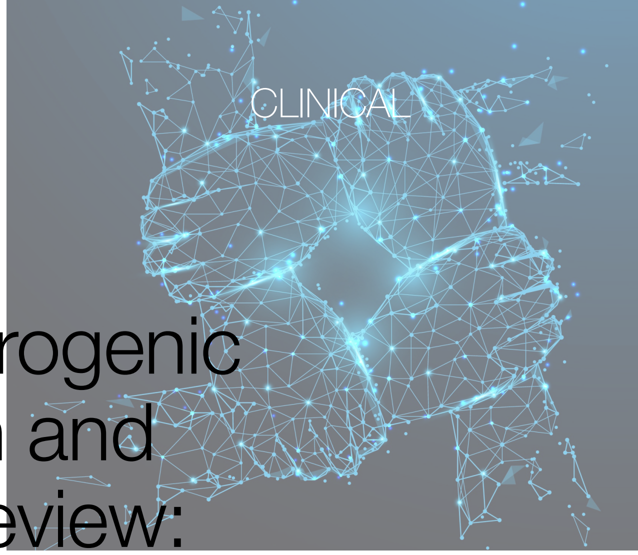
Asia-Pacific Chiropractic Journal



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

Part 2 Autonomic nervous system and somatic reflexes

Peter Rome and John Waterhouse

Abstract: Somatosensory reflexes inherently involve the autonomic nervous system as a natural physiological response from their activation to both physiological and pathophysiological stimuli. It is the noxious sensory bombardment that is suspected of being the neural factor with disturbed vertebral facets as discussed here as a current rationale behind the vertebral subluxation phenomenon.

Indexing terms: Vertebrogenic; somatosensory; autonomic reflexes; subluxation; chiropractic

Introduction

> *An important mode of control of visceral organs is the regulation of their function by reflexes originating from the peripheral sensory receptors'* (1)

This presentation is intended as an overview of some of the available literature supporting the hypothesis regarding a *Somato-Autonomic Visceral Complex* (SAVC). The title and subject matter of Sato's text describes the essence of one of the central elements in this complex, that is - the impact of somatosensory input on autonomic functions. (2, 3) In this review that phrase serves to emphasise the potential significance of noxious somatic input from disturbed joints or other disrupted somatic structures, and their impact upon visceral function. It also aims to explicate reported clinical outcomes in somatovisceral disorders noted by chiropractors, osteopaths and medical spinal manipulators. These practitioners address one of the key sources of the noxious input, the biomechanical or functional disturbance of articular surfaces commonly identified as a subluxation – a clinical finding which has been categorised under a variety of other terms. (4)

> *'manual intervention which may have the potential to remove, reduce or neutralise the noxious neural-somatic stimulation affecting the physiology, may thereby ameliorate the associated pathophysiology'*

As spinal segments appear to be a common and primary influential factor in this multifaceted clinical complex, a descriptive designation for this particular model could be more distinctly differentiated as a Vertebral Subluxation Autonomic Visceral Complex (VSAVC).

The neurophysiologists Sato and colleagues have published extensive findings which demonstrate somato-autonomic neurophysiological reflex effects on certain organs and functions.

Their research culminated in a 1997 text, although further research has since followed. This research included inter-professional collaboration with a chiropractor, Budgell (5, 6, 7, 8), at the *Department of the Autonomic Nervous System* at the *Tokyo Metropolitan Institute of Gerontology* in Tokyo, and the *Faculty of Medicine* at *Kyoto University* in Japan. Jänig acknowledges other institutions contributing to research on the autonomic nervous system around the world. These include the German Research Foundation (Prof Robert Schmidt), the A*ustralian Autonomic Neuroscience Society* (Prof Elspeth McLachlan), the *Public Health Institute of New York* (Dr Eric Kandel), *Pembroke College, Oxford* and *Oxford Regional Health Authority* (Sir Roger Bannister), *University College, London* (Prof Geoffrey Burnstock), and *Christian-Albrechts University* in Keil, Germany (Prof Wilfred Jänig). (1)

While visceral afferent activity has been recognised for some time. It is only since the 1950-60s that material even began to emerge on the neurophysiology of somatic afferent influence on visceral structures. In recognising the pioneering work of Sato, Schmidt stated in 2007 that the SAV reflexes were '*essential to developing a truly scientific understanding of the mechanisms underlying…a scientific basis to the application of all kinds of physical treatment*.' He went further to state that there were '*a multitude of reflex responses of visceral organs following the activation of somatic afferents.*'(1, 9)

Prior to Sato, Professors Chandler Brooks and Kiyomi Koizumi (*Princeton University*) conducted notable studies on the autonomic nervous system at the *University of New York, College of Medicine* where Prof. Akio Sato joined them in the 1960s. When Sato moved back to Japan he was joined in further neurophysiological studies by a number of other researchers including Prof Robert Schmidt and Prof Brian Budgell. (1, 9, 10, 11, 12, 13, 14)

It is notable to find that despite all this research, these findings concerning somato-autonomic influence have not been explored or adopted into greater acceptance for potential clinical benefit. It seems that currently, only chiropractic and osteopathy have maintained the appreciation for the concepts based on orthodox physiological sciences.(15, 16, 17, 18, 19)

The ANS

As the ANS controls virtually all physiology, its importance cannot be understated. Due to that importance, manual therapeutic access would be justified in seeking to moderate noxious somatic input which is recognised as pathophysiological somato-autonomic reflexes. Where identified, this concept could be deemed logical in regard to the potential to normalise the target organ's noxious innervation and associated dysfunction. This could also be seen as a conservative moderate physical intervention directed at an irritant pathophysiological aetiology. It may be regarded as quite a different model to one directed at the effect of an organ's dysfunction, as distinct from its cause. (20)

The noxious vertebral facet element (subluxation) may be regarded as the key medium for accessing and influencing somatosensory reflex activation through manual intervention. Its objective would be to positively influence associated pathophysiological neural aberration affecting visceral dysfunction. The phenomenon noted by Sato et al who stated,

> *'In contrast to the impressive body of knowledge concerning the effects of visceral afferent activity on autonomic functions, there is, generally speaking, much less information available on the reflex regulation of visceral organs by somatic afferent activity from skin, the skeletal muscle and their tendons, and from joints and other deep tissues. The elucidation of the neural mechanisms of somatically induced autonomic reflex responses, usually called somato-autonomic reflexes, is, however, essential to developing a truly scientific understanding of the mechanisms underlying most forms of*

physical therapy, including spinal manipulation and traditional as well as modern forms of acupuncture and moxibustion.' (21, 22)

Vascular tone is a further physiological feature under the influence of the autonomic nervous system. While there are a number of both extrinsic and intrinsic factors which govern the dilation and constriction of blood vessels, the chronic contraction of smooth muscles in the tunica media may have considerable influence on visceral structure and functions. Kaley notes that this myogenic response is one of the primary mechanisms of vascular tone, although endocrine and neuroendocrine elements are integral and complex. (23, 24, 25, 26, 27)

As well as the somatic influence of mechanoreceptors, Cramer and Darby have succinctly summarised the studies on the four primary ANS reflexes noted by Sato and others – particularly noxious spinogenic involvement, with associated clinical implications of somatovisceral disturbance. (28, 29, 30)

The enteric nervous system is associated with the CNS through sympathetic pre-vertebral ganglia and the thoracic spine, as well as the parasympathetic system through the vagus and sacral connections. Although the enteric nervous system may be regarded as a third nervous system, it will not be included as a separate entity in this overview. (31, 32)

Somatic afferents

Researchers have investigated the noxious input from somatic disturbance resulting in ANS activation through a variety of stimuli. These studies include acupuncture, capsaicin injections, massage, and electrical stimulants. The potential for musculoskeletal disturbance of the ANS as an aberrant spinogenic somato-autonomic reflex has also been proposed by Jenkins and colleagues, as well as by Giles. As different somatosensory initiators, transcutaneous electrical stimulation and monitoring of noxious ANS input has been observed in a range of smooth and cardiac muscle-controlled structures. These have been reflected in peripheral blood flow, skin temperature, blood pressure and heart rate. (2, 33, 34, 35, 36, 37, 38, 39, 40, 41)

Parasympathetic and sympathetic nervous system imbalance with the sympathetic arm dominant has been cited as factors associated with such functional conditions as fibromyalgia, chronic fatigue syndrome, irritable bowel syndrome and interstitial cystitis. In recognising this neural element, Martinez-Martinez et al suggest that non-pharmaceutical measures as well as pharmaceutical therapies may be employed to regain autonomic balance. (42, 43, 44, 45, 46)

In this discourse, the somatic afference is focussed on noxious vertebrogenic influence as an exacerbation of normal physiologic somato-autonomic tone and reflex activity. This input may also originate in visceral structures as segmentally-related viscerosomatic and viscerovisceral reflexes.

However, it is the noxious input from acute and chronic, sudden, or subliminal afference that may constitute key elements in the vertebral subluxation complex, and constitute different models of the SAVSC. Schmorl and Junghans refer to '*intervertebral instability and spondylogenic disturbances*' in relation to '*interplay between subthreshold autonomic nerve irritation and symptoms which appear a considerable distance from the nerve.*' (47, 48, 49, 50, 51, 52, 53)

Functional mechanical disturbance creating inflammatory processes in vertebral articulations may also trigger a barrage from proprioceptors, nociceptors and other mechanoreceptors. The degree and duration of nociception could be considered to be relatively common somatosensory and somatovisceral reflex elements in pathophysiological autonomic stimuli within the VSC. As discussed, these may be modified by counteractive segmental adjustments. (49, 54, 55, 56, 57)

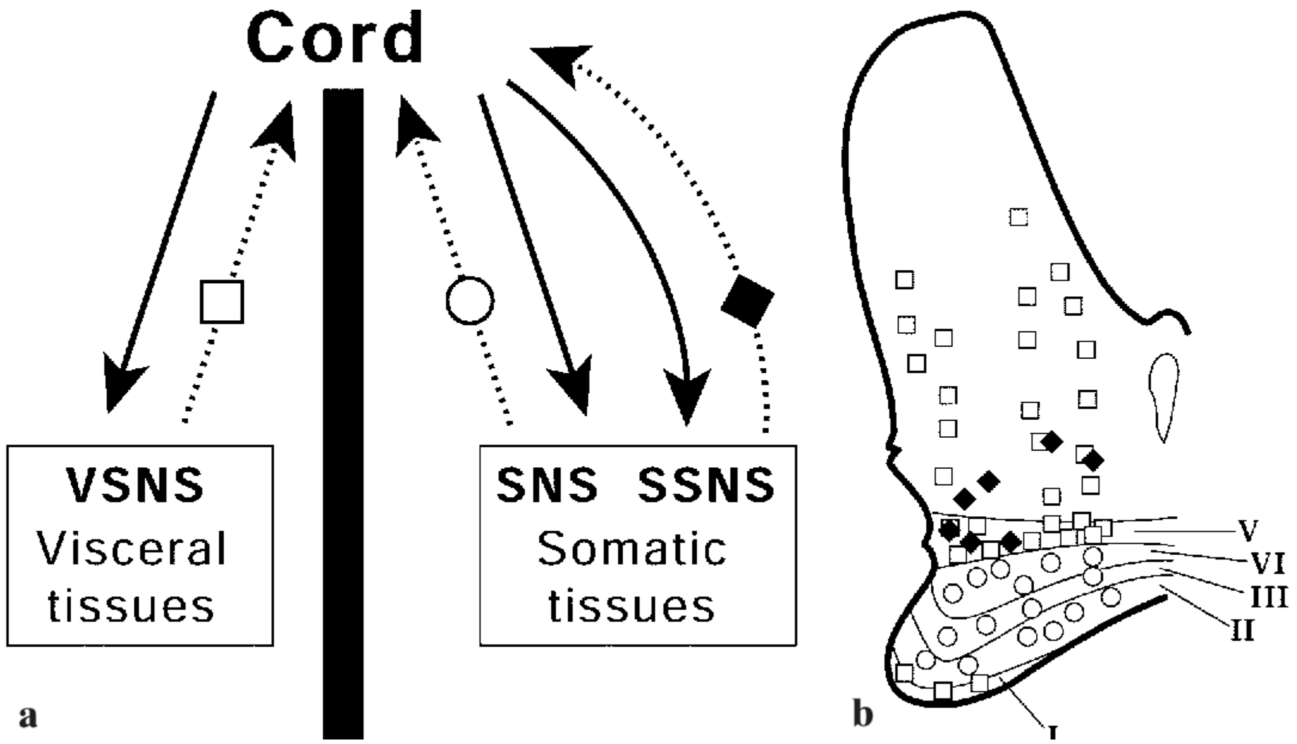
Inasmuch as chiropractic hypotheses are regarded as contextual and difficult to '*prove*' in a laboratory on human subjects, they are readily recognised clinically. It is a similar situation with pain, as in trying to objectively '*prove*' the existence of a headache. It is noted that at least nine theories of pain recognition have been offered since 1874, with the current theory being a biopsychosocial model.

Figure 1: Schematics of proposed configuration of peripheral nervous system and its central terminations, illustrating some of the principles of CNS neural *convergence* of peripheral neural input, and explaining in part the mechanism of *referred* pain:

a) Efferent pathways (solid arrows), afferent pathways (dashed arrows), visceral tissue sympathetic afferent fibers (open square), somatic tissue somatic afferent fibers (open circle), and hypothesized somatic tissue sympathetic afferent fibers (solid diamond). Note the use of the same symbols and meanings in figure b.(VSNS=visceral sympathetic nervous system; SNS=somatic nervous system; SSNS=somatic sympathetic nervous system).

b) Points of termination of visceral and somatic afferent fibers on cord neurons within dorsal and ventral gray matter of right spinal hemicord gray matter (ventral: top; dorsal: bottom; right hemicord to reader's left).

Note overlapping regions covered by squares and diamonds that theoretically result in a central nervous system convergence of afferent fibers from divergent origins (i.e., peripheral visceral and somatic neural fiber CNS convergence). (I-V=laminae of dorsal horn gray matter of spinal cord; termination of somatic [somatic tissue somatic] afferent fibers on somatic cord neurons [open circles; termination s of visceral [visceral tissue sympathetic] afferent fibers on visceral cord neurons [open squares]; terminations of somatic [proposed somatic tissue sympathetic] afferent fibers [alternate proposal: somatic tissue somatic fibers] on viscerosomatic cord neurons [solid diamonds])



Source: Jinkins JR. The anatomic and pohysiologic basis of local, referred and radiating lumbosacral pain syndromes related to disease of the spine. J Neuroradiol 2004;31:163-80

Somato-autonomic

In 1983, Jänig stated that the autonomic and somatic nervous systems operated hand in hand in that the ANS innervated the smooth muscles of all organs and glands in order to maintain homeostasis – the process of allostasis. (58, 59)

A possible corollary of neurological involvement in this model would then suggest that disturbed somato-autonomic-visceral physiology is particularly relevant to the manual sciences, in that it may be influenced by manipulation of certain somatic structures. (2, 60, 61, 62)

It is suggested that while it may not be the primary etiological factor in all cases, but may however be a secondary effect, which may then be contributing to varying degrees of influence across a wide range of effects. Such a possibility opens an area for potential research and to develop the findings of the earlier pathophysiology research of Sato, Schmidt, McLachlan and others. (1, 2)

Almost two decades ago, a review by Budgell into the primary objective addressed by spinal manipulation – the subluxation, concluded that there was support for a neurophysiologic rationale for the concept of segmentally organised ANS reflexes '*which may in turn alter visceral function*.' This statement tended to support the clinical observations reported by chiropractors and osteopaths for over a century. (15)

If a spinal somato-autonomic etiological factor originating in the cervical spine (cervicogenic) is associated with migraine and cluster headaches as indicated by some, (63) then a cardiac association noted by similar aberrant somatoautonomic mechanisms may also be subject to similar spinogenic somato-autonomic influence. The measurement of that somatic influence can be relatively readily conducted by monitoring symptoms, HRV, heart rate, blood pressure, and photoplethysmography. It would then seem reasonable to seek to neutralise or ameliorate these factors in order to reduce or eliminate input from such noxious somatic elements, thereby bringing symptomatic relief. (64, 65, 66, 67, 68, 69)

A review by Zwaaftink in 2016, concluded that there is evidence '*that spinal manipulation and mobilisation evoke significant neurovegetative reactions*' through such signs and symptoms as skin conduction, pressure pain threshold using algometers, visual analogue scales, local allodynia, hyperalgesia breathing rate, and heart rate, heart rate variability. (70)

A further example of the somatic influence on the ANS is reflected in an evaluation by Yamaga et al who monitored ECG changes on 150 patients with a thoracic outlet syndrome. The subjects reported symptoms such as - general fatigue, anorexia, nausea, insomnia, dizziness and headaches. These were assessed as signs of localised autonomic nervous system dysfunction associated with sensory activation attributed to somatic disturbance. (71)

A 2008 study by Welch and Boone found that manipulation of respective spinal regions influenced the sympathetic and parasympathetic elements of the ANS differently. Vertebral adjustments of the cervical spine were found to stimulate the parasympathetic nervous system. This was reflected in a lowering of diastolic blood pressure and a corresponding increase in pulse pressure. Vertebral adjustments of the thoracic spine resulted in a limited decreased pulse pressure, but also distinct changes in heart rate variability (HRV). (72, 73)

Somatosympathetic

In a somatosympathetic study of both animal and human subjects, Burton et al explored the relationship between chronic pain ('*prolonged (tonic) pain*') and cardiovascular regulation via the sympathetic nervous system. Their conclusion suggests that in such cases the amelioration of somatic pain through spinal manipulative care appears to positively influence irregular heart rate. They state that chronic nociceptive input '*may cause serious physiological consequences on regulation of other body systems. The sympathetic nervous system is inherently involved in a host of physiological responses evoked by noxious stimulation. Experimental animal and human models demonstrate a diverse array of heterogeneous reactions to nociception.*' (74)

Extending that observation would suggest that manual intervention which may have the potential to remove, reduce or neutralise the noxious neural-somatic stimulation affecting the physiology, may thereby ameliorate the associated pathophysiology. (75, 76, 77, 78)

In a systematic review, Kingston, colleagues and others studied the effect of spinal mobilisation on the sympathetic component of the autonomic nervous system. They found that it may influence such physiological conditions as, skin conductance, respiratory rates, blood pressure and heart rate. (79, 80, 81, 82, 83, 84)

In 1992, Giles found neural disturbance as a result of cervical spondylosis. While not a vertebral dysfunction or subluxation, it constituted a further example of adverse influence from somato-autonomic disturbance. (36)

Muheremu and Sun also found that cervical spondylotic myelopathy could produce a range of somatic initiated sympathetic symptoms including - vertigo, headache, palpitation, nausea, abdominal discomfort, tinnitus, blurred vision and hypomnesia. In this instance, these symptoms were alleviated by surgical intervention to reduce the spondylotic neural irritant. (85)

Somato-parasympathetic nervous system

Research by Ohtori and colleagues published in 2001 demonstrated how somatosensory influence may impact on the parasympathetic portion of the autonomic nervous system. They traced sensory stimulation from various levels of cervical facets to the *nodose ganglia* (vagus). This connection with the vagus nerve may help provide a rationale clarifying the neural influence of SMT upon aspects of visceral function. (86)

As with vertebrogenic somatosympathetic stimulation, the evidence suggests a distinct correlation of cervical, lower lumbar, and sacral spinal levels which may influence the parasympathetic division of the ANS. The influence of the parasympathetic vagus nerve upon viscera is extensive. This association with a disturbed cervical spine may be a significant consideration due to its potential to create a noxious somatovisceral reflex in certain cases. It then becomes a focus for manipulative intervention in seeking to ameliorate the process. (87)

The semi-autonomous enteric nervous system (ENS) is a part of the ANS. It innervates the gastrointestinal (GI) tract controlling motility and secretion amongst other GI functions. It comprises both sympathetic and parasympathetic fibres, which synapse with the vagus and spinal nerves in the GI wall. (88)

The capricious nature in the differentiation of sympathetic and parasympathetic systems is amplified by current (2017) debate as to whether the sacral neural outflow (sometimes named the '*inferior hypogastric plexus*') is sympathetic or parasympathetic. Espinosa-Medina et al have proposed it as a sympathetic categorisation, while Jänig et al rejected that classification. (89, 90)

Somatovisceral influence of spinal origin

Spinogenic, Cervicogenic, Thoracogenic, Lumbogenic - Vertebrogenic

The term vertebrogenic itself is implicated when specific segmental levels of the spine have been shown to be associated with particular organs and their function or dysfunction. (36, 91, 92, 93, 94, 95)

In further recognition of this model, Russian medical studies of manual manipulative care have been referred to as vertebroneurology. (96, 97, 98, 98, 100, 101, 102)

Except for cervicogenic, the terms thoracogenic and lumbogenic seldom seem to be used in relation to both physiological and pathophysiological autonomic symptoms of vertebrogenic origin. The latter terms have however been adopted in relation to radicular pain or paresthesia syndromes. Somatovisceral mechanisms have been demonstrated in association with vertebral subluxations using cat or rat subjects. (6, 7, 8, 15, 20, 78, 103)

The neurophysiologists Sato et al explored in detail the somatovisceral reflexes involving somato-gastric, somato-urinary-vesical, somato-cardiac, somato-adrenal, somato-splenic, sudomotor, as well as somatic afferent stimulation on cerebral circulation, peripheral circulation, immune and hormonal responses. The subjects of these somatogenic investigations were laboratory animals. (2, 104 ,105)

They concluded that with activation of the somatic element '*The analysis of neural mechanisms of these reflex responses seems to be very important for clinical application to regulate visceral function by physical treatment.*' They also stated that disruption of these somato-autonomic reflexes may interfere with homeostatic visceral function. (11, 78, 106, 107)

In 1974, the U.S. National Institute of Health through a Senate Health, Education and Welfare subcommittee established an '*independent, unbiased study of the fundamentals of the chiropractic profession*.' The submission by Sato stated that in rats, '*the function of various visceral organs can be influenced by proper cutaneous stimulation as a result of somatosympathetic or the somatoparasympathetic reflexes.*' He then went further in this somatovisceral model to conclude that this knowledge '*will be clinically useful in altering the visceral reflexes of humans*.' Apart from the manipulative sciences, his observation does not appear to have been adopted into the conventional care model apart from an association of a cohort of primarily European medical doctors. (108)

Budgell demonstrated somatoneural influence by forced lateral stress in the lumbar and lower thoracic spine in rats to induce pain which resulted in afferent stimulation increasing autonomic tone. He found this changed blood pressure, heart rate and sympathetic nerve activity. In reference to this biological phenomenon, he stated that '*Pain in general, and perhaps spinal pain in particular, is capable of eliciting changes in visceral function which can be distressing and even dangerous.*' (109) This finding could invite investigative research into the effects of chronic low level noxious somatic irritation. In 1964, Robbins stated that in relation to neoplasia '*at the present time, protracted mechanical or inflammatory irritation is suspect but deserves further study.*' (110)

Franz et al identified otological signs and symptoms in 420 patients with functional disorders of the upper cervical spine which affected the sympathetic innervation of the eye. They identified this as a diagnostic sign involving variation in pupil size which they nominated as the cervicogenic otoocular syndrome. As a possible predisposing factor, some 60% of these patients were identified as having previously experienced a whiplash injury. (111)

In 1997, Carrick mapped the changes of the retinal blind spot (*punctum caecum*) following adjustment of a specific cervical vertebra (C2). This mapping noted changes as improved blind spot size and shape and were attributed to somatic induced neural influence upon cortical brain function via a specific cervical segment adjustment. (112, 113)

In addition, Giblin and colleagues recognised a cervicogenic origin in trigeminal autonomic cephalgias and migraines. They attributed this to associated trigeminal neurogenic inflammation. In a case report, they noted alleviation of a patient's trauma-induced migraine headaches and autonomic symptoms with unilateral opioid nerve block and radio-frequency lesioning. (63, 114, 115, 116) The autonomic symptoms included;

- Periorbital and mandibular facial swelling,
- Tearing,
- Dilation of the conjunctival blood vessels and,
- Allodynia.

In a condition of cervical spondylosis which resulted in disc replacement surgery in 73 patients, Sun and colleagues noted associated autonomic symptoms as being of vertebrogenic origin due to myelopathy and/or radiculopathy. The following symptoms were reportedly relieved after surgical intervention. This clinical outcome would again tend to corroborate a somato-autonomic-spinal factor in such conditions, although the degree of spondylosis would likely be more anatomically intrusive. (117)

- Dizziness (46.6%)
- Tinnitus (41.1%)
- Facial flushing and sweating (41.1%)
- Headache (35.6%)
- Hypomnesia (30.1%)
- Nausea and vomiting (20.5%)
- Palpitations (39.7%)
- Blurred vision (20.5%)

Murtagh's text also lists a range of similar somato-autonomic–related symptoms which may be attributed to vertebral dysfunction. (118, 119) He recommends the need to differentiate them from other etiologies in arriving at a diagnosis in order to differentiate possible masquerades of the conditions including:

- Dizziness/Vertigo
- Dyspnoea
- Facial pain
- Fits, faints funny turns (Sic)
- Headache
- Migraine
- Painful ear
- Sore throat
- Tiredness and fatigue
- Visual dysfunction (diplopia).

If these vertebrogenic conditions are differentials for other forms of the same condition, and practitioners are not trained in masquerades of spinal origin, patients may receive an inappropriate or ineffective treatment. Ignoring this possibility is not in patients' interests.

Johnson reported that 39% of 250 consecutive back pain patients exhibited a range of visceral dysfunction symptoms as evidence of vertebrogenic autonomic dysfunction. This comprised 31% lower back patients, 54% thoracic spine pain patients, and 60% with posterior cervical sympathetic symptoms. (120, 121) These symptoms included:

- Cervicogenic cephalalgia,
- Disturbed vision,
- Disequilibrium,
- Constipation,
- Gastrointestinal upset,
- Menstrual disturbance.
- Nausea, flatus,
- Lumbalgia,
- Thoracalgia, and
- Urinary frequency.

In discussing vertebral locking, Schmorl and Junghanns nominated the spinal origin of autonomic influence when they refer to terms such as; spondylogenic-neuroautonomic, spondylogenic-vascular and spondylogenic pelvicopathy in relation to intervertebral insufficiency. These terms may be regarded as being indicative of segmental disturbance – the chiropractic subluxation. (122, 123, 124, 125, 126)

An indication of potential somatovisceral (spinal) influence on pathophysiological conditions is also provided in the osteopathic text by King and Patterson, who suggest that ‘the strongest evidence for the impact of manual therapy on physiologic function and systemic disorders may be in the conditions of pneumonia, asthma, and otitis media. (127, p. 306)

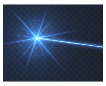
The adoption of the manipulative model in focussing on neutralising the aberrant somatic stimuli contributing to pathophysiology may be considered a therapeutic measure for some spine-related conditions. Further research should be instituted to identify apparent somatic factors, as well as the reported therapeutic benefits in manually addressing the stimuli. The possibility of a vertebrogenic contributing factor would be recommended. (128, 129, 130, 131, 132)

Conclusion

It is suggested that the optimal condition to control or mediate adverse spinogenic influence of the aspects of the ANS would be the attenuation of such vertebrogenic noxious sensory input. These may be instituted by the restoration and maintenance of a mobile, flexible, and supple spine, where each segment moves as freely and independently as possible within physiological norms, and demonstrates a lack of noxious input.

While somatosensory-autonomic-visceral reflexes area normal physiology their recognition as by means of manual influence would seem rational.

‘*In conclusion, this literature review provides evidence that spinal manipulation and mobilization evoke neurovegetative reactions.*’ (133)



Peter Rome
DC (ret), FICC
cadaps@bigpond.net.au

John D Waterhouse
DC, FACC
Private practice, Melbourne

Cite: Rome P. Waterhouse JD. Neurodynamics of vertebrogenic somatosensory activation and Autonomic Reflexes - a review: Part 2 Autonomic nervous system and somatic reflexes. Asia-Pacific Chiropr J. 2021;1.4. URL apcj.net/papers-issue-2-4/#RomeWaterhousePart2

References

1. Schmidt RF. The discoveries of Akio Sato on the impact of somatosensory input on autonomic function. Autonom Neurosci. 2007;135(1-2)16.
2. Sato A, Sato Y, Schmidt RF. The impact of somatosensory input on autonomic functions. Reviews of Physiology Biochemistry and Pharmacology. Blaustein MP et al Eds. Springer-Verlag, Berlin. 1997;130:1-2.
3. Zinnitz F, Otto W,Seuss W. [Autonomic tonus changes in the treatment of degenerative spine diseases.] Med Monatsschr. 1957 Aug;11(8):507-14. (German) (Pubmed Extract)
4. Rome PL. Usage of chiropractic terminology in the literature: 296 ways to say 'subluxation' – complex issues of the vertebral subluxation. Chiropr Tech. 1996;8(2):49-60
5. Budgell BS, Hotta, Sato A. Reflex responses of bladder motility after stimulation of interspinous tissue in the anaesthetised rat. J Manipulative Physiol Ther 1998;21(9):593-599.
6. Budgell BS, Sato, Suzuki A, Uchida S. Responses of adrenal function to stimulation of lumbar and thoracic interspinous tissues in the rat. Neurosci Res 1997;28(1):33-40.
7. Budgell B, Sato A. The cervical subluxation and regional blood flow. J Manipulative Physiol Ther 1997;20(2):103-107.
8. Budgell B, Hotta H, Sato A. Spinovisceral reflexes evoked by noxious and innocuous stimulation of the lumbar spine. JNMS 1995;3(3):122-131.
9. Koizumi K. A pioneering the autonomic studies: recollections of Akio Sato's ear;y research career. Autonom Neurosci. 2007;135(1-2)16-17.
10. McLachlan EM. Foreword. In: Jänig W. The integrative action of the autonomic nervous system. Neurobiology of homeostasis. Cambridge University Press. 2006: xv- xvii (Preface)
11. Sato A. Neural mechanisms of autonomic responses elicited by somatic sensory stimulation. Neurosci Behav Physiol. 1997;27(5):610-621.
12. Koizumi K, Brooks CM. The integration of autonomic reactions: a discussion of autonomic reflexes. Their control and their association with somatic reactions. Ergeb Physiol 1972;67:1-68
13. Koizumi K, Terui N, Kollai M, Brooks CM. Functional significance of coactivation of vagal and sympathetic cardiac nerves. Proc Natl Acad Sci USA 1982;79(6):2116-2120
14. Profile – Dr Brian Budgell, DC, PhD. J Can Chiropr Assoc. 2006;50(4):234.
15. Budgell BS. Reflex effects of subluxation: the autonomic nervous system. J Manipulative Physiol Ther. 2000;23(2):104-106.
16. Burke JM, Cunningham BM, Grimm DR. The effects of upper thoracic spinal manipulation on autonomic modulation of cardiovascular function in asymptomatic subjects during a cold test. (Poster presentation, The Association Chiropr Colleges. 13th Annual Conference, 2006.
17. Navid MS, Lelic D, Niazi IK, et al. The effect of chiropractic spinal manipulation on central processing of tonic pain – a pilot study using standardised low0resolution brain electromagnetic tomography (sLORETA) Scientific Rep. 2019;9: https://doi.org/10.1038/s41598-019-42984-3
18. Rechberger V, Biberschick M, Porthun J. Effectiveness if an osteopathic treatment on the autonomic nervous system: a systemic review of the literature. Eur J Med Res. 2019;24:36. doi: 10.1186/s40001-019-0394-5
19. Carnevali L, Lombardi L, Fornari M, Sgoifo A. Exploring the effects of osteopathic manipulative treatment on autonomic function through the lens of heart rate variability. Front Neurosci. 2020; 14:579365. doi: 10.3389/fnins.2020.579365. eCollection 2020
20. Ke-mi C, Wei-min L, Budgell B, Na L, Wuge. Effect of cervical manipulation on autonomic nervous function in healthy volunteers. J Acupunct Tuina Sci. 2006;4(5):267-270.
21. Sato A, Sato Y, Schmidt RF. (2. P 1-2)
22. Likhachev SA, Borisov IA, Borisenko AV. [The influence of vegetative status of patients with neurological signs of cervical osteochondrosis on manual therapy efficacy.] Zh Nevol Psikhiatr Im SS Korsakova. 2002;102(3):67-69. (Russian)
23. Kaley G. Regulation of vascular tone. Circulation Res 2000;87(1):4-5 https://doi.org/10.1161/01.RES.87.1.4
24. Fernandez-Alfonzo MS. Regulation of vascular tone. Hypertension. 2004;44:255-256.
25. Ohhashi T. Mechanisms for regulating tone in lymphatic vessels. Biochem Pharm 1993;45(10)1841-46.
26. Howarth D, Burstal R, Hayes C, Lan L, Lanfry G. Autonomic regulation of lymphatic flow in the lower extremity demonstrated on lymphoscintigraphy in patients with reflex sympathetic dystrophy. Clin Nucl Med 1999;24(6):383-387.
27. Rome P, Waterhouse JD. Noxious Somato-Autonomic reflex influence upon smooth muscle: Its integration with vascular tone and perfusion. A review. Asia-Pac Chiropr J. 2020;1.2:online only. URL https://apcj.rocketsparkau.com/ noxious-somato-autonomic-reflex-influence-upon-smo/
28. Darby SA, Daley DL. Neuroanatomy of the spinal cord. In: Cramer GD, Darby SA. In: Basic and clinical anatomy of the spine, spinal cord, and ANS. St Louis, Miss. Mosby.1995:251-303

29. Darby SA. Neuroanatomy of the autonomic nervous system. In: Cramer GD, Darby SA. Basic and clinical anatomy of the spine, spinal cord, and ANS. St Louis, Miss. Mosby. In:342-354.

30. Cramer GD, Darby SA. Pain of spinal origin. In: GD, Darby SA. Basic and clinical anatomy of the spine, spinal cord, and ANS. St Louis, Miss. Mosby. 355-374. DO (#355-374)

31. Furness JB, Callaghan BP, Rivera LR, Cho HJ. The enteric nervous system and gastrointestinal innervation: integrated local and central control. Adv Exp Med Biol. 2014;817:39-71. doi: 10.1007/978-1-4939-0897-4_3.

32. Furness JB. Enteric nervous system. Scholarpedia 2007;2(10):4064. doi:10.4249/scholarpedia.4064

33. Gatterman MI. Foundations of chiropractic subluxation. 2nd ed. St Louis. Elsevier Mosby.2005;152-157,331-336

34. Jinkins JR, et al. Autonomic dysfunction associated with disc extrusion. Am J Neuroradiology 1989;10:219-231

35. Jinkins JR, Whittemore AR, Bradley WG. The anatomic basis of vertebrogenic pain aand the autonomic syndrome associated with lumbar disc extrusion. Am J Roentg. 1989;152(6):1277-89.

36. Giles LGF. Paraspinal autonomic ganglion distortion due to vertebral body osteophytosis: A cause of vertebrogenic autonomic syndrome? J Manipulative Physiol Ther. Nov/Dec 1992;15(9):551-5.

37. Rome PL. Neurovertebral influence upon the autonomic nervous system: some of the somato-autonomic evidence to date. Chiropr J Aust. 2009;39(1):2-17.

38. Ebersold MJ, Laws ER, Albers JW. Measurements of autonomic function before, during and after transcutaneous stimulation in patients with chronic pain and control subjects. Mayo Clin Proc 1977;52:228-232

39. Leach RA. Hard outcome measures of dysfunction. In: The chiropractic theories, principles and clinical application. Baltimore Williams & Wilkins, 3rd edn. 1994:73-87.

40. Korr IM. Sustained sympatheticotonia as a factor in disease. Peterson B. Ed. The collected papers of Irvin M Korr. Newark. American Academy of Osteopathy. 1979:229-268..

41. Jänig W. The integrative action of the autonomic nervous system. Neurobiology of homeostasis. Cambridge University Press. 2006.

42. Taslitz, Barr. The influence of back massage on autonomic functions. Phys Ther 1970;50(12):1679-1691. (

43. Haker E., Egekvist H., Bjerring P. (2000). Effect of sensory stimulation (acupuncture) on sympathetic and parasympathetic activities in healthy subjects. J. Auton. Nerv. Syst. 79, 52–59.

44. Lee Y. H., Park B. N., Kim S. H. (2011). The effects of heat and massage application on autonomic nervous system. Yonsei Med. J. 52, 982–989.

45. Wang JD, Kuo TBJ, Yang CCH. An alternative method to enhance vagal activities and supress sympathetic activities in humans. Auton Neurosci Basic Clin. 2002;100:90-95.

46. Martinez-Martinez LA Mora T, Vargas A, Fuentes-Iniestra M, Martimez-Lavin M. Sympathetic nervous system dysfunction in fibromyalgia, chronic fatigue syndrome, irritable bowel syndrome, and interstitial cystitis: a review of case-controlled studies. J Clin Rheumatol 2014;20(3):146-150.

47. Schmorl G, Junghanns H. The human spine in health and disease. 2nd edn. New York. Grune & Stratton 1971;227

48. Coote JH. Physiological significance of somatic afferent pathways from skeletal muscle and joints with reflex effects on heart circulation. Brain Research 1975;87:138-144.

49. Kiyomi K. Autonomic system reactions caused by excitation of somatic afferents: Study of cutaneo-intestinal reflex. In: Korr IM (ed), The neurobiologic mechanism in Manipulative Therapy. New York, Plenum, 1978, pp 219-227.

50. Sato A. Reflex modulation of visceral functions by somatic afferent activity. 53-72. In: Patterson MM, Howell JN. Editors. The central connection: somatovisceral/viscerosomatic interaction. Proceedings of the 1989; Am Osteop Acad Symposium; Athens, Ohio. University Classics. 1992. earlier

51. Foreman RD. The functional organisation of visceral and somatic input to the spinothalamic system. 178-207. In: Patterson MM, Howell JN. Editors. The central connection: somatovisceral/viscerosomatic interaction. Proceedings of the 1989; Am Osteop Acad Symposium; Athens, Ohio. University Classics. 1992.

52. Wang JD, Kuo TBJ, Yang CCH. An alternative method to enhance vagal activities and supress sympathetic activities in humans. Autonomic Neurosci 2002;100:90-95.(acupuncture)

53. Longhurst JC. Regulation of autonomic function by visceral and somatic afferents. In: Llewellyn-Smith IJ, Verberne AJM. Eds. 21nd edn. Central regulation of autonomic functions. Oxford. Oxford University Press. 2011. 161-179

54. Johnstone T, Salomons TV, Backonja MM, Davidson RJ. Turning on the alarm: the neural mechanisms of the transition from innocuous to painful sensation. Neuroimage 2012;59(2):1594-1601.

55. Manchikanti L, Pampati V, Fellows B, Bakhit CE. Prevalence of lumbar facet joint pain in chronic low back pain. Pain Physician 1999;2(3):59-64

56. Windsor RE, King FJ,Hiester ED, Windsor RB. Cervical facet syndrome. Medscape 2014: https://emedicine.medscape.com/article/93924-overview#showall

57. Mäkelä M, Heliövaara M, Sievers K, et al. Prevalence, determinants and consequences of chronic neck pain in Finland. Am J Epidemiol 1991;134(11):1356-1367

58. Jänig W. Autonomic nervous system. In Schmidt RF, Thews G. eds; Human Physiology. Berlin. Springer-Verlag. 1983;111-144

59. McEwen BS, Wingfield JC. The concept of allostasis in biology and biomedicine. Horm Behav 2003;43:2-15.

60. Kimura A, Sato A. Somatic regulation of autonomic functions in anesthetized animals – neural mechanisms of physical therapy including acupuncture. Jpn J Vet Res. 1997;45(3):137-145.

61. Sato A. Physiological studies of the somatoautonomic reflexes. In: HaldemanS (Ed) Modern Developments in the Principles and Practice of Chiropractic. Appleton-Century-Crofts, New York. 1980;Chapter 5:93-105.

62. Sato A. The importance of somato-autonomic reflexes in the regulation of visceral organ function. J Can Chiro Assoc 1976;20(4):32-38.

63. Giblin K, Mewmarh JL, Brenner GJ, Wainger BJ. Headache plus: trigeminal and autonomic features in a case of cervicogenic headache responsive to third occipital nerve radiofrequency ablation. Pain Med. 2014;15(3):473-478. doi: 10.1111/pme.12334.

64. Boiardi A, Munari L, Milanesi I, et al. Impaired cardiovascular reflexes in cluster headache and migraine patients: Evidence for an autonomic dysfunction. Headache 1988;28(6):417-422.

65. Havanka-Kannianen H, Tolonen U, Myllyla VV. Autonomic dysfunction in migraine: a survey of 188 patients. Headache 1988;28(7):465-470

66. Havanka-Kannianen H, Tolonen U, Myllyla VV. Cardiovascular reflexes in young migraine patients. Headache 1986;26(8):420-424.

67. Hamunen K, Kontinen V, Hakala E, Talke P, Paloheimo M Kalso E. Effect of pain on autonomic nervous system indices derived from photoplethysmography in health volunteers. Brit J Anaesth. 2012;108(5):838-844.

68. Kang J-H, Chen H-S. Disability in patients with chronic neck pain heart rate variability analysis and cluster analysis. Clin J Pain 2012;28:797–803

69. Moore C, Adams J, Leaver A, Lauche R, Sibbritt D. The treatment of migraine within chiropractic: analysis of a nationally representative survey of 1869 chiropractors. BMC Compl Altern Med 2017;17:519. https://doi.org/10.1186/s12906-017-2026-3

70. Zwaaftink KG. Neurovegetative reactions of spinal; manipulations and mobilisations in manual therapy, chiropractic and osteopathic medicine: a literature review. Masters Thesis. Univ Appl Science, Tyrol, 2016. tent/uploads/2017/08/2016_Groot-Zwaaftink-Koen_Efferent-Neurovegetative-Reactions.pdf

71. Yamaga M, Takagi K, Ide J, Ikuta T. Quantitative evaluation of autonomic nervous dysfunction in patients with thoracic outlet syndrome. Neuro Orthop 1988;5(2):83-86

72. Welch A, Boone R. Sympathetic and parasympathetic responses to specific diversified adjustments to chiropractic vertebral subluxations of the cervical and thoracic spine. J Chiropr Med. 2008;7:86–93.

73. Briggs L, Boone WR. Effects of a chiropractic adjustment on changes in pupillary diameter: a model for evaluating somatovisceral response. J Manipulative Physiol Ther. 1988;11(3):181-9.

74. Burton AR, Fazalbhoy A, Macefield VG. Sympathetic responses to noxious stimulation of muscle and skin. Front Neurol. 2016 Jun 30;7:109. doi: 10.3389/fneur.2016.00109

75. Moulson A, Watson T. A preliminary investigation into the relationship between cervical snags and sympathetic nervous system activity in the upper limbs of an asymptomatic population. Man Ther. 2006;11:214–224.

76. Jordan T. Osteopathic manipulative approach to the sympathetic nervous system. Ohio University. http://www.bayviewmedical.org/wp-content/uploads/2016/01/balancing-sns.pdf

77. Pickar JG, Kenney MJ, Henderson CNR, Gudavalli MR et al. Somatosympathetic reflex mechanisms. In: King HH, Jänig W, Patterson MM. The science and clinical application of manual therapy. Edinburgh. Churchill Livingstone/Elsevier. 2011;p 55-70

78. Budgell BS. Modulation of visceral function by somatic stimulation. In: In: King HH, Jänig W, Patterson MM. The science and clinical application of manual therapy. Edinburgh. Churchill Livingstone/Elsevier. 2011;P71-84

79. Kingston L, Claydon L, Tumilty S. The effects of spinal mobilizations on the sympathetic nervous system: a systematic review. Man Ther. 2014;19(4):281-287. http://www.ncbi.nlm.nih.gov/pubmed/24814903

80. Chiu, T, Wright A. To compare the effects of different rates of application of a cervical mobilisation technique on sympathetic outflow to the upper limb in normal subjects. Man Ther. 1996;1:198–203.

81. Jowsey, P, Perry, J. Sympathetic nervous system effects in the hands following a grade III postero-anterior rotatory mobilisation technique applied to T4: a randomised, placebo-controlled trial. Man Ther. 2010;15:248–253.

82. Moutzouri, M., Perry, J., Billis, E. Investigation of the effects of a centrally applied lumbar sustained natural apophyseal glide mobilisation on lower limb sympathetic nervous system activity in asymptomatic subjects. J Manipulative Physiol Ther. 2012;35:286–294.

83. Burton AR, Fazalbhoy A, Macefield VG. Sympathetic responses to noxious stimulation of muscle and skin. Front Neurol. 2016;7:109. doi: 10.3389/fneur.2016.00109

84. Kim S-Y, Kim N-S, Kim L-S. Effects of cervical sustained natural apophyseal glide on head forward posture and respiratory function. J Phys Ther Sci 2015;27:1851-1854.

85. Muheremu A, Sun Y. Atypical symptoms in patients with cervical spondylosis might be the result of stimulation on the dura mater and spinal cord. Med Hypotheses, 2016;91:44-46. . doi: 10.1016/j.mehy.2016.04.006.

86. Ohtori S, Takahashi K, Chiba T, Sameda H, Moriya H. Sensory innervation of the cervical facet joints in rats. Spine 2001;26(2):147-150.

87. Autonomic innervation of abdominal and pelvic organs. https://anatomytopics.wordpress.com/2009/01/10/40autonomic-innervation-of-the-abdominal-and-pelvic-organs-the-cartilage-tissue-fetal-membranes-umbilical-cord-amniotic-fluid-fetal-circulation/

88. Washabau R, Miselis R, Pauli R. Enteric division of the ANS. http://cal.vet.upenn.edu/projects/giphys/review/entrev.htm

89. Espinosa-Medina L, Saha O, Boismoreau F, et al. The sacral autonomic outflow is sympathetic. Science 2016;354:893-397

90. Jänig W, Keast JR, McLachlan EM, Neuhuber WL, Southard-Smith M. Renaming all spinal autonomic outflows as sympathetic is a mistake. Auton Neurosci 2017;206:60-62

91. Dhami MS, Vernon HT. Vertebrogenic migraine. J Can Chiropr Assoc 1985;29(1):20-24

92. King HH, Jänig W, Patterson MM. The science and clinical application of manual therapy. Edinburgh. Churchill Livingstone/Elsevier. 2011; p 74

93. Grgić V. Vertebrogenic chest pain – 'pseudoangina pectoris' - etiopathogenesis, clinical manifestations, diagnosis, differential diagnosis and therapy. Lijec Vjesn. 2007:129(102):20-25. {Croatian)

94. Voĭtanik SA, Manual therapy of thoracalgia with autonomic-visceral manifestations. Vopr Kurortol Fizioter Lech Fiz Kult. 1986;5:35-38. (Russian)

95. Simonenko VB. Tesla AN, Shirokov FA, Davydov OV. [Some features of coronary artery disease combined with vertebrogenic thoracoalgias]. Klin Med (Mosk). 2007;85(1):61-63. (Russian) earlier

96. Popelianskiĭ II. [Vertebroneurology and manual therapy.] Zh Nevrol Psikhiatr Im S S Korsakova. 1998;98(2):66-67.

97. Sital AB. Brief historical review of manual therapy in Russia and abroad. Manual Medicine. 2005;1(17). http://www.mtj.ru/mtj_2005_english_summary_1.pdf

98. Popelansky A. Spinal neurology and manual therapy. PubMed-indexed for Medline. SPELLINGhttp://www.russianseattle.com/spinalneurology/3_article_list_eng.shtml

99. Editorial Staff. Soviet medical school to offer chiropractic degree. Dynamic Chiropr. 1991;9(17). http://www.dynamicchiropractic.com/mpacms/dc/article.php?id=44513.

100. Dr Press joins surgical staff for MUA. http://drpress.com/component/content/article/2-uncategorised/150-mua.html.

101. Gallyamova AF, Shchedrova NV, Yu O, Novikov. Medical and psychological rehabilitation of children of preschool age with delayed maturation of supreme brain function. Manual Therapy Department of Bashkirsky State Medical University. Russia.Manual Therapy [Мануальная Терапия] 2005;19(3) http://www.mtj.ru/mtj_2005_english_summary_1.pdf (Abstract)

102. Likhachev SA, Borisov IA, Borisenko AV. [The influence of vegetative status of patients with neurological signs of cervical osteochondrosis on manual therapy efficacy.] Zh Nevol Psikhiatr Im SS Korsakova. 2002;102(3):67-69. (Title only) (Russian)

103. Kang YM, Kenney MJ, Spratt KF, Pickar JG. Somatosympathetic reflexes from the low back in the anesthetizd cat. J Neurophysiol 2003;90:2548-2559.

104. Sato A, Sato Y, Schmidt RF, Toriqata Y. Somato-vesical reflexes in chronic spinal cats. J Auton Nerv Syst. 1983;7(3-4):351-362.

105. Schwartz E. [Manual treatment and internal medicine.] Schweizerische Rundschau fur Med Praxis 1974;63(27):837-841

106. Hawke C. Chiropractic practice, experience, and research related to somatovisceral interactions. In: King HH, Jänig W, Patterson MM. The science and clinical application of manual therapy. Edinburgh. Churchill Livingstone/Elsevier. 2011;217-236

107. Jänig W. Basic science on somatovisceral interactions. : peripheral and central evidence base and implications for research. P 275-300 In: King HH, Jänig W, Patterson MM. The science and clinical application of manual therapy. Edinburgh. Churchill Livingstone/Elsevier. 2011;, 275-300

108. Sato A. The somatosympathetic reflexes: their physiologic and clinical significance. In: Goldstein M, ed. The research status of spinal manipulative therapy. Dept Health Education Welfare. National Institute of Health Pub. No. 76-998. NINCDS Monograph No.15. Washington, DC. US Goverrnment Printing Office. 1975:163-172

109. Budgell B. Autonomic responses to spinal pain. Rigakuryohu Kagaka. 2000;15(3):81-87. (Citing: Sato A, Swenson RS. Sympathetic nervous system response to mechanical stress of the spinal column in rats. J Manipulative Physiol Ther. 1984;7:141-147

110. Robbins SL. Textbook of pathology with clinical application. Second edn. Philadelphia; WB Saunders Co. 1964:47.

111. Franz B, Altidis P, Altidis B, Collis-Brown G. The cervicogenic otoocular syndrome: a suspected forerunner of Ménière's Disease. Internatl Tinnitus J. 1999;5(2):125-130. CERV in REFs TOO

112. Carrick FR. Changes in brain function after manipulation of the cervical spine. J Manipulative Physiol Ther 1997;20(8):529-545.

113. Swingen LA, Goldsmith R, Boothby J, McDermott T, Kleibel C. Video nystagmography to monitor treatment in mild traumatic brain injury a case report. Integr Med (Encinitas) 2017;16(2):46-72

114. Benoliel R. Trigeminal autonomic cephalgias. Br J Pain. 2012;6(3):106-123.

115.Goadsby PJ, Cittadini E, Cohen AS. Trigeminal autonomic cephalalgias: paroxysmal hemicranias, SUNCT/SUNA, and hemicranias continua. Semin Neurol. 2010;30(2):186-191. doi: 10.1055/s-0030-1249227

116.Silberstein SD, Vodovskaia N. Trigeminal autonomic cephalalgias other than cluster headache. Med Clin North Am. 2013;97(2):321-328. doi:10.1016/j.mcna.2012.12.009.

117.Sun YQ, Zheng S, Yu J, Yan K, Tian W. Effect of disc replacement on atypical symptoms associated with cervical spondylosis. Eur Spine J. 2013;22(7):1553-1557.

118.Murtagh J. Spinal dysfunction.. General practice. 5th Edn. North Ryde. McGraw-Hill 2012. PAGEs

119.http://murtagh.mhmedical.com/content.aspx?sectionid=116026062&bookid=1522&Resultclick=2

120.Johnston RJ. Vertebrogenic autonomic dysfunction - subjective symptoms: A prospective study. J Can Chiropractic Assoc 1981;25(2):51-57. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2484246/pdf/jcca00090-0013.pdf

121.Robertson G. The role of spinal manipulation in the alteration of aberrant somato-autonomic reflex activity. Proceedings of the 1990 Internat'l Conference on Spinal Manipulation. 1990;May:116-121.

122.Schmorl G, Junghanns H. (47) pp185-242)

123.Wurster WD. Cardiac autonomic control – interaction of somatic and visceral afferents. In: King HH, Jänig W, Patterson MM. The science and clinical application of manual therapy. Edinburgh. Churchill Livingstone/Elsevier. 2011;p266-275

124.Johnston WL. Osteopathic clinical aspects of somatovisceral interaction. In: King HH, Jänig W, Patterson MM. The science and clinical application of manual therapy. Edinburgh. Churchill Livingstone/Elsevier. 2011;30-52

125.Cervero F. Visceral and spinal components of viscero-somatic interactions. In: King HH, Jänig W, Patterson MM. The science and clinical application of manual therapy. Edinburgh. Churchill Livingstone/Elsevier. 2011;77-85

126.Voĭtanik SA, [Manual therapy of thoracalgia with autonomic-visceral manifestations]. Vopr Kurortol Fizioter Lech Fiz Kult. 1986;Sept-Oct(5):35-38. (Title only)

127.King HH, Patterson MM. Clinical application of manual therapy on physiologic functions and systemic disorders: evidence bas and implications for research. In: King HH, Jänig W, Patterson MM. The science and clinical application of manual therapy. Edinburgh. Churchill Livingstone/Elsevier. 2011;301-312

128.Sato A, Swenson RS. Sympathetic nervous system response to mechanical stress of the spinal column in rats. J Manipulative Physiol Ther. 1984;7:141-147

129.Giles LGF. Spinal fixations and viscera. J Clin Chiro. 1973;1(3):144-165.

130.Kimura A, Sato A, Sato Y, Suzuki H. A- and C-reflexes elicited in cardiac sympathetic nerves by single shock to a somatic afferent nerve include spinal and supraspinal components in anesthetised rats. Neurosci Res. 1996;25(1):91-96.

131.Rychlíková E. Vertebrokardiální Syndrom. (The vertebrocardial syndrome) Praha: Avicenum. 1975 (Cited by Lewit K. The Heart. In: Manipulative therapy in rehabilitation of the locomotor system. 3rd edn. Butterworth Heinemann,Oxford 1999;283-284.)

132.Robertson G. The role of spinal manipulation in the alteration of aberrrant somatoautonomic reflex activity. Proceedings of the 1990 Internat'l Conference on Spinal Manipulation. 1990;May:116-121

133.Zwaaftink KG. Neurovegetative reactions of spinal manipulations and mobilisations in manual therapy, chiropractic and osteopathic medicine. Thesis. http://www.osteo-cura.nl/wp-content/uploads/2017/08/2016_Groot-Zwaaftink-Koen_Efferent-Neurovegetative-Reactions.pdf