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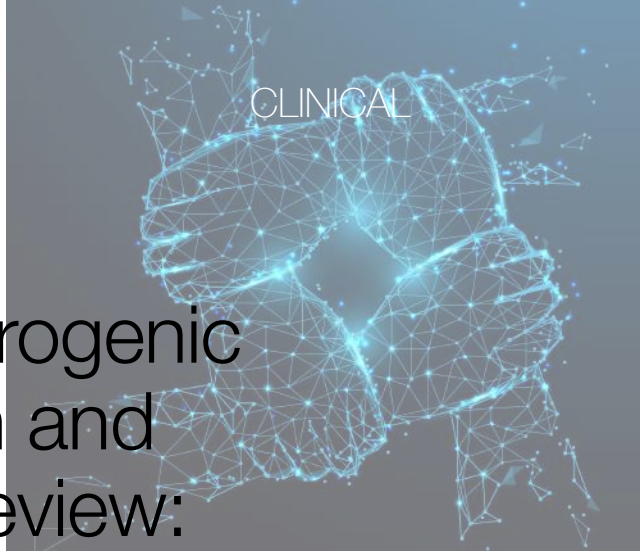

Neurodynamics of vertebrogenic somatosensory activation and Autonomic Reflexes - a review:

Part 5 Diversity in Vertebral Subluxations

Peter Rome and John Waterhouse

Abstract: Elements of the subluxation model are well known but other aspects are still emerging. Some remain in a contextual sense. This review presents a synopsis of currently available hypotheses on the types of segmental disturbances, the need for specificity, research involving animal subjects, and why the focussed adjustment to normalise dysfunctional segments is a significant part of the chiropractic model.

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

Introduction

As distinct from major tissue damage or pathology, the somatovisceral model discussed here is potentially a clinical pathophysiological contributor involving noxious or aberrant neural afference of somatic origin.

These are known to activate autonomic nervous system – somato-autonomic reflexes. The vertebral subluxation complex (VSC) - especially the disrupted vertebral articular elements, would appear to be a primary initiator of the noxious neural reflex arcs. These can be associated with somato-autonomic, somatovisceral and somatosympathetic, somatosomatic, somata-parasympathetic reflexes, with hypo or hyperreflexia pathophysiology. (1, 2, 3, 4, 5 6, 7, 8, 9, 10, 11)

subluxation

> *...it would seem apparent that the subluxation is far more complex than a mere mechanical manipulative lesion.'*

In order to clarify the complex role of disturbed vertebral physiology, the following definition of a subluxation is submitted.

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

In a further clarification aimed at differentiating the advanced form of correcting subluxations, the following definition of an adjustment is submitted.

The spinal adjustment is defined here as:

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

Other models of this lesion have also been proposed for a subluxation construct. Such a range of hypotheses would also suggest that there may be different forms of subluxations as well as being more than a simple mechanical displacement. Perhaps individual or various combinations of these models may be the somatic component activating somatovisceral reflexes. The range of subluxation models, or elements thereof reflect the complexity of the entity, they include:

- Biomechanical (12)
  - Intervertebral hypermobility (12)
  - Intervertebral hypomobility (13)
  - Intervertebral dyskinesia (13)
  - Intervertebral misalignment (12)
- Biomechanical fault (14)
- Dysafferentation Model (15)
- Facilitation Model (16)
- Functional neurology model (17)
- Malposition (18)
- Mechanical model (fixation, hypermobility) (19)
- Meniscoid entrapment (20)
- Neurobiologic model (21)
- Neurofasciogenic model (22)
- Neurological model (18)
- Nuclear fragmentation (19)
- Periarticular adhesions (23)
- Putative effects of the VSC (12)
  - Encroachment of intervertebral foramen or spinal canal
  - Altered afferent input from spinal and paraspinal tissues
  - Dentate ligament mediated cord distortion
- Sensory model (24)
- Somatosensory model (25)
- The fixation hypothesis (26)
- Trophic Model (18)
- Unified model for phases of VSC (27)
- Zygapophyseal joint sprain (28)

Senzon explored a detailed examination of the vertebral subluxation in a 10-part series with the models discussed in Part 9 in particular. (29) Other reviews have discussed the medical use of the subluxation model. (30, 31)

Despite reported amelioration following segmental adjustments of vertebral subluxations as recorded in the literature, (32, 33) this VSC entity has attracted controversy regarding its existence. (34) However, to the authors' knowledge, apart from superficial opinion and

unsubstantiated impressions and World Health Organisation recognition, (35) no formal evidential studies appear to have been produced to contradict it.

The target lesion for a specific adjustment must differ from other physically and functionally normal segments in order to have associated clinical signs and symptoms, and for them to respond to manipulative care. This would constitute cause and effect criteria which would justify conducting the corrective procedure of an adjustment.

In addition, there would be no valid reason in trying to manipulate a normally positioned and functioning asymptomatic vertebral segment. If the symptoms and signs are designated as vertebrogenic, then 'normal' functioning segments of the spine could hardly be held responsible. Unless presenting for ongoing supportive care where there may be no symptoms present, yet the clinician detects the presence of VSC's, much like a dentist may detect evidence of dental decay which is not yet symptomatic, a patient is unlikely to present themselves for care.

To question the legitimacy or effects of a *Somato-Autonomic Visceral Complex* (SAVC) hypothesis based merely on unsubstantiated opinion which lacks formal investigative research, demonstrates uninformed, unscientific, prejudicial bias. To do so is wilful ignorance of the available published evidence. Original scientifically researched evidence rejecting vertebral subluxation complex (VSC) concepts have not been forthcoming or seriously attempted.

As Stated by Sato et al, '*Thus the decrease in blood pressure and renal nerve activity during manipulation of the spine are thought to be supraspinal reflexes.*' (36) It would be more appropriate for those questioning the VSC to call for research to derive a definitive explanation as to why these segmental lesions seem directly related to patient symptoms, when a specific vertebral adjustment regularly alleviates those symptoms.

In 2011, Desmarais and colleagues demonstrated that thoracic spine manipulation may modulate somatosympathetic reflexes at a segmental level in health human subjects. Colloca, Keller et al. mechanically manipulated Merino sheep subjects with impulse instruments to study multi-axial vertebral segment motion. (37, 38, 39). Research of the science of subluxations and manipulation are noted both historically (40, 41), and in more recent reviews. (42, 43, 44) (Table 1)

Other professions now adopting forms of manual therapy have designated various terms for the subluxation finding. It is this entity that needs to be clinically identified and quantified in consideration with its articular component, in order to resolve the disturbances through specific manipulation. The clinical efficacy of spinal manipulation in addressing the lesion as a cause and effect observation may depend on a range of factors including:

- site
- duration
- severity
- degenerative change(s)
- trauma
- patient age
- hobbies
- pastimes, and
- occupation.

While most VSCs can be corrected or ameliorated, these factors may at times determine grounds for ongoing management or supportive care due to a loss of stability leading to recurrences. Such cases often require specific exercise programs to help strengthen such sites and

minimise exacerbations and relapses, along with lifestyle changes when they are indicated. (3, 4, 7, 12)

Table 1: Nominated segmental associations

SEGMENT LEVEL	ASSOCIATED ORGAN/ FUNCTION	AUTHOR	JOURNAL/YEAR
C1/C2 (Rats)	Heart/hypertension	He, Lv, Li, et al (70)	Biomed Res Int. 2017
T2/T3	Raynaud's Disease	Fraser DM (71)	Textbook, 1990
T4	Glove paresthesias	McGuckin N (72,73) DeFranca, Levine	Textbook, 1986 JMPT, 1995
T5	Angina pectoris	Hamberg, Lindall (74)	ACTA Med Scand, 1981
T5 (Rat subjects)	Impaired left ventricular function with enhanced sympathetic support	Lujan Janbaih DiCarlo (75)	J Applied Physiol, 2012
T5/6 (T4-T7)	Gastro-duodenal	Lewit (76)	Textbook, 1985
T6 'Anterior'	Dyspepsia	Rome (77)	Chiropr J Aust, 2000
T6-T9	Duodenal or gastric ulcers	Kameith (78)	Arch Orthop Unfallchir, 1958
[T13 (Rat)	Adrenal	Isa et al (79)	Neuro Sci, 1985
Multiple (Rat)	Depending on level Organ specific	Kimura A, Sato A (80)	Jpn J Vet Res. 1997

As with the diagnosis of headaches, chest pain, short sightedness and psychiatry, a large degree of subjective input may be beneficial to confirm the diagnostic localisation in the case of a VSC. Apart from clinical indications of patients' presenting symptoms and signs, at times patients may also require functional, static or other radiological imaging for further assessment, in order to rule out the possibility of contraindications for physical care. At times, imaging can assist in indicating the most likely area warranting attention as the cause of a patient's symptoms. A thorough case history and examination may comprise a physical palpation, motion palpation, as well as the standard physical, neurological, and orthopaedic testing. The results often correlate with the patients' symptoms as a starting point.

Clinically, a similar rationale with neural implications could be compared to that involved in the reduction of vertebrogenic pain, in cases of intercostal neuralgia, or in subluxation-related sciatica; a condition which can ultimately result in symptoms of paresthesias, dysesthesias, muscle dysfunction of weakness and muscle atrophy. Vertebrogenic conditions cannot logically be

confined solely to musculoskeletal conditions or an 'MSK' model, because of the deep integration and influence with the ANS. (48, 49, 50)

A comorbidity relationship of back pain and certain so-called visceral conditions was noted in 2017 by de Luca and colleagues. They discussed an association of such conditions as diabetes, cardiovascular disorder, obesity, and pulmonary disease with low back pain. The research did not however determine the effect a reduction in the back pain may have had on those conditions. (51)

In more recent times, and contrary to a 1972 opinion proposed by Wyke, Giles discovered free nerve endings in the synovial folds of lumbar vertebral facets. This anatomical contribution tends to focus attention on the disturbed facet being a primary cause of spinal pain, and refocuses more evidence on the importance of restoring normal articular sensory input. (52, 53, 54, 55)

In a detailed presentation, Lee and Salter note chondrocyte mechanotransduction as one of a number of functions at the cellular level which transmits sensory signals to chondrocytes under compressive strain. These histological physical features provide a far more complex picture than just a physical cartilage surface with dysfunction or minimal displacement. (56, 57)

In considering these aspects, it would seem apparent that the subluxation is far more complex than a mere mechanical manipulative lesion. If this was not the case, it would not be independently raised in the literature in association with noted common but apparent neurological symptoms, such as cervicogenic headaches, dyspepsia, blood pressure changes and HRV. See Parts 6, 7, 8 and 10 of this series.

This VSC condition also raises questions regarding the point at which displacement of a conventionally defined subluxated vertebra begins to become clinically significant and at which stage it affects somatosensory and other neuromusculoskeletal symptoms, as well as the mechanism that allows it to develop. The symptoms essentially demonstrate that subluxations involve more complex issues than just physical displacement and dysfunction.

Vertebrogenic-segment specific

Chiropractic has primarily based its health care model on the neurophysiology of articular segmental spinal influence. (58, 59, 60) Kirpalani and Mitra cited research of the cervical spine and stated that '*each joint produces a distinct referred pain pattern.*' (61,) The efficacy of this is supported by numerous case reports as noted in the literature, most notably the *Index to Chiropractic Literature.* (32)

In 1921, Firth published a chiropractic text with extensive correlations between specific spinal segments and particular clinical findings. Prior to that, in 1910 Palmer had noted a correlation between certain spinal segments and particular visceral and other conditions. (62, 63)

Also one hundred years ago, a medical study by Winsor at the University of Pennsylvania in 1921 conducted autopsies of 75 human and 22 cat subjects. He noted an association of spinal segmental specificity with diseased organs, a 96% correlation rate. In this study, his table of visceral disturbances lists 14 separate conditions. (64)

Warren claims that Winsor set out to disprove the chiropractic hypotheses, only to find his research was consistent with these concepts. (65)

In 1992, Jänig and McLachlan stated that '*The autonomic nervous system supplies each type of target organ via separate pathways which consists of sets or pre-and postganglionic neurones with distinct patterns of reflex activity.*' This has a homeostatic role in the protection and regulation of bodily functions. (66, 67)

It is noted further that neural irritation as explained by Sato and Schmidt, that in relation to the sympathetic reflexes in cats that '*The size of the early reflex component was largest when the*

afferent volley entered the spinal cord at the same segment or at the segment adjacent to the white ramus.' (68)

Cramer and Darby note rather specific vertebral correlations with organ nociception through preganglionic autonomic fibres. Their studies support the clinical observation of potential influence through spinal manipulation – the somatovisceral reflex association. They note that '*Since pain is the most important clinical visceral sensation, knowledge of the spinal cord segments to which visceral afferent fibers project (which is the same location as the sympathetic preganglionic cell bodies) is extremely important. This knowledge allows the clinician to more effectively diagnose pathological conditions occurring in the viscera.*' (69)

Stochkendahl and Christensen report '*segmental dysfunction of the cervical and thoracic spine' among other musculoskeletal disorders, as being "under-diagnosed"*' as well as a possible cause of thorax pain syndromes. While they recognise that the more serious considerations of chest pain must take priority, some 80% may be benign and approximately 50% of these would be musculoskeletal. The diagnostic and treatment consequences of these facts may at times be complex. (81)

In chiropractic research reported in *Neuroscience Letters*, Desmarais et al demonstrated segmentally responsive somatosympathetic reflexes throughout the thoracic spine. They found that spinal manipulation could modulate the effect of the supraspinal sympathetic reflex skin response to a heat stimulus in healthy humans. (37)

In further research in 1996, Kimura and colleagues confirmed that localised somatic stimulation of spinal-cardiac sympathetic reflexes in rats were segmentally organised.

Adrenal glands

Isa et al studied anaesthetised rat specimens, where somatic stimulation at the T13 segmental innervation level was activated through pinching, brushing and electric shock to the skin demonstrating a corresponding response of the adrenal glands. They noted '*clear and consistent decreases in blood pressure and renal nerve activity*.' (79, 83)

Sato et al noted an adrenal response with vertebral joint stimulation on rats at spinal levels between T10 and L5. Sato also anaesthetised animals in order to eliminate emotional factors. They found that somatic afferent stimulation can regulate visceral function and that particular organs can at times be segment-specific in regards to gastric motility and urinary vesical contractility. (84, 85, 86)

Others have also noted similar segmental anatomo-physiological associations. Using rat subjects, Strack et al noted that the adrenal gland was supplied with multi-segmental input from sympathetic preganglionic neurons and dorsal root ganglion cells. In acknowledging segmental specificity, they noted that one segment was the dominant source of the innervation. (87)

Grisel Syndrome

A vertebral subluxation has been recognised as being associated with a relatively rare pathophysiological medical condition of the upper cervical spine called *Grisel Syndrome*. This has been designated as being of uncertain etiology and usually, but not always, presents in children. (88) As a viscerosomatic reflex primary finding, the displacement of a cervical vertebra is adjudged to follow a range of conditions such as acute lymphadenopathy, head-neck surgery, infection, musculoskeletal (cervical ligamentous), physical trauma, and head/neck inflammation. Whether this associated displacement is cause or effect has not been definitively determined, but an apparent neural reflex is noted.

Until relatively recently, the conventional allopathic version of a subluxation would seem to be considered as a purely osseous anatomical displacement with limited consideration of its effects

on associated structures or physiological functions, especially neurological aberrations. Further, this interpretation does not appear to identify or differentiate the degree of displacement which may initiate the onset of symptoms - be they subtle or overt. (89, 90, 91, 92)

While *Grisel Syndrome* is generally considered to be identified by the increase of the C0/C1 pre-dental interspace, Martinez and colleagues identified a case involving a C2/C3 subluxation, while Lopes and Li identified a case at the C3-C4 level. The mechanism of how an infection may initiate a subluxation does not appear to have attracted serious consideration. (93, 94)

This syndrome characterises the integration of particular vertebral subluxations with autonomic and visceral components.

Scolioses

Lateral spinal curves in scolioses deviate from the midline and range from mild to severe. They may also be subject to VSC dysfunction within those curves. Manipulative management may address those VSCs, but it is also clinically important to restore them towards normal segmental mobility, function for symptomatic amelioration. In addition, maintaining general spinal flexibility within the patient's comfortable limits is also important. (95, 96, 97, 98)

In 1933 and again in 1940, research published by Ussher noted a correlation between particular spinal regions and *simulated condition* of specific organs. This association was related to patterns in lateral spinal curvature. (99, 100)

In a similar vein in 1958, Kameith reported radiographic findings indicating an association between scoliotic orientation and either gastric or duodenal ulcers. He noted that '*the percentile distribution of right-sided and left-sided scolioses coincided with the percentages of duodenal and gastric ulcers…(and further that)…all the scolioses involved vertebral segments corresponding to the stomach and duodenum, that is, T6 to T9*.' Kameith's findings appear to be supported by those of Giampietro et al in 2013, who noted the association of congenital scoliosis and certain health problems. (78, 101)

Congenital vertebral anomalies

A radiological study by Schey in 1976 examined a relationship between spinal anomalies and visceral abnormalities. While thought to be embryological in origin, there was a high correlation between the particular osseous spinal anomalies and visceral abnormalities. Although not considered vertebrogenic, the vertebro-visceral correlation would be considered relevant in a somato-visceral correlation. (102)

Denton found genitourinary tract and anal anomalies in 53% of cases correlated with lower spine anomalies - particularly sacral. Beals and colleagues noted that 61% of 218 patients with vertebral anomalies exhibited anomalies affecting seven systems. The segmental level only had a mild degree of correlation with the associated diagnosis. (103, 104, 105)

Trenga and colleagues found a 55% correlation of spinal cord anomalies associated with congenital spinal segments. They noted that the more complex the congenital malformation, the greater the incidence of cord anomaly. (106) On the other hand, Theiss and colleagues found minimal correlation between Klippel-Feil syndrome and cervical symptoms. (107)

The identification of block vertebrae by motion palpation is relatively straightforward as noted by Humphreys et al who concluded that '*relatively inexperienced examiners are capable of correctly identifying inter-segmental fixations in the cervical spine.*' However, the subtleties of degree, direction and type of dysfunction and/or minor displacement requires sensitive palpation and appreciation of the minutiae of subluxations. (108)

Conclusion

The independent and chiropractic evidence presented tends to confirm the model of a pathophysiological role of somato-autonomic factors associated with vertebral subluxations. We could not locate any evidence which contradicted this statement.

Ongoing chiropractic research continues to elucidate how the removal of VSCs produces the necessary benefits, especially at the neuronal level. It would be anticipated that such data would help explain apparent clinical efficacy.

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