vitro T lymphocyte response*' was enhanced following spinal manipulation. (323) This study comparing asymptomatic controls against patients with acute and chronic low back pain in 2018, Teodorczyk-Injeyan and colleagues found improved levels of nociceptive inflammatory biomarker CC-chemokines (CCL) in lower back pain patients following a series of spinal manipulations. (324) Their further findings essentially indicate a raised level of immune response to both pain and spinal manipulation. (325, 326)

A systematic review reported in the JAMA in 2021 by Chow et al found '*Eight articles reporting the results of 6 high- and acceptable-quality RCTs comprising 529 participants investigated the effect of SMT on biomarkers. Spinal manipulative therapy was not associated with changes in lymphocyte levels or physiological markers among patients with low back pain or participants who were asymptomatic compared with sham manipulation,...and venipuncture control groups. Spinal manipulative therapy was associated with short-term changes in selected immunological biomarkers among asymptomatic participants compared with sham manipulation,... and venipuncture control groups*.' As there was considerably more to ascertain, further research on the implication of this in relation to immune function and infectious conditions would be recommended. (327)

New Zealand physiotherapists Sampath and colleagues found that spinal manipulation affected a number of biochemical markers which included substance-P, neurotensin, oxytocin and interleukin, but not epinephrine or nor-epinephrine. (328)

Pioneering positron emission tomography (PET) crossover studies by Inami (2017), Ogura (2011), and colleagues, using glucose labelled with [18F] fluorodeoxyglucose, monitored metabolic changes in the brain following spinal manipulation. The subjects' cervical spines were adjusted using an Activator™ instrument. A number of changes were recorded including both increases and decreases in glucose metabolism in differing but specific regions of the brain. Areas of the brain in which increased glucose metabolic changes occurred in the research included the inferior prefrontal cortex, anterior cingulated cortex and middle temporal gyrus. (329) Decreased metabolism was recorded in the cerebellar vermis and visual association cortex. It was also reflected in a lowered visual analogue scale an indication of pain reduction and a relaxation of the sympathetic tone. A similar study in 2017 by Inami, Ogura, Watanuki et al, produced similar outcomes. (330) Other studies also recognise a central processing and a tonic influence with chiropractic care. (331, 332, 333)

A recent (2020) study of the response of brain metabolites to spinal manipulation in lower back pain patients using a proton magnetic resonance spectroscopy, was also conducted. Didehdar et al found that following the manipulation, pain and functional disability '*significantly reduced*,' while the thalamus as well as specific areas of the brain displayed significant metabolic changes against their baseline. (334)

A study of an association between cortisol and spinal manipulation was published by Tuchin in 1998. (335) He found a temporary elevation of cortisol levels following manipulation. Similar findings were made by Christian et al in 1988 (336),Whelan et al in 2002 (337) and Padavachy in 2010 (338).

Additional physiotherapy studies by Sampath et al found an immediate decrease in neuro-endocrine indicators of salivary cortisol levels, and a reduced testosterone/cortisol (T/C) ratio some 6-hours following spinal manipulation. They suggested this was a cascade of responses via sympathetic excitation involving the hypothalamic/pituitary axis. (339, 340) Other studies noted biochemical changes associated with the immune and endocrine systems, and in urinary pH analysis in studies with spinal manipulation. (341, 342)

From a different vertebrogenic perspective involving degenerative spinal discs as the somatic factor, Teraguchi et al noted significant metabolic changes being influenced at corresponding spinal regions, especially with the thoracic intervertebral disc. These changes involved alterations in hypertension, glucose tolerance, lipidemia and body weight. (343)

Further studies explore the biochemical increases in response to spinal manipulation. Plaze-Manzano and colleagues stated that '*The mechanical stimulus provided by spinal manipulation triggers an increase in neurotensin, oxytocin, and cortisol blood levels. Data suggest that the initial capability of the tissues to tolerate mechanical deformation affects the capacity of these tissues to produce an induction of neuropeptide expression*.' (344, 345)

In additional indications of integration of the ANS with homeostasis, hormonal influences, immunology and visceral function, Sato and Schmidt point out and their research tended to confirm Fulton's expressed opinion from his 1949 textbook '*Physiology of the Nervous System*.'

They state that '*the posterior pituitary neurosecretion system (i.e. for oxytocin and vasopressin) could be considered a part of the parasympathetic nervous system. In the study of body homeostasis and environmental adaptation it would seem very important to further analyze the contribution of somatic afferent input to the autonomic nervous and hormonal regulation of visceral organ activity. Also, some immunological functions have been found to be influenced by autonomic nerves or hormones (e.g. adrenal cortical hormone and catecholamines). Finally, we must take into account, as we have briefly discussed, that visceral functions can be modulated by somatic afferent input via various degrees of integration of autonomic nerves, hormones, and immunological processes*.' (346)

In acknowledging modulation of visceral function by somatic afferent activity The authors project further by stating *'We trust that such research will be expanded to higher species of mammals, and that ultimately this knowledge of somato-visceral reflexes obtained in the physiological laboratory will become clinically useful in influencing visceral functions.*' (346)

Somato-autonomic neuroimmunology

The pioneering research by Gordienko and colleagues in researching autonomic nervous system (ANS) involvement in the field of immunogenesis some 60 years ago appears to be the origin of an emerging field. (347) Since that time, this field has developed its own terminology, with PubMed first listing the term neuroimmunology in the title of Nandy's 1982 paper. (348) The ANS is now identified as a factor in the body's immune response. (212, 349, 350, 351, 352, 353) Chiropractic literature on the topic has been discussed in various textbooks. (354, 355, 356, 357, 358)

Sato et al devote a whole section to their research on the somatosensory role with the immune system in animal subjects. They also point out Selye's findings of psychovisceral effects on the gastric, thymus and adrenal organs. They conclude that the immune function may be facilitated or inhibited by somatosensory stimulation in humans. (359)

Kimura and colleagues confirmed that in rats, somatic afferent stimulation produced a reflex effect on immune function through efferent autonomic nerves. (360)

It is recognised however, that a variety of other factors can also be involved with the body's immune defence.(361) A number of chiropractic and osteopathic researchers have explored neuroimmunology as it relates to spinal manipulation by monitoring biochemical changes to inflammatory markers and cellular immune response. (362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372)

The understanding of the nervous system's role in the immune response, inflammation and homeostasis appears to be still evolving. As recently as 2010 a new family of lymphocytes was discovered. (373) One of the main properties of this innate lymphoid cell (ILC) is to communicate with both the peripheral and central nervous systems, including the brain. Its function tends to confirm that the immune system does not operate independently and is integrated with the ANS. (374, 375, 376, 377, 378)

Further research into the full clinical implications and application of immunology, biochemistry, and humoral findings invites further research and development. (327) That said, it is apparent that spinal manipulation appears to have biological influence beyond merely back pain, headache, and neck ache. The actual degree of involvement and influence is yet to be determined.

General discussion

The evidence offered here, most of which is available on PubMed, indicates that the somatovisceral model may influence positive outcomes for a range of clinical conditions. We could not locate formal medical research that contradicts this neuromechanical pathophysiological vertebrogenic model.

This evidence does not suggest a claim that spinal manipulation is a panacea for mentioned conditions. It does however justify grounds for research to assess the degrees of influence or contributory role the somato-autonomic-visceral triad may play. (5)

In the past, allopathy appears to have shown comparatively little emphasis on the influence of vertebrogenic aberrant aspects upon the nervous systems other than by pharmaceutical means. However, evidence does exist to indicate a manipulative-somatic influence upon human physiology. (379) Mein and colleagues support this concept when they state '*Less emphasized has been the capability for manual therapy to regulate physiology, re-establishing equilibrium and balance among the various systems and processes of the body …*' (380).

An indication as to the concept that spinal segmental disturbance may contribute to more than back pain is indicated by the fact that the terms vertebrogenic as a segmental dysfunction, and visceral dysfunction are now appearing in medical papers. The terms are regularly noted both in the text as well as the reference list of this paper.

Tacit recognition of the subluxation model is evident in the medical use of synonyms and euphemisms (381, 382). The following terms were noted references cited in this paper:

- Articulo-cardiac (52, 125)
- Articulogenic (383)
- Articulo-heart rate response (125)
- Inefficient motor segment (23)
- Intervertebral insufficiency (23
- Neuroanatomical (384)
- Neurophysiological (384)
- Somatocardiovascular (105)
- Spondylogenic, (18, 23, 266)
- Vertebral blockage (12, 251)
- Vertebral syndrome (23)
- Vertebrogenic
- Vertebrovisceral (83, 275)

In recognising a possible vertebrogenic factor in a range of conditions not regarded as musculoskeletal, Simonenko and Davydov examined 830 patients with what they classified to be such spondylogenic visceropathies, as being bronchial, cardiac and abdominal. (18)

In preparing case reports and narrative anecdotes for journal publication, it is not as though a practitioner author might make unsubstantiated claims. Instances may exist where a mid-spinal pain patient might inquire if their back problem might be related to the relief of certain other symptoms, and could the vertebral adjustments have alleviated their asthma or indigestion for instance. Based on precedence and experience, it would be disingenuous to deny the possibility even if it was only symptomatic relief. Such information should have been gleaned during the initial consultation/examination. In view of the evidence, it would be natural, indeed responsible, to answer positively.

In addition, by such case reports, future offers of a trial of care subject to appropriate examination findings would be a rational consideration. Conversely, it would be irresponsible or negligent not to record such outcomes. It can also be noted that chiropractic is not necessarily limited to spinal adjustments. Other measures may also be incorporated in patient management such as advice on life style, exercise, sport, occupation, hobbies, postures, and diet.

There are far too many case reports and patient accounts of positive outcomes to not recognise that there must at least be a degree of influence contributing to these narratives under chiropractic care. In addition, more recent adoption of chiropractic techniques and principles by mostly Continental Western European medical practitioners is a form of tacit endorsement of this somatovisceral model. To ignore these reports and this trend without formal research is unscientific and a disservice to the health and welfare of potential patients. To discourage accessing such care, or not being aware of it, is not in the interest of patients (385) and would be deemed to be clinically and professionally negligent.

While the authors do not claim that spinal manipulation to be a panacea, the clinical evidence and experience suggests that it appears to be a relieving factor in a range of spine-related conditions other than those regarded loosely as musculoskeletal. Case reports of some less common conditions have also been published in Pubmed listed journals. (234, 386, 387, 388, 389, 390, 391) This includes such conditions as myasthenia gravis, myopic retinoschisis, (392, 393) A prospective trial by Athaide and colleagues found an improvement in visual acuity involving 23 subjects as another neurological function that appeared to be related to spinal adjustments. (394) Such reports suggest that a vertebrogenic influence may be a factor in these rather exceptional conditions. (395, 396, 397)

Just as hearing loss can be associated with cervical spinal trauma, amelioration of associated segmental dysfunction (subluxations) and associated deafness has been reported with manipulative care of the cervical spine. Current reports tend to highlight the original case that marked the initiation of chiropractic as a profession. (398, 399, 400, 401, 402, 403)

In 1918, the medical surgeon Warbasse explained that '*subluxations of vertebrae occur in all parts of the spine and in all degrees. When the dislocation is so slight as not to effect the spinal cord, it will still produce disturbances in the spinal nerves, passing off through the spinal foramina.' He recommended applying 'corrective manipulation*' and claimed that the omission of vertebral subluxations by medicine was scientific neglect. (404)

Conclusion

The evidence summarised in this review indicates the demonstrable pathophysiological science of a somatovisceral contributing factor related to a range of conditions. This rationale would justify continuing research and ongoing clinical therapeutic ministrations which address this spinal/somato-autonomic-visceral reality. An instrument or manual vertebral adjusting model would appear to be the optimal form of manipulation as counteractive interventions addressing the initiating somatic component of the VSC.

It is iterated here that the somato-sensory activation is not necessarily the major factor in all visceral conditions, but it may be a contributory factor in many as a causative or indirect consequence. The volume of evidence invites serious collaborative dialogue, clinical trials and research opportunities in order to ascertain the degree of that contribution or influence, and ultimately for the benefit of the patient.

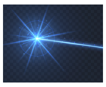
In view of the plethora of evidence, it would be virtually impossible to deny that noxious somatosensory input has an influence on internal physiology potentially leading to degrees of pathophysiology. Claims that there is no evidence in support of vertebrogenic-pathosensory concepts are shown here to be anachronistic. Currently the degree of that contribution or influence is subject to determination which primarily depends on positive clinical outcomes.

The presented review may not be the cogent evidence sought by some, however it is supportive of the somato-autonomic-visceral vertebrogenic model, and far stronger than unsubstantiated opinion or dearth of formal evidence to the contrary, whether it be under the term subluxation or other synonyms representing this primary somatosensory source.

In the absence of evidence to the contrary, one cannot help but question the resistance to such a logical approach or understanding when there is not the research to support that resistance or position.

The evidence presented here supports the concept of vertebral subluxations and a vertebrogenic-autonomic element in a range of conditions. Although this influence may not be quantifiable, these biomechanical lesions are deemed to be a contributory factor in designated somatovisceral clinical presentations. Rather than reject the concepts out of intransigence, many patients may benefit from trials of manipulative care with outcomes recorded and reported in a case report process common to all professions. These may lead to further randomised controlled trials, as well as to formal inter-professional comparative studies on efficacy.

‘Recent neuroscience research supports a neurophysiologic rationale for the concept that aberrant stimulation of spinal or paraspinal structures may lead to segmentally organised reflex responses of the autonomic nervous system, which in turn may alter visceral function.’
Budgell (2)



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