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The Vertebral Subluxation premise:

Principle 4, Segmental and neural disturbance is associated with clinical signs and symptoms, and a range of conditions

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Narrative: This is the fifth of a 6-paper series which presents a descriptive narrative of the Western medical literature to identify and report evidence for each of the five principles of the Vertebral Subluxation Complex (VSC) premise as established in 1947 by Janse, Houser, and Wells (National College of Chiropractic). This literature includes Chiropractic papers in the medical indices and is additional to that from the chiropractic perspective which is available in the electronic Index to Chiropractic Literature.

This paper presents the evidence for Principle Four by documenting the evidence for the signs, symptoms, and a range of conditions associated with segmental, neural disturbance.

This 6-part series describes the incontrovertible acknowledgement and weight of recognition of the effect of physical, biomechanical, and physiological vertebral disturbances collectively contributing to the VSC and demonstrates strong support of the chiropractic nomenclature, neurophysiological and clinical implications of the Vertebral Subluxation Complex as recorded in the medical literature.

Indexing terms: Subluxation; Vertebral Subluxation Complex (VSC); segmental neural disturbance; neurophysiology.

Editor's note:

Rome and Waterhouse continue their exploration of the spinal lesions or levels of dysfunction known to chiropractors as indicative of the Vertebral Subluxation Complex (VSC).

This 5th paper in our new series of six documents evidence supportive of Principle 4, that there are '*signs, symptoms, and a range of conditions associated with segmental and neural disturbance*' as documented by medical authors.

All papers in this series are listed at the conclusion of this paper. Further. hese papers are also collected on the *Journal* website as 'MasterClasses' as an invaluable reference base.

To maximise the usefulness of these papers, each key narrative element is immediately supported by a compendium of source references, a departure from the usual practice of collecting cited references at the end of the work.

… Principle 4 of the VSC is that there are signs, symptoms, and a range of conditions associated with segmental and neural disturbances …'

Phillip Ebrall
Editor

This series to date ...

The first papers, Parts1 and 2 of Principle One that '*a vertebrae may subluxate*' and established that the clinical practices of Chiropractic, manipulative medicine and Osteopathy collectively recognise the biomechanical and physiological phenomena and associated neural ramifications of spinal lesions. The third paper reported the evidence for Principle Two by documenting evidence for the effect of physical, biomechanical, and physiological vertebral disturbances collectively contributing to the VSC. It demonstrated strong support of the chiropractic nomenclature, neurophysiological and clinical implications of the Vertebral Subluxation Complex as recorded in the medical literature.

The fourth paper presented evidence for Principle Three, the clinical findings of altered physiological function associated with the VSC including effects on skeletal muscle, vascular smooth muscle, sphincters and organs. This is Paper 5, addressing Principle 4.

To date we have presented the preponderance of papers from the field of manipulative medicine which support the chiropractic nomenclature of the VSC and we continue by reporting the literature relating to the signs, symptoms, and a range of conditions associated with segmental and neural disturbance.

Introduction to Principle 4

'segmental and neural disturbance is associated with signs, symptoms, and a range of conditions'

As a result of altered innervation to structures such as muscles, organs, and sphincters, smooth muscle may undergo dysfunction resulting in signs and symptoms. The reversal of many of these vertebrogenic conditions has been clinically reported in the medical index accessed through *PubMed*. (Andersen et al, 2000; Barron et al, 1973; Bialosky et al, 2012; Bitmar et al, 2021; Boal & Gillette, 2004; Coronado et al, 2012; Cramer, 2013; Fengler et al, 1986; Fritz et al, 2011; Harvey et al, 1991; Henderson, 2012; Hobbs et al, 1992; Kang et al, 2002; Kondziella, 1995; Leung, 1977; Pickar, 2002; Picker & Wheeler, 2001; Sung et al, 2005; Simonenko, 2010; Pickar & Bolton, 2012; Niazi et al, 2015; Shaballot et al, 2021)

> *'In this narrative review, the authors summarize literature published in the last decade and analyze the relationship between musculoskeletal disorders and systemic medical conditions such as diabetes mellitus; they also discuss the efficacy and cost-effectiveness of OMT in managing somatic dysfunction in patients with chronic diseases.'* (Asahi et al, 2020)

Vertebrogenic symptomatology and pathoneurophysiology

A plethora of neurological signs and symptoms are noted in a wide range of descriptive terms and conditions in four nominated medical textbooks. These portray a distinctive somato-autonomic-visceral association. (Schmörl and Junghanns, 1971; Cailliet, 1967; Maigne, 1972; Biedermann, 2004)

In one of the most supportive medical recognitions of the broader chiropractic and osteopathic concepts, Schmörl and Junghanns cite over 120 medical references over fourteen pages regarding spondylogenic symptoms and syndromes which they attribute to intervertebral insufficiency. (p. 213-23) They also recognise a possible manipulative role in their amelioration. (p. 223-7) A list of these vertebrogenic conditions include neural disruption by way of sensory, motor, or autonomic pathways, or vascular means. Emphasis on somatovisceral conditions were placed on the autonomic nervous system, those conditions include:-

- Abdominal pain (p. 219)
- Adverse effects of additional stimuli (p. 223)
- Autonomic pathways (p. 216)
- Cardiac disturbances (p220) without cardiac disease (p. 217)
- Cardiac function (p. 217)
- Cervicocephalic symptoms (p. 218)
- Cervical dizziness (p. 218)
- Cervical migraine (p. 217)
- Cervicogenic syncope (p. 218)
- Disease potential (p. 217)
- Disturbance of swallowing mechanism (p. 219)
- Disturbance of the heart without heart disease (p. 218)
- Disturbances of blood pressure (p. 218)
- Disturbances of cardiac and vascular functions (p. 217)
- Disturbances of ears and eyes (p. 218)
- Disturbances of perspiration (p. 218)
- Disturbances of the autonomic nervous system (p. 218)
- Dupuytren's contraction (p. 218)
- Dyesthesia (p. 217)
- Dysphagia (p. 219)
- Elevated cholinesterase activity (p. 218)
- Elevated cholinesterase (p. 218)
- Equilibrium (p. 218, 223)
- Gynecological vertebral syndrome (p. 219)
- Headache (p. 218)
- Hearing (p. 218)
- Hydrops cochlearis (p. 218)
- Hypotonic functional disturbances of the intestinal tract (p. 219)
- Lermoyez disease (p. 218)
- Low spinal fluid pressure (p. 217)
- Menièré's disease (p. 218)
- Pathologic route leads through the autonomic nervous system (p. 218)
- Perspiration (p. 218)
- Psychic changes (p; 217)
- Quadrant syndrome (p. 217)
- Rectogenital pain (p. 219)
- Skin sensitivity (p. 217)
- Spondylogenic consequences (p. 223)
- Spondylogenic hypotonic functional disturbances of the intestinal tract (p. 219)

- Spondylogenic neuro-autonomic symptoms (p. 219, 220)
- Spondylogenic neuromotor disturbance (p. 219)
- Spondylogenic neurosensory disturbance (p. 219)
- Spondylogenic pelvicopathy (p. 219)
- Spondylogenic sequelae (p. 223)
- Spondylogenic symptoms and syndromes (p. 216, 218, 219)
- Spondylogenic vascular disturbances (p. 218, 219)
- Spondylogenic vascular mechanics (p. 219)
- Spondylogenic vascular symptoms and syndromes (p. 219)
- Stimuli and their effects (p. 214)
- Subthreshold irritation. (p. 217)
- Sudeck's atrophy (p. 218)
- Vascular disturbances of the brain (with ECG changes) (p. 217, 218)
- Vascular function (p. 217)
- Vestibular neuronitis (p. 218)
- Visual disturbance (p. 218)

Such a compilation of medical notations would logically contribute to supporting an appreciation of somato-autonomic-influence on functional visceral conditions. We surmise that as medicine moved towards a pharmaceutical model which was 'easier' to implement, reservations, even against European medical colleagues appear to be contradictory. By ignoring the many citations by Schmörl and Junghanns, the English language journals have essentially created the opportunity for patients to seek manual care from other professions. Perhaps the cause of scepticism is intransigence, and has become more a political opposition by the English speaking medical colleagues.

The physical medicine specialist Cailliet listed a number of non MSK symptoms as a result of cervical subluxations, often as a result of whiplash-type injuries. (Cailliett, 1967, p. 60-85)

- Barré-Liéou Syndrome
- Blurred vision
- Brachialgia
- Corneal hypesthesia
- Deafness
- Dilated pupils
- Facial flushing
- Facial pain
- Headache
- Hyperhidrosis
- Insomnia
- Lacrimation
- Miosis
- Mood changes
- Nasal disturbance

- Pharyngeal paresthesias
- Photophobia
- Restlessness
- Retro-orbital pain
- Rhinorrhea
- Tinnitus
- Vasomotor changes affecting, facial and pharyngeal nerves
- Vasomotor instability
- Vertigo

In '*Orthopaedic medicine: a new approach to vertebral manipulation*', Maigne (1972, p. 164, 181+) states that functional disturbances of vertebrae may be involved with patients with:

- Asthma
- Basedow's disease
- Mastodynia
- Pseudo ulcers
- Headaches
- Migraine
- Posterior cervical syndrome of Barré
- 'Vestibular troubles'
  - Labyrinthine hypo-excitability
  - Spontaneous nystagmus (rare)
  - Vertigo
- "Auditory troubles"
  - Diminution of hearing
  - Tinnitus
- Ringing, roaring, whistling sounds
- Visual Disturbances
-
- Pharyngolaryngeal Disturbances
  - Aphonia
  - Hoarseness
  - Pharyngeal paresthesias
- Vasomotor and Secretional disturbances
  - Alternating paling and flushing of face
  - Hot flushes
  - Nasal hypersecretion
  - Perspiration
  - Tearing or conversely decrease lacrimation, salivation or nasal secretions
- Psychic disturbances

- Anxiety
  - Depression
  - Difficult concentration
  - Memory loss
  - Mental fatigue

In recognition of the influence of neck injuries attributed to neck injuries, the text *The Cervical Syndrome*, Jackson (1966) notes that seemingly insignificant vertebral derangements may cause severe nerve root irritation. She cites a range of symptoms such as:

- Auditory disturbances
- Blurred vision
- Capsulitis.
- Dilation of pupil
- Headaches
- Loss of balance
- Sudeck's atrophy (reflex sympathetic dystrophy)
- Swelling and stiffness of fingers
- Tendinitis
- Tinnitus

The vertebrogenic symptoms in Biedermann's (2004) text are far too numerous to list extensively. However, he notes specifically:

- Torticollis (p. 292)
- Dyspraxia (p. 303-12)
- Plagiocephaly (p. 294)
- Dysgnosia (p. 303-12)
- Colic (p. 295
- Attention deficit disorder (p. 133-44)
- Mechanical dyspnea (p. 195)
- Tietze syndrome (p. 196)
- Apnea (p. 125)
- Sweating (p. 125-7)
- Heart rate changes (p. 125-7)
- Flushing(p. 125-7)

These lists of conditions do not mean that all these conditions are vertebrogenic somato-autonomic in origin, but those that are might best be managed by manual interventions. Some of these conditions are attributed to exostosis developments suggesting that earlier manual intervention and functional improvement may have ameliorated the development of symptoms. Such osseous conditions may further illustrate the spondylogenic or an arthrogenic role and the noxious somatosensory and somato-inflammatory input.

In a further somato-autonomic-visceral affiliation, the quadrant syndrome (QS) is described by Bayerl and Fischer as '*a functional disturbance of the vegetative system, characterized by the distribution of subjective and objective lesions to a quarter of the body (quadrant). The neurological* *aspect of the Q.S. varies so much in character, that it may mistakenly be considered to be psychogenic in origin*.' (Bayerl et al, 1977)

Extended reference compilation

Vertebrogenic Symptomatology & Pathoneurophysiology

Bayerl W, Fischer K. Das vegetative Quadranten-Syndrom [The autonomous quadrant-syndrome (author's transl)]. Arch Orthop Unfallchir. 1977 Jun 26;88(2):169-75. German. (Abstract only)

Biedermann H (Ed). Manual therapy in children. Edinburgh: Churchill Livingstone. 2004.

Cailliet R. Subluxations of the cervical spine including the 'whiplash' syndrome. In: Neck and arm pain. Philadelphia: FA Davis Co. 1967:60-85.

Jackson R. The Cervical Syndrome. 3e. Springfield: Charles C Thomas.1966:73.

Maigne R. Orthopaedic Medicine: a new approach to vertebral manipulation. Springfield: Charles C Thomas; 1972.

Schmörl G, Junghanns H. The human spine in health and disease. New York. Grune & Stratton. 2USe. 1971.

Somatovisceral

'*Irritation of spinal joint nociceptors simultaneously evokes a large number of reflex alterations, including paravertebral muscle spasm and alterations in cardiovascular, respiratory and endocrine function.*' (Grieve, 1988)

Spinal manipulation is also thought to affect reflex neural outputs to both muscle and visceral organs. (Jones & Gunzenhauser, Undated) Due to the nature of invasive research, much biological pathophysiological studies have been conducted on animal subjects. This also tends to limit any emotional factors. (Sato et al, 1997, p.5) However some rather extensive clinical studies on humans have also been published.

The somatovisceral reflex effect could also be termed a somatophysiological phenomenon. (Kodat et al, 2005) '*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*.' (Sato & Schmidt, 1987)

'*Recent studies from this laboratory have shown that cutaneous stimulation can modify functions of various organs including the heart, gastrointestinal tract, and urinary bladder, by evoking autonomic nervous system reflexes that are mediated at spinal cord and brainstem level.*' (Kurosawa et al, 1986)

This paper concerns somato-autonomic reflex responses in various visceral organs following somatic sensory stimulation in animals anesthetised to eliminate emotional factors. Various forms of somatic sensory stimulation can produce different autonomic reflex responses, depending on the visceral organs and which somatic afferents are stimulated. Some responses have a dominant sympathetic efferent involvement, whereas others have predominantly parasympathetic efferent involvement. Some responses have propriospinal and segmental characteristics, while others have supraspinal and systemic characteristics in their reflex nature. (Kimura & Sato, 1997)

'*The findings support the hypothesis that referred pain may be produced by dichotomizing sensory fibers, one branch passing to visceral organs and the other branch to the site of reference in muscle or skin*.' (Bahr et al, 1981)

'*Single medullary reticular formation (MRF) neurons receive multiple somatovisceral convergent inputs originating from many different spinal and cranial nerves, including the pelvic nerve (PN), dorsal nerve of the penis (DNP), and the abdominal branches of the vagus*.' (Hubscher, 2004)

'In addition to the overlap of visceral afferents onto spinal pathways that receive somatic efferents, there also exists an overlap of visceral afferents onto spinal pathways that receive somatic afferents, resulting in the sensory experience of referred pain in segmentally related structures. This means that abnormal afferent activity from a structure such as the heart may be passed to segmentally related somatic efferents and segmentally related somatic afferents through viscero-somatic reflex arcs located in the spinal cord.' (Michigan State Univ, 2017)

Extended reference compilation

Somatovisceral

'Upper thoracic respiratory interneurons integrate noxious somatic and visceral information in rats.' (Qin et al, 2002)

Ali, S., Hayek, R., Holland, R. et al. The somatovisceral effects of chiropractic treatment on the Hypothalamo-Adrenal Axis and immunity of the respiratory system in asthmatics. 2001;208. Abstract from World Federation of Chiropractic Biennial Congress, Paris, France. Somatovisceral Pathway: Rapidly Conducting Fibers in the Spinal Cord

Andersen PM, Fagerlund M. Vertebrogenic dysphagia and gait disturbance mimicking motor neuron disease. J Neurol Neurosurg Psychiatry. 2000;69(4):560-1.

Asahi MG, Briganti D, Cam E, et al. The role of musculoskeletal disorders in chronic disease: a narrative review. J Am Osteopath Assoc. 2020;120(10):665-670. DOI 10.7556/jaoa.2020.134.

Ashby EC. Abdominal pain of spinal origin. Value of intercostal block. Ann R Coll Surg Engl. 1977;59:242-6.

Bahr R, Blumberg H, Jänig W. Do dichotomizing afferent fibers exist which supply visceral organs as well as somatic structures? A contribution to the problem or referred pain. Neurosci Lett. 1981 Jun 12;24(1):25-8.

Bakkum BW, Cramer GD. Spinal manipulative therapies in visceral conditions. J Altern Complement Med. 2018;24(2):104-105. DOI 10.1089/acm.2017.0327.

Barron W, Coote JH. The contribution of articular receptors to cardiovascular reflexes elicited by passive limb movements. J. Physiol. (Lond.), 1973;235: 423-36.

Bialosky JE, Simon CB, Bishop MD, et al. Basis for spinal manipulative therapy: a physical therapist perspective. J Electromyogr Kinesiol. 2012:643-7. DOI 10.1016/j.jelekin.2011.11.014.

Bitnar P, Stovicek J, Hlava S, et al. Manual cervical traction and trunk stabilization cause significant changes in upper and lower esophageal sphincter: A randomized trial. J Manipulative Physiol Ther. 2021 May;44(4):344-351. DOI 10.1016/j.jmpt.2021.01.004.

Boal RW1, Gillette RG. Central neuronal plasticity, low back pain and spinal manipulative therapy. J Manipulative Physiol Ther. 2004:314-26.

Bolton PS, Budgell B. Visceral responses to spinal manipulation. J Electromyogr Kinesiol. 2012 Oct;22(5):777-84. DOI 10.1016/j.jelekin.2012.02.016.

Budgell B, Hotta H, Sato A. Spinovisceral reflexes evoked by noxious and innocuous stimulation of the lumbar spine. JNMS 1995;3(3):122-31.

Budgell BS. Modulation of visceral function by somatic stimulation/ In: King HH, Jänig W, Patterson MM. The science and clinical application of manual therapy. Edinburgh: Churchill Livingstone. 2011:71-83

Camilleri M, Malagelada JR, Kao PC, Zinsmeister AR. Effect of somatovisceral reflexes and selective dermatomal stimulation on postcibal antral pressure activity. Am J Physiol. 1984;247(6 Pt 1):G703-8.

Cervero F, Connell LA, Lawson SN. Somatic and visceral primary afferents in the lower thoracic dorsal root ganglia of the cat. J Comp Neurol. 1984;228(3):422-31.

Coronado RA, Gay CW, Bialosky JE, Carnaby GD, Bishop MD, George SZ. Changes in pain sensitivity following spinal manipulation: a systematic review and meta-analysis. J Electromyogr Kinesiol. 2012;22(5):752-67.

Cramer GD, Darby SA. Basic clinical anatomy of the spine, spinal cord, and ANS; St Louis: Mosby. 1995:343-4.

Cramer GD, Cambron J, Cantu JA, et al. Magnetic resonance imaging zygapophyseal joint space changes (gapping) in low back pain patients following spinal manipulation and side-posture positioning: a randomized controlled mechanisms trial with blinding. J Manipulative Physiol Ther. 2013 May;36(4):203-17. DOI 10.1016/j.jmpt.2013.04.003.

Dalsgaard CJ, Ygge J. Separate populations of primary sensory neurons project to the splanchnic nerve and thoracic spinal nerve rami of the rat. A fluorescent double labelling study. Med Biol. 1985;63(2):88-91.

Fengler H, Schulze KJ, Kleditzsch J, Opitz JU. Vertebragene zervikoenzephale Syndrome [Vertebrogenic cervico-encephalic syndrome]. Z Arztl Fortbild (Jena). 1986;80(21):877-81. German. PMID: 3564550.

Fields HL, Partridge LD Jr, Winter DL. Somatic and visceral receptive field properties of fibers in ventral quadrant white matter of the cat spinal cord. J Neurophysiol. 1970 Nov;33(6):827-37. DOI 10.1152/jn.1970.33.6.827.

Foreman RD. The functional organisation of visceral and somatic input to the spinothalamic system. In: Patterson MM, Howell JN. The central connection: somatovisceral/viscerosomatic interaction. Proceedings of the 1989 American Academy of Osteopathy International Symposium. Athens OH, University Classics Ltd. 1992:178-207.

Fritz JM, Koppenhaver SL, Kawchuk GN, Teyhen DS, Hebert JJ, Childs JD. Preliminary investigation of the mechanisms underlying the effects of manipulation: exploration of a multivariate model including spinal stiffness, multifidus recruitment, and clinical findings. Spine (Phila Pa 1976). 2011;36(21):1772-81.

Garo-Falides B, Wainwright TW. Pseudo-appendicitis: abdominal pain arising from thoracic spine dysfunction – a forgotten entity and a reminder of an important clinical lesson. BMJ. 2016. DOI10.1136/bcr-2016-216490.

Grieve G. Autonomic nervous system in vertebral pain syndromes. In: Common vertebral joint problems. 2e. Elsevier: London. 1988:179.

Harvey D, Byfield D. Preliminary studies with a mechanical model for the evaluation of spinal motion palpation. Clinical Biomechanics 1991;6(2):79-82.

Hawk C. Chiropractic practice, experience, and research related to somatovisceral interactions. In: Chapter 13. In: King HH, Jänig W, Patterson MM. (eds) The science and clinical application of manual therapy. New York, Churchill Livingstone. 2011;217-36.

Henderson CNR. The basis for spinal manipulation: chiropractic perspective of indications and theory. J Electromyogr Kinesiol. 2012;22(5):632-42. DOI 10.1016/j.jelekin.2012.03.008.

Hobbs SF, Chandler MJ, Bolser DC, Foreman RD. Segmental organisation of visceral and somatic input onto C3-T6 spinothalamic tract cells of the monkey. J Neurophysiol. 1992;68(5):1574-88.

Honda CN. Visceral and somatic afferent convergence onto neurons near the central canal in the sacral spinal cord of the cat. J. Neurophysiol. 1985;53:1059–78.

Hubscher CH, Johnson RD. Effects of chronic dorsal column lesions on pelvic viscerosomatic convergent medullary reticular formation neurons. J Neurophysiol. 2004 Dec;92(6):3596-600. DOI 10.1152/jn.00310.2004.

Iimura K, Watanabe N, Masunaga K, et al. Effects of a gentle, self-administered stimulation of perineal skin for nocturia in elderly women: a randomized, placebo-controlled, double-blind crossover trial. PLoS One. 2016;11(3):e0151726.

Jänig W. Basic science on somatovisceral interactions: peripheral and central evidence base and implications for research. In: King HH, Jänig W, Patterson MM. The science and clinical application of manual therapy. Edinburgh: Churchill Livingstone. 2011:275-300. Also available https://musculoskeletalkey.com/basic-science-on-somatovisceral-interactions-peripheral-and-central-evidence-base-and-implications-for-research/.

Johnston WL. Osteopathic clinical aspects of somatovisceral interaction. In: Patterson MM, Howell JN. The central connection: somatovisceral/viscerosomatic interaction. Proceedings of the 1989 American Academy of Osteopathy International Symposium. Athens OH, University Classics Ltd. 1992;30-52.

Johnston WL, Golden WJ. Segmental definition--Part IV. Updating the differential for somatic and visceral inputs. J Am Osteopath Assoc. 2001 May;101(5):278-83. PMID: 11381563.

Jones S, Gunzenhauser A.(eds) Spinal manipulation. https://www.physio-pedia.com/Spinal_Manipulation.

Kagitani F, Kimura A, Sato A, et al. The role of the spinal cord as a reflex center for the somatically induced reflex responses of splenic sympathetic and natural killer cell activity in anesthetized rats, Neuro Lett. 1996;217(2-3):109 12.

Kang YM, Choi WS, Pickar JG. Electrophysiologic evidence for an intersegmental reflex pathway between lumbar paraspinal tissues. Spine (Phila Pa 1976). 2002;27(3):E56-63.

Karason AB, Drysdale IP. Somatovisceral response following osteopathic HVLAT: A pilot study on the effect of unilateral lumbosacral high-velocity low-amplitude thrust technique on the cutaneous blood flow in the lower limb. J Manipulative Physiol Ther 2003;26(4):220-5.

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):137-45.

Kimura A, Nagai N, Sato A. Somatic afferent regulation of cytotoxic activity of splenic natural killer cells in anesthetized rats. Jpn J Physiol. 1994;44(6):651-64.

Kimura A, Ohsawa H, Sato A, Sato Y, et al. Somatocardiovascular reflexes in anesthetized rats with the central nervous system intact or acutely spinalised at the cervical level. Neurosci Res. 1995;22(3):297-305.

King HH, Patterson MM. Clinical applications of manual therapy on physiologic functions and systemic disorders: evidence base and implications for research. In: King HH, Jänig W, Patterson MM. The science and clinical application of manual therapy. Edinburgh Churchill Livingstone. 2011:301-12.

Kondziella W. Uber den vertebragenen Faktor beim Brustwandschmerz [The vertebrogenic factor and thoracalgia.] Schmerz. 1995;9(1):34-8.

Kodat V, Sobota J, Kebza V, et al. Correlations of somatophysiological, biochemical, psychosocial and behavioral risk factors of cardiovascular diseases in a sample of employees of Prague enterprises and institutions. Cent Eur J Public Health. 2005;13(4):191-9.

Kurosawa M, Sato A, Sato Y, et al. Reflex responses of sympatho-adrenal medullary functions produced by somatic afferent stimulation. In: Emotions, Neuronal and Chemical Control. Yutaka Oomura, Ed. Japan Scientific Soc. Press. Tokyo: Karger. 381-91. https://www.karger.com/Article/Abstract/413544.

Kurosawa M. [Effects of noxious and innocuous cutaneous stimulation on adrenal sympathetic efferent nerve activity in rats]. Hokkaido Igaku Zasshi. 1985 Jul;60(4):509-27. Japanese. PMID: 4054820.

Kunert W. Functional disorders of internal organs due to vertebral lesions. CIBA Symp. 1965;13(3):85-96.

Leung, S. The value of cineradiographic motion studies in the diagnosis of dysfunctions of the cervical spine. Bull Eur Chiro Union 1977; 25(2):28-43.

Levichkina E, Pigareva ML, Limanskaya A, et al. Somatovisceral convergence in sleep-wake cycle: transmitting different types of information via the same pathway. Front Netw Physiol. 2022;2:1-14. https://www.frontiersin.org/articles/10.3389/fnetp.2022.840565/full.

Mørch CD, Hu JW, Arendt-Nielsen L, Sessle BJ. Convergence of cutaneous, musculoskeletal, dural and visceral afferents onto nociceptive neurons in the first cervical dorsal horn. Eur J Neurosci. 2007 Jul;26(1):142-54. DOI 10.1111/j.1460-9568.2007.05608.x.

Menétrey D, Basbaum AI. Spinal and trigeminal projections to the nucleus of the solitary tract: a possible substrate for somatovisceral and viscerovisceral reflex activation. J Comp Neurol. 1987 Jan 15;255(3):439-50. DOI 10.1002/cne.902550310.

Michigan State University. Principles of manual medicine. – Reflex activity. https://hal.bim.msu.edu/CMEonLine/Autonomic/Sympathetic/ReflexActivity.html 2017.

Morrison JFB, Sato A, Sato Y, et al. The influence of afferent inputs from skin and viscera on the activity of the bladder and the skeletal muscle surrounding the urethra in the rat. Neuroscience Research. 1995;23(2):195-205.

Nansel D, Szlazak M. Somatic dysfunction and the phenomenon of visceral disease simulation: a probable explanation for the apparent effectiveness of somatic therapy in patients presumed to be suffering from true visceral disease. J Manipulative Physiol Ther. 1995 Jul-Aug;18(6):379-97.

Neuhuber WL, Sandoz PA, Fryscak T. The central projections of primary afferent neurons of greater splanchnic and intercostal nerves in the rat. A horseradish peroxidase study. Anat Embryol (Berl). 1986;174(1):123-44. DOI 10.1007/BF00318344.

Niazi IK, Turker KS, Flavel S, et al. Changes in H reflex and V waves following spinal manipulation. Exp Brain Res. 2015;233(4):1165073.

Nicholas NS. Proceedings: Correlation of somatic dysfunction with visceral disease. J Am Osteopath Assoc. 1975 Dec;75(4):425-8.

Nosaka S, Sato A, Shimada F. Somatosplanchnic reflex discharges in rats. J Auton Nerv Syst. 1980 Jul;2(2):95-104.

Passatore M, Roatta S. Influence of sympathetic nervous system on sensorimotor function: whiplash associated disorders (WAD) as a model. Eur J Appl Physiol. 2006;98:423-49.

Patterson MM, Howell JN. The central connection: Somatovisceral/viscerosomatic interaction. 1989 International Symposium. American Acad Osteop. 1992.

Paunescu-Podeanu A, Ciobanu V. [Vertebrogenic visceropathies: Critical analysis of visceral disorders produced by diseases of the spinal column]. Med Interna (Bucur). 1962 Jun;14:641-8. Romanian. PMID: 13942037.

Piché M, Watanabe N, Hotta H. Regulation of gastric motility and blood flow during acute nociceptive stimulation of the paraspinal muscles in urethane-anaesthetised rats. J Physiol Sci. 2014 Jan;64(1):37-46. DOI 10.1007/s12576-013-0288-1.

Pickar JG, Wheeler JD. Response of muscle proprioceptors to spinal manipulative-like loads in the anesthetized cat. J Manipulative Physiol Ther. 2001 Jan;24(1):2-11.

Pickar JG. Neurophysiological effects of spinal manipulation. Spine J. 2002;2(5):357-71.

Pickar JG, Bolton PS. Spinal manipulative therapy and somatosensory activation. J Electromyogr Kinesiol. 2012;22(5):785-94. DOI 10.1016/j.jelekin.2012.01.015.

Pierce LM, Reyes M, Thor KB, et al. Immunohistochemical evidence for the interaction between levator ani and pudendal motor neurons in the coordination of pelvic floor and visceral activity in the squirrel monkey. Am J Obstet Gynecol. 2005;192(5):1506-15. DOI 10.1016/j.ajog.2004.10.607..

Pierau FK, Fellmer G, Taylor DC. Somato-visceral convergence in cat dorsal root ganglion neurones demonstrated by double-labelling with fluorescent tracers. Brain Res. 1984;321(1):63-70.

Qin C, Chandler MJ, Foreman RD, et al. Upper thoracic respiratory interneurons integrate noxious somatic and visceral information in rats. J Neurophysiol. 2002 Nov;88(5):2215-23. DOI 10.1152/jn.00120.2002.

Richards DG, McMillin DL, Mein EA, et al. Osteopathic regulation of physiology. Am Acad Osteop J. 2001;11(3):34-8. http://files.academyofosteopathy.org/files/fall2001.pdf

Salehi A, Hashemi N, Imanieh MH, et al. Chiropractic: is it efficient in treatment of diseases? review of systematic reviews. Int J Community Based Nurs Midwifery. 2015;3(4):244-54.

Sandhouse ME, Shechtman D, Fecho G, et al. Effect of osteopathic cranial manipulative medicine on visual function. J Am Osteopath Assoc. 2016;116(11):706-14.

Sato A, Schmidt RF. The modulation of visceral functions by somatic afferent activity. Jpn J Physiol. 1987;37(1):1-17. DOI 10.2170/jjphysiol.37.1.

Sato A. Somatovisceral reflexes. J Manipulative Physiol Ther 1995;18(9):597-602.

Sato Y, Schiable, H.-G, Schmidt RF. Reactions of cardiac postganglionic sympathetic neurons to normal and inflamed knee joints. J. Auton. Nerve. System 1985;12:1-13

Sato A. Neural mechanisms of somatic sensory regulation of catecholamine secretion from the adrenal gland. Adv Biophys. 1987;23:39-80.

Sato A. The reflex effects of spinal somatic nerve stimulation on visceral function. J Manipulative Physiol Ther. 1992;15(1):57-61.

Sato A. Reflex modulation of visceral functions by somatic afferent activity. In: Patterson MM, Howell JN. The central connection: somatovisceral/viscerosomatic interaction. Proceedings of the 1989 American Academy of Osteopathy International Symposium. Athens OH, University Classics Ltd. 1992:53-76.

Sato A. Neural mechanisms of autonomic responses elicited by somatic sensory stimulation. Neurosci Behav Physiol. 1997;27(5):610-21. DOI 10.1007/BF02463910.

Seaman DR. Somatic dysfunction and the phenomenon of visceral disease simulation: a probable explanation for the apparent effectiveness of somatic therapy in patients presumed to be suffering from true visceral disease. J Manipulative Physiol Ther. 1997;20(3):218-24.

Seaman DR. Winterstein JF. Dysafferentation: a novel term to describe the neuropathophysiological effects of joint complex dysfunction. A look at likely mechanisms of symptom generation. J Manipulative Physiol Ther. 1998;21(4):267-80.

Shaballot N, Aloumar A, Manual J, et al. Lateralisation and bodily patterns of segmental signs and spontaneous pain in acute visceral disease: observational study. J Med Internet Res. 2021;23(8): e27247. DOI 10.2196/27247.

Showers MJ, Lauer EW. Somatovisceral motor patterns in the insula. J Comp Neurol. 1961;117:107-15.

Simonenko VB, Davydov OV. [Spondylogenic visceropathies.] Klin Med (Mosk). 2010;88(3):59-62.

Smilowicz A. An osteopathic approach to gastrointestinal disease: somatic clues for diagnosis and clinical challenges associated with helicobacter pylori antibiotic resistance. J Am Osteop Assoc. 2013;113(5):404-16.

Sung PS, Kang YM, Pickar JG. Effect of spinal manipulation duration on low threshold mechanoreceptors in lumbar paraspinal muscles: a preliminary report. Spine (Phila Pa 1976). 2005 Jan 1;30(1):115-22.

Vaňásková E, Hep A, Lewit K, et al. Cervical dysfunction with disturbed oesophageal motility – scintigraphic assessment. J Orthop Med 2001;23(1):9-11.

Vaňásková E, Hep A, Vižďa J, Tosnerová V. Swallowing disorders related to vertebrogenic dysfunction. Ceska a Slovenska Neurologie a Neurochirurgie 2007;70(6):692-696. (English abstract) https://www.csnn.eu/en/journals/czech-and-slovak-neurology-and-neurosurgery/2007-6-1/swallowing-disorders-related-to-vertebrogenic-dysfunctions-52591

Vanaskova E, Dolina J, Hep A. Swallowing disorders related to vertebrogenic dysfunctions. New advances in the basic and clinical gastroenterology. In Brzozowski T. The basic and clinical gastroenterology. In Tech. 2012. 175-84. https://cdn.intechopen.com/pdfs/35448/InTech-Swallowing_disorders_related_to_vertebrogenic_dysfunctions.pdf

Vernon H, Steiman I, Hagino C. Cervicogenic dysfunction in muscle contraction headache and migraine: a descriptive study. J Manipulative Physiol Ther. 1992;15(7):418-29.

Cardiovascular

'During-intervention, the PA (Posterior to anterior -au) group had a significant reduction in SBP (Systolic BP-au), while the placebo group had an increase in SBP. The change in SBP during-intervention was significantly different between the PA and the placebo group (p-value=0.003).' (Yung, et al, 2017)

The results of this study suggest that parasympathetic activity can be influenced by body position, upper thoracic compression and manual contact, baroreceptor reflex, breathing, and the presence of pain. (da Silva et al, 2018)

Angina

Beal MC, Kleiber GE. Somatic dysfunction as a predictor of coronary artery disease. J Am Osteopath Assoc. 1985;85(5):302-7.

Beal MC. Palpatory testing for somatic dysfunction in patients with cardiovascular disease. J Am Osteopath Assoc. 1983;82(11):822-31.

Belash VO, Mokhov DE, Tregubova ES. Osteopaticheskaia korrektsiia v kompleksnoĭ terapii i reabilitatsii patsientov s sindromom pozvonochnoĭ arterii [The use of the osteopathic correction for the combined treatment and rehabilitation of the patients presenting with the vertebral artery syndrome]. Vopr Kurortol Fizioter Lech Fiz Kult. 2018;95(6):34-43. (Russian) (English abstract).

Bruehl S, Chung OK. Interactions between the cardiovascular and pain regulatory systems: an updated review of mechanisms and possible alterations in chronic pain. Neurosci Biobehav Rev. 2004;28(4):395-414.

Grgić V. Vertebrogena bol u prsima--"pseudoangina pektoris": etiopatogeneza, klinicka slika, dijagnoza, diferencijalna dijagnoza i terapija [Vertebrogenic chest pain--"pseudoangina pectoris": etiopathogenesis, clinical manifestations, diagnosis, differential diagnosis and therapy]. Lijec Vjesn. 2007 Jan-Feb;129(1-2):20-5. Croatian. PMID: 17489514.

Grgic V. Cervikogena angina. Bol u prsima uzrokovana neprepoznatom hernijacijom diska u segmentu c6-c7: prikaz bolesnika [Cervicogenic angina. Chest pain caused by unrecognized disc herniation at the segment c6-c7: a case report]. Lijec Vjesn. 2008 Sep-Oct;130(9-10):234-6. Croatian. PMID: 19062759.

Passmore SR, Dumm AS. Positive patient outcome after spinal manipulation in a case of cervical angina. Man Ther. 2009;14(6):702-5.

Schnell H. Von akutem Koronarsyndrom bis Zoster: Differenzialdiagnostik bei segmentaler und somatischer Dysfunktion an Brustwirbelsäule und Rippen [From acute coronary syndrome to zoster : Differential diagnostics in segmental and somatic dysfunction of the thoracic spine and ribs]. Orthopade. 2022 Apr;51(4):274-282. German. DOI 10.1007/s00132-022-04227-8.

Shakhnazarov AB. Vertebrogennyĭ kardialgicheskiĭ sindrom [Vertebrogenic cardialgia syndrome]. Vrach Delo. 1977 Mar;(3):84-5. Russian. PMID: 855304.

Sokov EL, Kornilova LE, Filimonov VA, Ganzhula PA. [Osteogenic factor in pathogenesis of vertebrogenic cardialgia]. Klin Med (Mosk). 2009;87(5):37-43. (English abstract)

Arrhythmia

Budgell B, Igashi Y. Response of arrhythmia to spinal manipulation: Monitoring by ECG with analysis of heart-rate variability. J Neuromusculoskel Syst. 2001;9(3(:97-102.

Cohen TJ, Auerbach AM. Effects of osteopathic manipulative therapy on arrhythmias. (Clinical Trial underway) https://clinicaltrials.gov/ct2/show/NCT04004741

Autonomic influence

Chandler MJ, Zhang J, Foreman RD. Vagal, sympathetic and somatic sensory inputs to upper cervical (C1-C3) spinothalamic tract neurons in monkeys. J Neurophysiol. 1996;76(4):2555-67. DOI 10.1152/jn.1996.76.4.2555.

Chandler MJ, Zhang J, Qin C, Foreman RD. Spinal inhibitory effects of cardiopulmonary afferent inputs in monkeys: neuronal processing in high cervical segments. J Neurophysiol. 2002 Mar;87(3):1290-302. DOI 10.1152/jn.00079.2001.

Evans B, Polus B. The effect of cervical rotation on autonomic control of the cardiovascular system in the awake human. World Federation of Chiropractic 8th Biennial Congress Sydney Australia June 16-18, 2005;207-8.

Hotta H, Schmidt RF, Uchida S, et al. Gentle mechanical skin stimulation inhibits the somatocardiac sympathetic C-reflex elicited by excitation of unmyelinated C-afferent fibers. Eur J Pain. 2010;14(8):806-13. DOI 10.1016/j.ejpain.2010.02.009.

Mahadi KM, Lall VK, Deuchars SA, Deuchars J. Cardiovascular autonomic effects of transcutaneous auricular nerve stimulation via the tragus in the rat involve spinal cervical sensory afferent pathways. Brain Stimul. 2019;12(5):1151-8.

Maixner W. Autonomic and somatosensory interactions: physiological and pathophysiological implications. Proc Finn Dent Soc. 1989;85(4-5):395-407.

McGuiness, J. Vicenzino, B, Wright, A. Influence of a cervical mobilization technique on respiratory and cardiovascular function. Man Ther. 1997;2:216–20.

Rodrigues PTV, Corrêa LA, Reis FJJ, et al. One session of spinal manipulation improves the cardiac autonomic control in patients with musculoskeletal pain: a randomized placebo-controlled trial. Spine (Phila Pa 1976). 2021;46(14):915-922. DOI 10.1097/BRS.0000000000003962.

Rodrigues P, Correa L, Ribeiro M, et al. Patients with impaired descending nociceptive inhibitory system present altered cardiac vagal control at rest. Pain Physician. 2018;21(4):E409-E418.

Sato A, Sato Y, Schmidt RF. Somatosensory modulation of the cardiovascular system. In: The impact of somatosensory input on autonomic function. Rev Physiol Biochem Pharmacol. 1997;130:115-66.

Vicenzino, B, Cartwright, T, Collins, D, Wright, A. Cardiovascular and respiratory changes produced by lateral glide mobilization of the cervical spine. Man Ther. 1998;3:67–71.

Wang QA, Guo XQ, Li P. The inhibitory effect of somatic inputs on the excitatory responses of vagal cardiomotor neurones to stimulation of the nucleus tractus solitarius in rabbits. Brain Res. 1988;439(1-2):350-3. DOI 10.1016/0006-8993(88)91493-x.

Watanabe N, Hotta H. Heart rate changes in response to mechanical pressure stimulation of skeletal muscles are mediated by cardiac sympathetic nerve activity. Front Neurosci. 2017;10:614. DOI 10.3389/fnins.2016.00614.

Watanabe N, Reece J, Polus BI. Effects of body position on autonomic regulation of cardiovascular function in young, healthy adults. Chiropr Osteopat. 2007 Nov 28;15:19. DOI 10.1186/1746-1340-15-19.

Watanabe N, Uchida S, Hotta H. Age-related change in the effect of gentle mechanical cutaneous stimulation on the somato-cardiac sympathetic C-reflex. J Physiol Sci. 2011;61:297-91.

Yates BJ, Bolton PS, Macefield VG. Vestibulo-sympathetic responses. Compr Physiol. 2014 Apr;4(2):851-87. DOI 10.1002/cphy.c130041.

Yung E, Wong M, Williams H, Mache K. Blood pressure and heart rate response to posteriorly directed pressure applied to the cervical spine in young, pain-free individuals: a randomized, repeated-measures, double-blind, placebo-controlled study. J Orthop Sports Phys Ther. 2014 Aug;44(8):622-6. DOI 10.2519/jospt.2014.4820.

Blood pressure

Bakris G, Dickholtz M, Meyer P, et al. Atlas vertebra realignment and achievement of arterial pressure goal in hypertensive patients: a pilot study. J Human Hypertension. 2007;21(5):347-52.

Balogun, JA, Abereoje, OK, Olaogun, MO, Obajuluwa, VA, Okonofua, FE. Cardiovascular responses of healthy subjects during cervical traction. Physiother Can. 1990;42:16–22.

Celander, E, Koenig, AJ, Celander, DR. Effect of osteopathic manipulative therapy on autonomic tone as evidenced by blood pressure changes and activity of the fibrinolytic system. J Am Osteopath Assoc. 1968;67:1037-8.

Cerritelli F, Carinci F, Pizzolorusso G, et al. Osteopathic manipulation as a complementary treatment for the prevention of cardiac complications: 12-Months follow-up of intima media and blood pressure on a cohort affected by hypertension. J Bodyw Mov Ther. 2011 Jan;15(1):68-74.

Chu ECP. Long-term relief from temsion-type headache and major depression following chiropractic treatment. J Family Med Prim Care 2018;7(3):629-631

Dimmick KR, Young MF, Newell D, Chiropractic manipulation affects the difference between arterial systolic blood pressures on the left and right in normotensive subjects. J Manipulative Physiol Ther. 2006;29(1):46-50.

Fazalbhoy A, Birznieks I, Macefield VG. Individual differences in the cardiovascular responses to tonic muscle pain: parallel increases or decreases in muscle sympathetic nerve activity, blood pressure and heart rate. Exp Physiol. 2012:1084-92.

Fedin AI, Kakorin SV, Gaikin AV, et al. Impact of chiropractic methods on blood pressure in patients with essential hypertension and cervical osteochondrosis. Kardiologiya, 1991; 31: 56-59.

Gassner A. Review of the neurophysiological responses to spinal manipulation therapy: review protocol and narrative review. Masters dissertation. University Hospital, Balgrist, Zurich. 2016

Goertz CM, Salsbury SA, Vining RD, et al. Effect of spinal manipulation of upper cervical vertebrae on blood pressure. Results of a pilot sham-controlled trial. J Manipulative Physiol Ther. 2016;39(5):369-80.

Goertz CH, Grimm RH, Svendsen K, et al. Treatment of Hypertension with Alternative Therapies (THAT) Study: a randomized clinical trial. J Hypertens. 2002 Oct;20(10):2063-8. DOI 10.1097/00004872-200210000-00027.

Harris W, Wagnon RJ. The effects of chiropractic adjustments on distal skin temperature. J Manipulative Physiol Ther. 1987;10(2):57-60.

He Z-B, Lv Y-K, Chen D-C, et al. Manipulation therapy to treat 60 patients of cervicogenic hypertension with atlanto-axial dislocation. J Cervicodynia and Lumbodynia. 2011;32(2):156-57.

He ZB, Lv YK, Li H, et al. Atlantoaxial misalignment causes high blood pressure in rats: a novel hypertension model. Biomed Res Int. 2017;2017:5986957. DOI 10.1155/2017/5986957.

Ivanovych LM. Vasyliovych MV, Yuriivna MM. [Method for diagnosis and treatment of symptomatic vertebrogenic hypertension Marfins-Lazarus] 2001. (Uzhhorod State University, Ukranian) (Abstract only) https://dspace.uzhnu.edu.ua/jspui/handle/lib/25780

Johnston WL, Kelso AF, Babcock HB. Changes in presence of a segmental dysfunction pattern associated with hypertension: Part 1. A short-term longitudinal study. J Am Osteopath Assoc. 1995;95(4):243-8, 253-5.

Johnston WL, Kelso AF. Changes in presence of a segmental dysfunction pattern associated with hypertension: Part 2. A long-term longitudinal study. J Am Osteopath Assoc. 1995;95(5):315-8.

Knutson GA. Significant changes in systolic blood pressure post vectored upper cervical adjustment vs resting control groups: a possible effect of the cervicosympathetic and/or pressor reflex. J Manipulative Physiol Ther. 2001;24(2):101-9.

Liu H, Ploumis A. Cervicogenic hypertension – a possible etiology and pathogenesis of essential hypertension. Hypothesis 2012;10(1):e4; DOI10.5779/hypothersis.v10i.297.

Nansel D, Jansen R, Cremata E, et al. Effects of cervical adjustments on lateral-flexion passive end-range asymmetry and on blood pressure, heart rate and plasma catecholamine levels. J Manipulative Physiol Ther 1991;14(8):450-6.

Pastellides AN. The effect of cervical and thoracic spinal manipulations on blood pressure in normotensive males. 2009. Dissertation. Durban University. https://openscholar.dut.ac.za/handle/10321/490.

Plaugher G, Long CR, Alcantara J, et al. Practice-based randomized controlled-comparison clinical trial of chiropractic adjustments and brief massage treatment at sites of subluxation in subjects with essential hypertension: pilot study. J Manipulative Physiol Ther. 2002;25(4):221-39. DOI 10.1067/mmt.2002.123171.

Plaugher G, Bachman TR. Chiropractic management of a hypertensive patient. J Manipulative Physiol Ther. 1993;16:544-9.

McCall AA, Miller DM, Yates BJ. Descending Influences on vestibulospinal and vestibulosympathetic reflexes. Front Neurol. 2017;8:112.

Reis DJ, Mossison S, Ruggiero DA. The C1 area of the brainstem in tonic and reflex control of blood pressure state of the art lecture. Hypertension. 1988;11(2):18-113.

Roffers SD, Menke JM, Morris DH. A somatovisceral reflex of lowered blood pressure and pulse rate after spinal manipulative therapy in the thoracic region. Asian J Multidiscip Studies. 2015;3(6):30-6.

Spiegel AJ, Capobianco JD, Kruger A, Set al. Osteopathic manipulative medicine in the treatment of hypertension: an alternative, conventional approach. Heart Dis. 2003;5:272-8.

Sullivan SGB, Paolacci S, Kiani AK, et al. Chiropractic care for hypertension: Review of the literature and study of biological and genetic bases. Acta Biomed 2020;91(S13).e2020017. DOI:10.23750/abm.v91i13-S.10524.

Titkin VP, Goĭdenko VS, Dobrotvorskaia TE,et al . Vertebrogennyĭ aspekt gemodinamicheskikh adaptatsionnykh razlichiĭ v zavisimosti ot nalichiia soputstvuiushcheĭ arterial'noĭ gipertenzii u bol'nykh, perenesshikh infarkt miokarda [The vertebrogenic aspect of hemodynamic adaptive differences in relation to the presence of concomitant arterial hypertension in patients with a history of myocardial infarct]. Vopr Kurortol Fizioter Lech Fiz Kult. 1994 Sep-Oct;(5):7-11. Russian. PMID: 7709624.

Win NN, Jorgensen AM, Chen YS, Haneline MT. Effects of upper and lower cervical manipulative therapy on blood pressure and heart rate variability in volunteers and patients with neck pain: a randomised controlled, cross-over, preliminary study. J Chiropr Med. 2015;14(1):1-9.

Ward J, Tyer K, Coats J, et al. Immediate effects of upper thoracic spine manipulation on hypertensive individuals. J Man Manip Ther. 2015;23(1):43-50.

Yates RG, Lamping DL, Abram NL, Wright C. Effects of chiropractic treatment on blood pressure and anxiety: a randomized, controlled trial. J Manipulative Physiol Ther. 1988 Dec;11(6):484-8.

Yung EY, Oh C, Wong MS, et al. The immediate cardiovascular response to joint mobilization of the neck - a randomized, placebo-controlled trial in pain-free adults. Musculoskelet Sci Pract. 2017;28:71-78. DOI10.1016 /j.msksp.2017.01.013

Yung E, Wong M, Williams H, Mache K. Blood pressure and heart rate response to posteriorly directed pressure applied to the cervical spine in young pain-free individuals: a randomized, repeated-measures, double-blind, placebo-controlled study. J Orthop Sports Phys Ther 2014;44(8):622-6.

Heart rate

Barron W, Coote JH. The contribution of articular receptors to cardiovascular reflexes elicited by passive limb movements. J Physiol. 1973:235:423-36.

Budgell B, Hirano F. Innocuous mechanical stimulation of the neck and alterations in heart-rate variability in healthy young adults. Auton Neurosci. 2001;91(1-2):96-99.

da Silva AC, Marques CMG, Marques JLB. Influence of spinal manipulation on autonomic modulation and heart rate in patients with rotator cuff tendinopathy. J Chiropr Med. 2018;17(2):82-89. DOI 10.1016/j.jcm.2017.12.003.

Koch L.E, Koch H, Graumann-Brunt S. Heart rate changes in response to mild mechanical irritation of the high cervical spinal cord region in infants. Forensic Sci Int, 2002, 128(3):168-76.

Nakayama T, Suzuki A, Ito R. The articulo-cardiac sympathetic reflex in spinalized, anesthetized rats. J Physiol Sci. 2006 Apr;56(2):137-43. DOI 10.2170/physiolsci.RP000705.

Nansel D, Jansen R, Cremata E, et al. Effects of cervical adjustments on lateral-flexion passive end-range asymmetry and on blood pressure, heart rate and plasma catecholamine levels. J Manipulative Physiol Ther 1991;14(8):450-6.

Sato A, Sato Y, Schmidt RF. Somatosensory modulation of the cardiovascular system..In: The effects of somatic afferent activity on heart rate. In: Brooks CM, Koizumi K, Sato A. Eds. Integrative Functions of the Autonomic Nervous System. Tokyo, Univ of Tokyo, Press. Elsevier, 1979:119-65.

Seuss W. Therapie des bluthochdrucks durch chiropractic. (Therapy for high blood pressure through chiropractic. Heilkunst 1960;73. (As cited in Weiant CW, Goldschmidt S. Medicine and chiropractic. Self Published; New York.1966:123.

Simonenko VB, Teslq AN, Shirokov EA, Davydov OV. [Some features of coronary artery disease combined with vertebrogenic thoracoalgias]. Klin Med (Mosk). 2007;85(1):61-3. Russian. PMID: 17419359. (English abstract)

Sitel AB, Fedin AI, Abrin GV, et al. Dinamika intervala Q--T EKG u bol'nykh s sheĭnym osteokhondrozom pri primenenii manual'noĭ terapii [The dynamics of the ECG Q-T interval in patients with cervical osteochondrosis undergoing manual therapy]. Ter Arkh. 1990;62(11):114-7. Russian. PMID: 2094973.

Uchida S, Kagitani F, Watanabe N, Hotta H. Sympatho-inhibitory response of the heart as a result of short-term acupuncture-like stimulation of the rat hindlimb is not augmented when sympathetic tone is high as a result of hypercapnia. J Physiol Sci. 2010;60(3):221-5. DOI 10.1007/s12576-009-0084-0.

Watanabe N, Hotta H. Heart rate changes in response to mechanical pressure stimulation of skeletal muscles are mediated by cardiac sympathetic nerve activity. Front Neurosci. 2017 Jan 10;10:614. DOI 10.3389/fnins.2016.00614.

Watanabe N, Piché M, Hotta H. Types of skin afferent fibers and spinal opioid receptors that contribute to touch-induced inhibition of heart rate changes evoked by noxious cutaneous heat stimulation. Mol Pain. 2015;12;11:4. DOI 10.1186/s12990-015-0001-x.

Yung E, Wong M, Williams H, Mache K. Blood pressure and heart rate response to posteriorly directed pressure applied to the cervical spine in young pain-free individuals: a randomized, repeated-measures, double-blind, placebo-controlled study. J Orthop Sports Phys Ther 2014;44(8):622-6.

Heart rate variability (HRV)

Amoroso Borges BL, Bortolazzo GL, Neto HP. Effects of spinal manipulation and myofascial techniques on heart rate variability: A systematic review. J Bodyw Mov Ther. 2018;22(1):203-8.

Borges BLA, Bortolazzo GL, Neto HP. Effects of spinal manipulation and myofascial techniques on heart rate variability: a systematic review. J Bodywork Movement Ther 2017;22:203-8

Budgell B, Igashi Y. Response of arrhythmia to spinal manipulation: Monitoring by ECG with analysis of heart-rate variability. J Neuromusculoskel Syst. 2001;9(3):97-102.

Budgell B, Polus B. The effects of thoracic manipulation on heart rate variability: a controlled crossover trial. J Manipulative Physiol Ther. 2006;29(8):603-10.

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.

Eingom AM, Muhs GJ. Rationale for assessing the effects of manipulative therapy on autonomic tone by analysis of heart rate variability. J Manipulative Physiol Ther. 1999;22(3):161-5.

Giles PD, Hensel KL, Pacchia CF, et al. Suboccipital decompression enhances heart rate variability indices of cardiac control in healthy subjects. J Altern Complement Med. 2013;19(2):92-96. DOI 10.1089/acm.2011.0031

Henley CE, Ivins D, Mills M, et al. Osteopathic manipulative treatment and its relationship to autonomic nervous system activity as demonstrated by heart rate variability: a repeated measures study. Osteopath Med Prim Care. 2008;2:7. DOI 10.1186/1750-4732-2-7.

Injeyan HS, Budgell BS. Mitigating bias in the measurement of heart rate variability in physiological studies of spinal manipulation: a comparison between authentic and sham manipulation. J Manipulative Physiol Ther. 2022;45(2):104-13.

Kessinger RC, Anderson MF, Adington JW. Improvement in pattern analysis, heart rate variability and symptoms following upper cervical chiropractic care. J Upper Cervical Chiropr Res. 2013;2:32-42.

Kent C. Heart rate variability to assess the changes in autonomic nervous system function associated with vertebral subluxation. RRNS 2017;1(3)14-21. https://www.researchgate.net/publication/320306138_Heart_Rate_Variability_to_Assess_the_Changes_in_Autonomic_Nervous_System_Function_Associated_With_Vertebral_Subluxation

Roy RA, Boucher JP, Comtois AS. Heart rate variability after manipulation in pain-free patients vs patients in pain. J Manipulative Physiol Ther 2009;32(4):277-86.

Ruffini N, D'alessandro G, Mariani N, et al. Variations of high frequency parameter of heart rate variability following osteopathic manipulative treatment in healthy subjects compared to control group and sham therapy. Frontier Neurosci 2015;9:272.

Shafiq H McGregor C, Murphy B. The impact of cervical manipulation on heart rate variability. Conf Proc IEEE Eng Med Biol Soc 2014;2014:3406-9. DOI 10.1109/EMBC.2014.6944354

Swenson DM, Heart rate variability and spinal manipulation: a review of the literature. J Acad Chiropr Orthoped. 2011;8(4):189-238.

Win NN, Jorgensen AM, Chen YS, et al. Effects of upper and lower cervical manipulative therapy on blood pressure and heart rate variability in volunteers and patients with neck pain: a randomised controlled, cross-over, preliminary study. J Chiropr Med. 2015;14(1):1-9.

Wurster RD, Geis GS. Electrophysiologic evidence for spinal pathways for cardiac reflexes initiated by small somatic afferent fibers. J Cardiovasc Electrophys 1991;2(2):s26-s33. https://doi.org/10.1111/j.1540-8167.1991.tb01365.x

Zhang J, Dean D, Nosco D, Strathopulos D, Floros M. Effect of chiropractic care on heart rate variability and pain in a multisite clinical study. J Manipulative Physiol Ther. 2006;29(4):267-274.

Haemodynamics

Budgell B, Sato A. The cervical subluxation and regional blood flow. J Manipulative Physiol Ther 1997;20(2):103-7.

Driscoll MD, Hall MJ. Effects of spinal manipulative therapy on autonomic activity and the cardiovascular system: a case study using the electrocardiogram and arterial tonometry. J Manipulative Physiol Ther. 2000;23(8):545-50.

Driscoll MD. Arterial tonometry and assessment of cardiovascular alterations with chiropractic spinal manipulative therapy. J Manipulative Physiol Ther. 1997;20(1):47-55.

Fujimoto T, Budgell B, Uchida S. Arterial tonometry in the measurement of the effects of innocuous mechanical stimulation of the neck on heart rate and blood pressure. J Auton Nerv Syst 1999;75(2-3):109-15.

Saeki Y, Sato A Sato Y, Trzebski A. Effects of stimulation of cervical sympathetic trunks with various frequencies on the local cortical cerebral blood flow measured by laser Doppler flowmetry in the rat. Jpn J Physiol 1990;40(1):15-32

Myocardial infarct

Erfanian P. Patient with signs and symptoms of myocardial infarction presenting to a chiropractic office: a case report. J Canad Chiropr Assoc.2001;45(1):35-41

Haller K, Schaub K. Vertebrogene Auslösung von Herzinfarkten [A Vertebrogenic cause of heart infarction]. Med Klin. 1967 Apr 28;62(17):665-7. German. PMID: 5595334.

Cardiovascular - OMT and cardiac surgery

Baltazar GA, Betier MP, Alella K, et al. Effect of osteopathic manipulative treatment on incidence of postoperative ileus and hospital length of stay in general surgical patients. J Am Osteopath Assoc 2013;113(3):204-9.

King HH. Benefit of OMT in patients who underwent heart surgery. J Am Osteopath Assoc. 2017;117(5):332-333. DOI 10.7556/jaoa.2017.061.

Noll DR. The effect of OMT on postoperative medical and functional recovery of coronary artery bypass graft patients. J Am Osteopath Assoc. 2013;113(8):595-6. DOI 10.7556/jaoa.2013.018.

O-Yurvati AH, Carnes MS, Clearfield MB, et al. Hemodynamic effects of osteopathic manipulative treatment immediately after coronary artery bypass graft surgery. J Am Osteopath Assoc. 2005;105(10):475-81.

Racca V, Bordoni B, Castiglioni P, et al. Osteopathic manipulative treatment improves heart surgery outcomes: a randomized controlled trial. Ann Thor Surg 2017; pii: S0003-4975(16)31438-2. DOI 10.1016/j.athoracsur.2016.09.110.

Rogers FJ, Starzinski ME. The challenges of OMT in postsurgical management of cardiac patients. J Am Osteopath Assoc. 1989;89(10):1274-7.

Wax CM, Abend DS, Pearson PH. Chest pain and the role of somatic dysfunction. J Am Osteopath Assoc. 1997;97(6):347-52, 355. DOI 10.7556/jaoa.1997.97.6.347.

Weiting JM, Beal C, Roth GL, et al. The effect of osteopathic manipulative treatment on postoperative medical and functional recovery of coronary artery bypass graft patients. J Am Osteo Assoc 2013;113(5):384-93.

Endocrine

'In certain pathophysiological situations, however, it may happen that activity in sympathetic post-ganglionic neurones, which supply an extremity, leads to excitation of afferent axons, thus establishing a vicious circle between primary afferent neurones, spinal cord and sympathetic outflow.' (Jänig, 1985)

Araki T, Ito K, Kurosawa M, et al. Responses of adrenal sympathetic nerve activity and catecholamine secretion to cutaneous stimulation in anesthetized rats. Neuroscience, 1984;12: 289-99.

Berkowitz MR. Resolution of hypothyroidism after correction of somatovisceral reflex dysfunction by refusion of the cervical spine. J Am Osteopath Assoc. 2015 Jan;115(1):46-9. DOI 10.7556/jaoa.2015.007.

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.

Colombi A, Testa M. The effects induced by spinal manipulative therapy on the immune and endocrine systems. Medicina (Kaunas, Lithuania) 55(8):448. DOI:10.3390/medicina55080448.

Farrell G< Bell M, Chapple C, et al. Autonomic nervous system and endocrine system response to upper and lower cervical spine mobilization in healthy male adults: a randomized crossover trial. J Man Manip Ther. 2023;16:1-14.

Fornari M, Carnevali L, Sgoifo A. Single osteopathic manipulative therapy session dampens acute autonomic and neuroendocrine responses to mental stress in healthy male participants. J Am Osteopath Assoc. 2017;117(9):559-67.

Jänig W. Systemic and specific autonomic reactions in pain: efferent, afferent and endocrine components. Eur J Anaesthesiol. 1985;2(4):319-46.

Licciardone JC, Kearns CM, Hodge LM, et al. Osteopathic manual treatment in patients with diabetes mellitus and comorbid chronic low back pain: subgroup results from the Osteopathic Trial. J Am Osteopath Assoc. 2013;113(6):468-78.

Radjieski JM, Lumley MA, Cantieri MS. Effect of osteopathic manipulative treatment of length of stay for pancreatitis: a randomized pilot study. J Am Osteopath Assoc. 1998;98(5):264-72. Erratum in: J Am Osteopath Assoc 1998;98(7):408.

Sampath KK, Botnmark E. Mani R, Turnilty S. Neuro-endocrine response following a thoracic spinal manipulation in healthy med. J Orthop Sports Physical Ther. 2017;47(9):617-28.

Sato A, Sato Y, Schmidt RF. Somatosensory modulation of hormonal secretion. In The impact of somatosensory input on autonomic functions. Reviews of Physiology Biochemistry and Pharmacology. Blaustein MP, Grunicke H, Pette D, Schultz G. Schweiger M, Habermann M. Eds. Berlin: Springer-Verlag. 1997;219-53.

Sato A, Sato Y, Schmidt RF. The effects of knee joint stimulation on the sympatho-adrenal medullary functions in anesthetized cats. Neurosci Res 1985;3(Suppl 1):S18.

Valera-Calero A, Lluch Girbés E, Gallego-Izquierdo T, et al. Endocrine response after cervical manipulation and mobilization in people with chronic mechanical neck pain: a randomized controlled trial. Eur J Phys Rehabil Med. 2019 Dec;55(6):792-805. DOI 10.23736/S1973-9087.19.05475-3.

Gastrointestinal

'These results suggest that noxious chemical stimulation of the interspinous tissues elicits a segmentally organized reflex which is mediated principally at the spinal level and which expresses itself principally, but not exclusively via sympathetic efferents traversing the coeliac ganglion.' (Budgell & Suzuki, 2000)

Gastrointestinal '*somatovisceral reflex responses may be functioning during spinal manipulative therapy in conscious humans*.' (Sato, 1992) '*Unstable thoracolumbar vertebrae is* (sic) *the cause of irritable bowel syndrome. It is a simple and effective way by manipulation on thoracolumbar* *vertebrae to release compression and stimulation on peripheral nerve and vascular for treating this disease.*' (Qu, 2009)

'*Conclusion. The displacement of inter-vertebral disks and/or vertebra in the thoracic or lumbar region seems to be a contributing factor in the symptoms of irritable bowel syndrome. Thumb pressing manipulation on jiaji points in the thoracic and/or lumbar region can correct the displacement of inter-vertebral disks and/or vertebra, resolving the stimuli caused by pressure exerted on the nerves and vessels around the spine. So it is an effective treatment for IBS.*' (Xing et al, 2013)

A somatovisceral reflex association does not appear to be a consideration under a medical model despite research by Sato and others. (Accarie et al, 2020)

These behavioural and electrophysiology studies suggest that colonic hypersensitivity following noxious somatic stimulation is due to somatovisceral convergence in the spinal cord and is unlikely due to axonal dichotomy, since the existence of somatovisceral dichotomized afferents is very rare. (Sengupta, 2009)

'*Upper thoracic respiratory interneurons integrate noxious somatic and visceral information in rats.*' (Qin et al, 2002)

Aarimaa H. Panel discussion. In: Krag E. Other causes of dyspepsia – especially abdominal pain of spinal origin. Scand J Gastroenterol Suppl. 1982;79:32-7.

Accarie A, Vanuytsel T. Animal Models for Functional Gastrointestinal Disorders. Front Psychiatry. 2020 Nov 11;11:509681. DOI 10.3389/fpsyt.2020.509681.Alcantara J, Anderson R. Chiropractic care of a pediatric patient with symptoms associated with gastroesophageal reflux disease, fuss-cry-irritability with sleep disorder syndrome and irritable infant syndrome of musculoskeletal origin. J Can Chiropr Assoc. 2008;52(4):248-55.

Andersen PM, Fagerlund M. Vertebrogenic dysphagia and gait disturbance mimicking motor neuron disease. J Neurol Neurosurg Psychiatry. 2000;69(4):560-1.

Angus K, Asgharifar S, Gleberzon B. What effect does chiropractic treatment have on gastrointestinal (GI) disorders: a narrative review of the literature. J Can Chiropr Assoc. 2015;59(2):122-33.

Azizi S, Rezasoltani Z, Najafi S, et al. The relationship between dorsal spine dysfunction and gastrointestinal pain and efficacy of manipulation on them. Phys Med Rehab Electrodiag 2020;2(1):2-6.

Baumann A, Katz PO. Functional disorders of swallowing. Handb Clin Neurol. 2016;139:483-8. DOI 10.1016/B978-0-12-801772-2.00039-4.

Bitnar P, Stovicek J, Hlava S, et al. Manual cervical traction and trunk stabilization cause significant changes in upper and lower oesophageal sphincter: A randomized trial. J Manipulative Physiol Ther. 2021;44(4):344-51. DOI 10.1016/j.jmpt.2021.01.004.

Bonaz B, Sinniger V, Pellissier S. The vagus nerve in the neuro-immune axis: implications in the pathology of the gastrointestinal tract. Front Immunol. 2017. https://www.frontiersin.org/articles/10.3389/fimmu.2017.01452/full.

Browning KN. Role of central vagal 5-HT3 receptors in gastrointestinal physiology and pathophysiology. Front Neurol. 2015; https://doi.org/10.3389/fnins.2015.00413.

Budgell B, Suzuki A. Inhibition of gastric motility by noxious chemical stimulation of interspinous tissues in the rat. J Auton Nerv Syst 2000;80(3):162-8.

Camilleri M, KadouhH, Chedid V, et al. Effect of T6 dermatome electrical stimulation on gastroduodenal motility in healthy volunteers. https://classic.clinicaltrials.gov/ProvidedDocs/05/NCT03316105/Prot_SAP_000.pdf.

Chiu JH, Kuo YL, Lui WY, et al. Somatic electrical nerve stimulation regulates the motility of sphincter of Oddi in rabbits and cats: evidence for a somatovisceral reflex mediated by cholecystokinin. Dig Dis Sci. 1999;44(9):1759-67. DOI 10.1023/a:1018870017774.

Chu EC, Butler KR. Resolution of Gastroesophageal Reflux Disease Following Correction for Upper Cross Syndrome-A Case Study and Brief Review. Clin Pract. 2021;11(2):322-326. DOI 10.3390/clinpract11020045.

Chang L. Review article: epidemiology and quality of life in functional gastrointestinal disorders. Aliment Pharmacol Ther. 2004 Nov;20 Suppl 7:31-9.

Chuang A. Chiropractic treatment of gastro-esophageal reflux disease in a pediatric patient: a case report. J Clin Chiropr Pediatr. 2014;14(2):1139-41. https://jccponline.com/gastro-esophageal.html.

Davies NJ. The irritable baby syndrome. Chapter 5 In Chiropractic pediatrics: a clinical handbook. Edinburgh: Churchill Livingstone; 2000;63-71.

DeBoer KF, Schutz M, McKnight ME. Acute effects of spinal manipulation on gastrointestinal myoelectric activity in conscious rabbits. Man Med 1988;3:85-94.

Dukovac N, Postlethwaite R, McIvor C. Resolution of infant reflux concomitant with chiropractic care: A series of 5 cases. Asia-Pac Chiropr J. 2022;3.2. apcj.net/Papers-Issue-3-2/#DukovacInfantReflux

Durianová J. Vertebrovisceráline vztahy pri vredovej chorobe dvanástnika [Vertebrovisceral relations in duodenal ulcer]. Fysiatr Revmatol Vestn. 1975 Jun;53(3):156-60. Slovak. PMID: 124300.

Falling CL, Stebbings S, Baxter GD, et al. Somatosensory assessments in patients with inflammatory bowel disease: a cross-sectional study examining pain processing pathways and the role of multiple patient factors. Eur J Gastroenterol Hepatol. 2022 May 1;34(5):503-11.

Fikree A, Grahame R, Aktar R, et al. A prospective evaluation of undiagnosed joint hypermobility syndrome in patients with gastrointestinal symptoms. Clin Gastroenterol Hepatol. 2014;12(10):1680-87.e2.

Grundy D. Neuroanatomy of visceral nociception: vagal and splanchnic afferent. Gut. 2002;51(Suppl 1):i2-i5.

Hains G. Hains F. Descarreaux M.. Gastroesophageal reflux disease, spinal manipulation therapy and ischemic compression: a preliminary study. J Am Chirop Assoc. 2007;44(1):59-61.

Hein T. Some effects of chiropractic manipulation on reflux oesophagitis: a case report. Br J Chiropr. 1999 Aug;3(3):59-61.

Hobbs SF, Chandler MJ, Bolser DC, Foreman RD. Segmental organisation of visceral and somatic input onto C3-T6 spinothalamic tract cells of the monkey. J Neurophysiol. 1992;68(5):1574-88.

Hu C, Ye M, Huang Q. Effects of manual therapy on bowel function of patients with spinal cord injury. J Phys Ther Sci. 2013 Jun;25(6):687-8.

Iyer MM, Skokos E, Piombo D. Chiropractic management using multimodal therapies on 2 pediatric patients with constipation. J Chiropr Med.2017;16(4):340-45.

Jackson SB. Gastroesophageal reflex disease. Topics Clin Chiropr 1996;2(1):24-9.

Jonasson AK, Knaap SF. Gastroesophageal reflux disease in an 8-year-old boy: a case study. J Manipulative Physiol Ther. 2006;29(3):245-7.

Krag E. Other causes of dyspepsia - especially abdominal pain of spinal origin. Scand J Gastroenterol Suppl. 1982;79:32-37.

Lamb K, Zhong F, Gebhart GF, Bielefeldt K. Experimental colitis in mice and sensitization of converging visceral and somatic afferent pathways. Am J Physiol Gastrointest Liver Physiol. 2006;290(3):G451-7.

Manabe N, Tanaka T, Hata J, et al. Pathophysiology underlying irritable bowel syndrome – from the viewpoint of dysfunction of autonomic system activity. J Smooth Muscle Res. 2009;45(1):15-23.

Piché M, Watanabe N, Hotta H. Regulation of gastric motility and blood flow during acute nociceptive stimulation of the paraspinal muscles in urethane-anaesthetised rats. J Physiol Sci. 2014;64(1):37-46. DOI 10.1007/s12576-013-0288-1.

Qin C, Chandler MJ, Foreman RD, et al. Upper thoracic respiratory interneurons integrate noxious somatic and visceral information in rats. J Neurophysiol. 2002 Nov;88(5):2215-23. DOI 10.1152/jn.00120.2002.

Qu LX. [Relationship between irritable bowel syndrome and unstable thoracolumbar vertebrae]. Zhongguo Gu Shang. 2009;22(6):456-7. Chinese. PMID: 19594048.

Qu LX, Xing LY, Wanda N, et al. A clinical observation of functional abdominal pain syndrome in patients treated by traditional Chinese spinal orthopedic manipulation. Chin J Integr Med. 2018;24(2):140-146. DOI 10.1007/s11655-016-2261-3.

Mazur M, Stepień A, Pawlus J, et al. Wpływ aktywacji odruchów somatyczno-trzewnych (TENS) na opróznianie pecherzyka zółciowego u pacjentów z kamica pecherzyka zołciowego [Influence of somatovisceral reflexes activation (TENS) on gallblader emptying in cholelithiasis patients]. Folia Med Cracov. 2005;46(3-4):67-74. Polish. PMID: 17252989.

Menétrey D, Basbaum AI. Spinal and trigeminal projections to the nucleus of the solitary tract: a possible substrate for somatovisceral and viscerovisceral reflex activation. J Comp Neurol. 1987;255(3):439-50.

Peles S, Miranda A, Shaker R, et al. Acute nociceptive somatic stimulus sensitizes neurones in the spinal cord to colonic distension in the rat. J Physiol. 2004;560(Pt 1):291-302. DOI 10.1113/jphysiol.2004.069070.

Peterson C. A case study of chiropractic management of pregnancy-related heartburn with postulated fetal epigenome implications. Explore (NY). 2012;8(5):304-8. DOI 10.1016/j.explore.2012.06.001.

Pizzolorusso G, Turi P, Barlafante G, et al. Effect of osteopathic manipulation treatment on gastrointestinal dysfunction and length of stay in preterm infants: an exploratory study. Chiropr Man Ther. 2011;19(1):15.

Popa SL, Chiarioni G, David L, et al. Functional Emesis. J Gastrointestin Liver Dis. 2019 Sep 1;28(3):319-325. DOI 10.15403/jgld-236.

Qu L, Xing L, Norman W, Chen H, Gao S. Irritable bowel syndrome treated by traditional Chinese spinal orthopedic manipulation. J Tradit Chin Med. 2012 Dec;32(4):565-70. DOI 10.1016/s0254-6272(13)60072-2.

Ratto C, Litta F, Parello A, et al. Sacral nerve stimulation is a valid approach in fecal incontinence due to sphincter lesions when compared to sphincter repair. Colon Rectum. 2010;53(3):26444-472.

Rice AD, King R, Reed ED,et al. Manual physical therapy for non-surgical treatment of adhesion-related small bowel obstructions: two case reports. J Clin Med. 2013 Feb 4;2(1):1-12. DOI 10.3390/jcm2010001.

Sato A. The reflex effects of spinal somatic nerve stimulation on visceral function. J Manipulative Physiol Ther. 1992 Jan;15(1):57-61.

Sato A, Sato Y, Suzuki A, Uchida S. Neural mechanisms of the reflex inhibition and excitation of gastric motility elicited by acupuncture-like stimulation in anesthetized rats. Neurosci Res. 1993 Oct;18(1):53-62. DOI 10.1016/0168-0102(93)90105-y.

Sato A, Sato Y, Schmidt RF. Somatosensory modulation of the digestive system. In The impact of somatosensory input on autonomic functions. In: Reviews of Physiology Biochemistry and Pharmacology. Blaustein MP, Grunicke H, Pette D, Schultz G. Schweiger M, Habermann M. Eds.Berlin: Springer-Verlag. 1997;130;166-88.

Sengupta JN. Visceral pain: the neurophysiological mechanism. Handb Exp Pharmacol. 2009;(194):31-74. DOI 10.1007/978-3-540-79090-7_2.

Şimşek TT, Bol H, Şimşek IE, et al. The effects of osteopathic treatment on constipation in children with cerebral palsy: a pilot study. J Manipulative Physiol Ther. 2009;32(8):648-53.

Snider KT, Schneider RP, Snider EJ, et al. Correlation of somatic dysfunction with gastrointestinal endoscopic findings: An observational study. J Am Osteopath Assoc. 2016 Jun 1;116(6):358-69. DOI 10.7556/jaoa.2016.076.

Tamburella F, Princi AA, Piermaria J, et al. Neurogenic bowel dysfunction changes after osteopathic care in individuals with spinal cord injuries: A Preliminary randomized controlled trial. Healthcare (Basel). 2022 Jan 21;10(2):210. DOI 10.3390/healthcare10020210.

Uvnäs-moberg K, Lundeberg T, Bruzelius G, et al. Vagally mediated release of gastric and cholecystokinin following sensory stimulation. Acta Physiol Scand. 1992;146(3):349.

Vanaskova E, Hep A, Lewit K, et al. Cervical dysfunction with disturbed oesophageal motility - scintigraphic assessment. J Orthop Med. 2001;23(1):9-11.

Vaňásková E, Hep A, Vižďa J, et al. Swallowing disorders related to vertebrogenic dysfunction. Ceska a Slovenska Neurologie a Neurochirurgie 2007;70(6):692-696. (English abstract) https://www.csnn.eu/en/journals/czech-and-slovak-neurology-and-neurosurgery/2007-6-1/swallowing-disorders-related-to-vertebrogenic-dysfunctions-52591.

Vanaskova E, Dolina J, Hep A. Swallowing disorders related to vertebrogenic dysfunctions. New advances in the basic and clinical gastroenterology. In Brzozowski T. The basic and clinical gastroenterology. In Tech. 2012. 175-84. https://cdn.intechopen.com/pdfs/35448/InTech-Swallowing_disorders_related_to_vertebrogenic_dysfunctions.pdf.

Vitton V, Abysique A, Gaigé S, et al. Colonosphincteric electromyographic responses to sacral root stimulation: evidence for a somatosympathetic reflex. Neurogastroenter Motility. 2008;20(4):407-16.

Wiles MR. Observations on the effects of upper cervical manipulations on the electrogastrogram: A preliminary report. J Manipulative Physiol Ther. 1989;12:281-88.

Young MF, McCarthy PW, King S. Chiropractic manual intervention in chronic adult dyspepsia. Eur J Gastroenterol Hepatol. 2009;21(4):482-3.

Xing L, Qu L, Chen H, Gao S. A clinical observation of irritable bowel syndrome treated by traditional Chinese spinal orthopedic manipulation. Complement Ther Med. 2013;21(6):613-7. DOI 10.1016/j.ctim.2013.09.005.

Colic - paediatrics

'2 weeks of spinal manipulation reduced infantile colic behaviour at 4–11 days compared with 2 weeks of dimethicone.' (Wiberg et al, 1999)

The *University of Maryland* website notes that under chiropractic care 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 lists parents reporting that chiropractic manipulation has been noted as '*soothing crying babies*', one of the symptoms of colic. (Erlich, 2016; Rome et al, 2019; Mayo Clinic, 2022)

Alcantara J, Alcantara JD, Alcantara J. The chiropractic care of infants with colic: a systematic review of the literature. Explore (NY). 2011;7(3):168-74. DOI 10.1016/j.explore.2011.02.002.

Alcantara J, Anderson R. Chiropractic care of a pediatric patient with symptoms associated with gastroesophageal reflux disease, fuss-cry-irritability with sleep disorder syndrome and irritable infant syndrome of musculoskeletal origin. J Can Chiropr Assoc. 2008;52(4):248-55.

Armijo Olivo S, Magee DJ, Parfitt M, et al. The association between the cervical spine, the stomatognathic system, and craniofacial pain: a critical review. J Orofac Pain. 2006 Fall;20(4):271-87.

Biedermann H. Colic in newborn and the functional pathology of the cervical spine: A catamnestic study of 150 cases. 1-15. https://www.pph34.de/en_texte/Colic_JMPT_0903.pdf.

Browning M, Miller J, Bachmann J. Comparison of the short-term effects of chiropractic spinal manipulation and occipito-sacral decompression in the treatment of infant colic: A single-blinded, randomised, comparison trial. Dtsch Z Akupunkt.2009;52:50–1. https://doi.org/10.1016/j.dza.2009.07.004.

Carnes D, Plunkett A, Ellwood J, et al Manual therapy for unsettled, distressed and excessively crying infants: a systematic review and metanalyses. BMJ Open. 2018;8(1):e019040.

Cerritelli F, Cicchitti L, Martelli M et al. Osteopathic manipulative treatment and pain in preterms: study protocol for a randomised controlled trial. Trials. 20158;16:84. DOI 10.1186/s13063-015-0615-3.

Cerritelli F, Pizzolorusso G, Renzetti C, et al. A multicenter, randomized, controlled trial of osteopathic manipulative treatment on preterms. PLOS One. 2015;10(5):e0127370. DOI 10.1371/journal.pone.0127370.

Chuang A. Chiropractic treatment of gastro-esophageal reflux disease in a pediatric patient: a case report. J Clin Chiropr Pediatr. 2014;14(2):1139-41. https://jccponline.com/gastro-esophageal.html.

Driehuis F, Hoogeboom TJ, Nijhuis-van der Sanden MWG, et al. Spinal manual therapy in infants, children and adolescents: A systematic review and meta-analysis on treatment indication, technique and outcomes. PLoS One. 2019 Jun 25;14(6):e0218940. DOI 10.1371/journal.pone.0218940.

Dukovac N, Postlethwaite R, McIvor C. Resolution of Infant Reflux Concomitant with Chiropractic Care: A series of 5 cases. Asia-Pac Chiropr J. 2022;3.2. apcj.net/Papers-Issue-3-2/#DukovacInfantReflux.

Ehrlich SD. Infantile colic. University of Maryland Medical Center. http://www.umm.edu/health/medical/altmed/condition/infantile-colic.

Ellwood J, Draper-Rodi JD, Carnes D. Comparison of common interventions for the treatment of infantile colic: a systematic review of reviews and guidelines. BMJ Open 2020;10:e035405. DOI10.1136/ bmjopen-2019-035405.

Elsing C, Böhm M. Functional dyspepsia: alternative therapy by osteopathy. Internat Academy Osteop. 2020; https://www2.osteopathie.eu/en/publications/abstract-master-thesis/functional-dyspepsia-alternative-therapy-osteopathy

Elster E. Sixteen infants with acid reflux and colic undergoing upper cervical chiropractic care to correct vertebral subluxation: a retrospective analysis of outcome. J Pediatr Maternal Family Health Chiropr. 2009;(2):1-7.

Eriksen K. Infantile colic and breast-feeding. In: Upper cervical subluxation complex. a review of the chiropractic and medical literature. Baltimore. Lippincott Williams & Wilkins. 2006;296-9.

Frimodt-Møller N. Kiropraktorbehandling af børn i første leveår [Chiropractic treatment of infants in the first year of life]. Ugeskr Laeger. 1988 Sep 26;150(39):2355-6. Danish.

Grunnet-Nilsson N, Wiberg J. Infantile colic and chiropractic spinal manipulation. Arch Dis Child. 2001;85(3):268. DOI 10.1136/adc.85.3.268.

Haavik H. The contemporary understanding of the chiropractic subluxation. Chapter 4 In: Anrig CA, Plaugher G. Eds. Pediatric chiropractic, 3e. Wolters Kluwer/Lippincott Williams & Wilkins Health. ISBN/ISSN:9781975163105.

Hipperson AJ. Chiropractic management of infantile colic. Clin Chiropr. 2004;7(4):180-6.

Holm, L.V., Jarbøl, D.E., Christensen, H.W. et al. The effect of chiropractic care on infantile colic: results from a single-blind randomised controlled trial. Chiropr Man Therap. 2021;29,15. https://doi.org/10.1186/s12998-021-00371-8.

Jonasson AK, Knaap SF. Gastroesophageal reflux disease in an 8-year-old boy: a case study. J Manipulative Physiol Ther. 2006;29(3):245-7. DOI 10.1016/j.jmpt.2006.01.004.

Klougart N, Nilsson N, Jacobsen J. Infantile colic treated by chiropractors: a prospective study of 316 cases. J Manipulative Physiol Ther. 1989;12(4):281-8.

Krasilnikoff PA. Kiropraktorbehandling af spaedbarnskolik [Chiropractor treatment of infantile colic]. Ugeskr Laeger. 1988;150(30):1823-4. Danish. PMID: 3413851.)

Langkau J, Miller J. An investigation of musculoskeletal dysfunction in infants includes a case series of KISS diagnosed children. J Clin Chiro. 2012; 13(1):958–67.

Margolius FR. Compared with dimethicone, 2 weeks of spinal manipulation reduced infantile colic behaviour at 4-11 days after initial treatment. Evid based Nursing. 2000;42(3):42. (Commentary: on Wiberg et al, 1999) http://ebn.bmj.com/.

Mayo Clinic. Colic. Diagnosis and treatment. Mayo Foundation for Medical Education and Research. https://www.mayoclinic.org/diseases-conditions/colic/diagnosis-treatment/drc-20371081.

Mercer C, Nook BC. The efficacy of chiropractic spinal adjustments as a treatment protocol in the management of infantile colic. In: Haldeman S, Murphy B, eds. 5th Biennial Congress of the World Federation of Chiropractic. Auckland, 1999:170-1.

Miller J, Newell D. Prognostic significance of subgroup classification for infant patients with crying disorders: a prospective cohort study. J Can Chiropr Assoc. 2012;56(1):40-8.

Miller JE, Newell D, Bolton JE. Efficacy of chiropractic manual therapy on infant colic: a pragmatic single-blind, randomized controlled trial. J Manip Physiol Ther. 2012;35(8):600-7.

Miller JE, Phillips HL. Long-term effects of infant colic: a survey comparison of chiropractic treatment and nontreatment groups. J Manipulative Physiol Ther. 2009;32(8):635-8. DOI 10.1016/j.jmpt.2009.08.017.

Ostby G. Kiropraktorbehandling ved spedbarnskolikk [Chiropractic treatment of colic in infants]. Jordmorbladet. 1994;(4):24-6. Norwegian. PMID: 7953170.

Paravicini I. Manipulation under anesthesia in infants with arthrogenic newborn torticollis: a retrospective case series. J Chiropr Med. 2018;17(4):289-97.

Rome PL, Waterhouse JD, Maginness G, Ebrall P. Medical management of infantile colic and other conditions with spinal manipulation: a narrative review of the European medical literature. J Contemporary Chiropr. 2019;2:60-75.

Snider KT. Th use of osteopathic manipulative treatment as part of an integrated treatment for infantile colic: a case report. AAO J. 2016;26(2):15, 18, 33.

Spicer A. Colic. In: Loo M, (Ed) Integrative medicine for children. Chapter 23. London. Elsevier Health.2002;248-58. [Chiropractic 250-1.

Waddington EL, Snider KT, Lockwood MD, Pazdernik VK. Incidence of somatic dysfunction in healthy newborns. J Am Osteopath Assoc. 2015;115(11):654-65. DOI 10.7556/jaoa.2015.136. (ClinicalTrials.gov number NCT01496872).

Waheed A, Malone M, Samiullah S. Functional gastrointestinal disorders: functional gastrointestinal disorders in children. FP Essent. 2018;466:29-35.

Wiberg JM, Nordsteen J, Nilsson N. The short-term effect of spinal manipulation in the treatment of infantile colic: a randomized controlled clinical trial with a blinded observer. J Manipulative Physiol Ther. 1999;22(8):517-22. DOI 10.1016/s0161-4754(99)70003-5.

Wiberg KR, Wiberg JM. A retrospective study of chiropractic treatment of 276 danish infants with infantile colic. J Manipulative Physiol Ther. 2010;33(7):536-41. DOI 10.1016/j.jmpt.2010.08.004.

Genitourinary

'In considering the possible routes for somatic stimulation to affect visceral functions it is clear that the autonomic nervous system represents one route. An equally plausible mechanism for alteration in visceral function by somatic afferent stimulation considers possible effects of such stimulation on the other main control system of the body, the endocrine system …' (Kurosawa et al, 1986)

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):593-9.

Cashley MA, Cashley MA. Chiropractic care of interstitial cystitis/painful bladder syndrome associated with pelvic lumbar spine dysfunction: a case series. J Chiropr Med. 2012;11(4):260-6. DOI 10.1016/j.jcm.2011.10.010.

Chen SY, Chai CY. Coexistence of neurons integrating urinary bladder activity and pelvic nerve activity in the same cardiovascular areas of the pontomedulla in cats. Chin J Physiol. 2002;45(1):41-50.

Cuthbert SC, Rosner AL. Conservative chiropractic management of urinary incontinence using applied kinesiology: a retrospective case-series report. J Chiropr Med. 2012;11(1):49-57. DOI 10.1016/j.jcm.2011.10.002.

Dungaria TR. A case report of sacroiliac joint dysfunction with urinary symptoms. Man Ther. 1998;3(4):220-1.

Franke H, Hoesele K. Osteopathic manipulative treatment (OMT) for lower urinary tract symptoms (LUTS) in women. J Bodyw Mov Ther. 2013;17(1):11-8. DOI 10.1016/j.jbmt.2012.05.001. Erratum in: J Bodyw Mov Ther. 2014;18(1):92.

Hobbs SF, Oh UT, Brennan TJ, Chandler MJ, Kim KS, Foreman RD. Urinary bladder and hindlimb stimuli inhibit T1-T6 spinal and spinoreticular cells. Am J Physiol. 1990;258(1 Pt 2):R10-20. DOI 10.1152/ajpregu.1990.258.1.R10.

Kaddumi EG, Hubscher CH. Changes in rat brainstem responsiveness to somatovisceral inputs following acute bladder irritation. Exp Neurol. 2007;203(2):349-57. DOI 10.1016/j.expneurol.2006.08.011.

Kurosawa M, Sato A, Sato Y, Schmidt RF, Swenson, RS: Reflex responses of sympatho-adrenal medullary functions produced by somatic afferent stimulation. In: Emotions, Neuronal and Chemical Control. Oomura Y. Ed. Japan Scientific Soc. Press. Tokyo: Karger pp. 381-391. https://www.karger.com/Article/Abstract/413544.

Lo Basso F, Pilzer A, Ferrero G, et al. Manual treatment for kidney mobility and symptoms in women with nonspecific low back pain and urinary infections. J Osteopath Med. 2021;121(5):489-97. DOI 10.1515/jom-2020-0288.

Marx S, Cimniak U, Beckert R, et al. Chronische Prostatitis/chronisches Beckenschmerzsyndrom. Einfluss osteopathischer Behandlungen - eine randomisiert kontrollierte Studie [Chronic prostatitis/chronic pelvic pain syndrome. Influence of osteopathic treatment - a randomized controlled study]. Urologe A. 2009;48(11):1339-45. German. DOI 10.1007/s00120-009-2088-z. Erratum in: Urologe A. 2010;49(1):55.)

Morrison JFB, Sato A, Sato Y, et al. The influence of afferent inputs from skin and viscera on the activity of the bladder and the skeletal muscle surrounding the urethra in the rat. Neurosci Res. 1995;23(2):195-205.

Rabal Conesa C, Cao Avellaneda E, López Cubillana P, et al. Manual therapy intervention in men with chronic pelvic pain syndrome or chronic prostatitis: An exploratory prospective case-series. Cureus. 2022 Apr 25;14(4):e24481. DOI 10.7759/cureus.24481.

Headache

Cervicogenic headache, occipital neuralgia, 'differentiate migraine'

'Conservative therapeutic approaches are considered first-line.'

(Barmherzig & Kingston 2019)

The cervicogenic headache is classified 11.2.1 by the International Headache Society. The initial proponents in recognising and successfully ameliorating cervicogenic headaches were chiropractors and osteopaths. However, a *PubMed* search of cervicogenic headache treatment notes 1,120 listings: https://pubmed.ncbi.nlm.nih.gov/?term=cervicogenic+headache+treatment&timeline=expanded. (Noted Aug 31, 2023.)

The Timeline starts to mount about the year 2000 with relatively few before that year. This indicates the delay with medical recognition in the clinical phenomenon evolving more recently. [Inexplicably, 'Cervicogenic headache' lists 374 listings. 'Cervicogenic headache manual' does not present any listings!]

These results show that a considerable population of sensory neurones show convergent input from both dura as well as cervical cutaneous, articular, and muscle territories, which supports the view of a functional continuum between the caudal trigeminal nucleus and upper cervical segments involved in cranial nociception. The facilitatory effect of GON (*Greater Occipital Nerve*) stimulation on dural stimulation suggests a central mechanism at the second order neurone level. This mechanism '*may be important in pain referral from cervical structures to the head and therefore have implications for most forms of primary headache*.' (Bartsch, 2002)

Alexander J. Resolution of new daily persistent headache after osteopathic manipulative treatment. J Am Osteopath Assoc. 2016;116(3):182-5. DOI 10.7556/jaoa.2016.035.

Amiri M, Jull G, Bullock-Saxton J, et al. Cervical musculoskeletal impairment in frequent intermittent headache. Part 2: subjects with concurrent headache types. Cephalalgia. 2007;27(8):891-8. DOI 10.1111/j.1468-2982.2007.01346.x.

Antonaci F, Bono G, Chimento P. Diagnosing cervicogenic headache. J Headache Pain. 2006;7(3):145-8. DOI 10.1007/s10194-006-0277-3.

Antonaci F, Ghirmai S, Bono G, et al. Cervicogenic headache: evaluation of the original diagnostic criteria. Cephalalgia. 2001;21(5):573-83. DOI 10.1046/j.0333-1024.2001.00207.x.

Bansevicius D, Salvesen R. Cervikogen hodepine [Cervicogenic headache]. Tidsskr Nor Laegeforen. 2003;123(19):2701-4. Norwegian. PMID: 14600739.

Barmherzig R, Kingston W. Occipital Neuralgia and Cervicogenic Headache: Diagnosis and Management. Curr Neurol Neurosci Rep. 2019;19(5):20. DOI 10.1007/s11910-019-0937-8.

Bartsch T, Goadsby PJ. Stimulation of the greater occipital nerve induces increased central excitability of dural afferent input. Brain. 2002;125(7):1496-509.

Bartsch T, Paemeleire K, Goadsby PJ. Neurostimulation approaches to primary headache disorders. Curr Opin Neurol. 2009;22(3):262-8. DOI 10.1097/wco.0b013e32832ae61e.

Bartsch T, Goadsby PJ. Increased responses in trigeminocervical nociceptive neurons to cervical input after stimulation of the dura mater. Brain. 2003;126(Pt 8):1801-13. DOI 10.1093/brain/awg190.

Bartsch T, Goadsby PJ. Central mechanisms of peripheral nerve stimulation in headache disorders. Prog Neurol Surg. 2011;24:16-26. DOI 10.1159/000323008.

Becker WJ. Cervicogenic headache: evidence that the neck is a pain generator. Headache. 2010 Apr;50(4):699-705. DOI 10.1111/j.1526-4610.2010.01648.x.

Biondi DM. Noninvasive treatments for headache. Expert Rev Neurother. 2005;5(3):355-62. DOI 10.1586/14737175.5.3.355.

Biondi DM. Physical treatments for headache: a structured review. Headache. 2005;45(6):738-46. DOI 10.1111/j.1526-4610.2005.05141.x.

Biondi DM. Cervicogenic headache: diagnostic evaluation and treatment strategies. Curr Pain Headache Rep. 2001;5(4):361-8. DOI 10.1007/s11916-001-0026-x.

Bogduk N, Govind J. Cervicogenic headache: an assessment of the evidence on clinical diagnosis, invasive tests, and treatment. Lancet Neurol. 2009;8(10):959-68. DOI 10.1016/S1474-4422(09)70209-1.

Bogduk N. The anatomical basis for cervicogenic headache. J Manipulative Physiol Ther 1992;15(1):67-70.

Boline PD, Kassak K, Bronfort G, et al. Spinal manipulation vs. amitriptyline for the treatment of chronic tension-type headaches: a randomized clinical trial. J Manipulative Physiol Ther. 1995;18(3):148-54.

Bono G, Antonaci F, Dario A, et al. Unilateral headaches and their relationship with cervicogenic headache. Clin Exp Rheumatol. 2000;18(2 Suppl 19):S11-5.

Braaf MM, Rosner S. More recent concepts on treatment of headache. Headache. 1965;5:38-44. DOI 10.1111/j.1526-4610.1965.hed0502038.x.

Braaf MM, Rosner S. Trauma of cervical spine as cause of chronic headache. J Trauma. 1975;15(5):441-6. DOI 10.1097/00005373-197505000-00011.

Bradnam L, Barry C. The role of the trigeminal sensory nuclear complex in the pathophysiology of craniocervical dystonia. J Neurosci. 2013;33(47):18358-67. DOI 10.1523/JNEUROSCI.3544-13.2013.

Bronfort G, Assendelft WJ, Evans R, et al. Efficacy of spinal manipulation for chronic headache: a systematic review. J Manipulative Physiol Ther. 2001;24(7):457-66.

Cardoso R, Seixas A, Rodrigues S, et al. The effectiveness of sustained natural apophyseal glide on flexion rotation test, pain intensity, and functionality in subjects with cervicogenic headache: a systematic review of randomized trials. Arch Physiother. 2022;12(1):20. DOI 10.1186/s40945-022-00144-3.

Çoban G, Çöven İ, Çifçi BE, et al. The importance of craniovertebral and cervicomedullary angles in cervicogenic headache. Diagn Interv Radiol. 2014;20(2):172-7. DOI 10.5152/dir.2013.13213.

Chaibi A, Tuchin PJ. Chiropractic spinal manipulative treatment of cervicogenic dizziness using Gonstead method: a case study. J Chiropr Med. 2011;10(3):194-8. DOI 10.1016/j.jcm.2011.06.001.

Comley L. Chiropractic management of greater occipital neuralgia. Clin Chiropr. 2003;6(3-4):120-8.

Correia C, Monteiro P. Cefaleia cervicogénica [Headache of cervical origin]. Acta Med Port. 1992;5(3):155-8. Portuguese. PMID: 1595387.

D'Amico D, Leone M, Bussone G. Side-locked unilaterality and pain localization in long-lasting headaches: migraine, tension-type headache, and cervicogenic headache. Headache. 1994;34(9):526-30. DOI 10.1111/j.1526-4610. 1994.hed3409526.x.

Dunning JR, Butts R, Mourad F. et al. Upper cervical and upper thoracic manipulation versus mobilization and exercise in patients with cervicogenic headache: a multi-center randomized clinical trial. BMC Musculoskelet Disord. 2016;17, 64. https://doi.org/10.1186/s12891-016-0912-3

Dvorak J, Wälchli B. Kopfschmerzen beim Zervikalsyndrom [Headache in cervical syndrome]. Ther Umsch. 1997;54(2):94-7. German. PMID: 9139412.

Edmeans J. Cervicogenic headaches. Canadian Pain Society Symposium. Pain research management. 1996;1. https://doi.org/10.1155/1996/931056./ and https://www.hindawi.com/journals/prm/1996/931056/

Edmeads J. Céphalées d'origine cervicale [Headache of cervical origin]. Rev Prat. 1990;40(5):399-402. French. PMID: 2309070. (Abstract)

Espí-López GV, Gómez-Conesa A. Efficacy of manual and manipulative therapy in the perception of pain and cervical motion in patients with tension-type headache: a randomized, controlled clinical trial. J Chiropr Med. 2014;13(1):4-13. DOI 10.1016/j.jcm.2014.01.004.

Fengler H, Schulze KJ, Kleditzsch J, et al. [Vertebrogenic cervicoencephalic syndrome.] Z Arztl Fortbild (Jena). 1986;80(21):877-81.

Fernández-de-las-Peñas C, Alonso-Blanco C, Cuadrado ML, et al. Spinal manipulative therapy in the management of cervicogenic headache. Headache, 2005;45(9):1260-3.

Fernández-de-las-Peñas C, Courtney CA. Clinical reasoning for manual therapy management of tensions type and cervicogenic headache. J Man Manip Ther. 2014;22(1):44-50.

Fernandez M, Moore C, Tan J, et al. Spinal manipulation for the management of cervicogenic headache: A systematic review and meta-analysis. Eur J Pain. 2020;24(9):1687-702. DOI 10.1002/ejp.1632.

Frese A, Schilgen M, Husstedt IW, et al. Pathophysiologie und Klinik zervikogener Kopfschmerzen [Pathophysiology and clinical manifestation of cervicogenic headache]. Schmerz. 2003;17(2):125-30. German. DOI 10.1007/s00482-002-0194-6.

Garcia JD, Arnold S, Tetley K, et al. Mobilisation and manipulation of the cervical spine in patients with cervicogenic headache: any scientific evidence? Front Neurol. 2016;7:40. DOI 10.3389/fneur.2016.00040. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4800981/

Giblin K, Newmark JL, Brenner GJ, et al. Headache plus: trigeminal and autonomic features in a case of cervicogenic headache responsive to third occipital nerve radiofrequency ablation. Pain Med. 2014;15(3):473-8. DOI 10.1111/pme.12334.

Grgić V. Cervikogena glavobolja: etiopatogeneza, karakteristike, dijagnoza, diferencijalna dijagnoza i terapija [Cervicogenic headache: etiopathogenesis, characteristics, diagnosis, differential diagnosis and therapy]. Lijec Vjesn. 2007;129(6-7):230-6. Croatian. PMID: 18018715.

Grimshaw DN. Cervicogenic headache: manual and manipulative therapies. Curr Pain Headache Rep. 2001;5(4):369-75. DOI 10.1007/s11916-001-0027-9.

Haas M, Spegman A, Peterson D, et al. Dose response and efficacy of spinal manipulation for chronic cervicogenic headache: a pilot randomized controlled trial. Spine J. 2010;10(2):117-28. DOI 10.1016/j.spinee.2009.09.002.

Haas M, Bronfort G, Evans R. Dose-response and efficacy of spinal manipulation for care of cervicogenic headache: a dual-center randomized controlled trial. Spine J. 2018;18(10):1741-54. DOI 10.1016/j.spinee.2018.02.019.

Haldeman S, Dagenais S. Cervicogenic headaches: a critical review. Spine J. 2001 Jan-Feb;1(1):31-46. DOI 10.1016/s1529-9430(01)00024-9.

Hall T, Briffa K, Hopper D. Clinical evaluation of cervicogenic headache: a clinical perspective. J Man Manip Ther. 2008;16(2):73-80. DOI 10.1179/106698108790818422.

Hall TM, Briffa K, Hopper D, et al. The relationship between cervicogenic headache and impairment determined by the flexion-rotation test. J Manipulative Physiol Ther. 2010;33(9):666-71. DOI 10.1016/j.jmpt.2010.09.002.

Hobson WH, Shiraki R, Steiner D, Van Horn M. Spinal manipulation vs. amitriptyline for the treatment of chronic tension headache: a randomized clinical trial. J Manipulative Physiol Ther. 1996;19(4):278-9.

Hong J, Ball PA, Fanciullo GJ. Neurostimulation for neck pain and headache. Headache. 2014;54(3):430-44. DOI 10.1111/head.12292.

Hu JW, Sun KQ, Vernon H, et al. Craniofacial inputs to upper cervical dorsal horn: implications for somatosensory information processing. Brain Res. 2005;1044(1):93-106. DOI 10.1016/j.brainres.2005.03.004.

Hubka MJ. Cervicogenic dysfunction in muscle contraction headache and migraine: a descriptive study. J Manipulative Physiol Ther. 1993;16(6):428-31.

Inan N, Ateş Y. Cervicogenic headache: pathophysiology, diagnostic criteria and treatment. Agri. 2005 Oct;17(4):23-30.

James A. Viti, Stanley V. Paris. The use of upper thoracic manipulation in a patient with headache. J Man Manip Ther. 2000;8(1):25.

Jensen S. Neck related causes of headache. Aust Fam Physician. 2005;34(8):635-9.

Jull G, Trott P, Potter H, et al. A randomized controlled trial of exercise and manipulative therapy for cervicogenic headache. Spine (Phila Pa 1976). 2002;27(17):1835-43; discussion 1843. DOI 10.1097/00007632-200209010-00004.

Jull G, Amiri M, Bullock-Saxton J, et al. Cervical musculoskeletal impairment in frequent intermittent headache. Part 1: Subjects with single headaches. Cephalalgia. 2007;27(7):793-802. DOI 10.1111/j.1468-2982.2007.01345.x.

Knackstedt H, Kråkenes J, Bansevicius D, et al. Magnetic resonance imaging of craniovertebral structures: clinical significance in cervicogenic headaches. J Headache Pain. 2012 Jan;13(1):39-44. DOI 10.1007/s10194-011-0387-4.

Kovács A. Nyakcsigolyaeltolódások okozta krónikus fejfájások [Chronic headaches caused by cervical vertebral displacements]. Orv Hetil. 1958;99(33):1139-42. Hungarian.

Kovács A. Subluxation and deformation of the cervical apophyseal joints – a contribution to the aetiology of headache. ACTA Radiol. 1955;43(1):1-16.

Leone M, D'Amico D, Grazzi L, et al. Cervicogenic headache: a critical review of the current diagnostic criteria. Pain. 1998;78(1):1-5. DOI 10.1016/S0304-3959(98)00116-X.

Leone M, D'Amico D, Moschiano F, et al. Possible identification of cervicogenic headache among patients with migraine: an analysis of 374 headaches. Headache. 1995;35(8):461-4. DOI 10.1111/j.1526-4610.1995.hed3508461.x.

Lewit K. Pathomechanismen des zervikalen Kopfschmerzes [Pathomechanisms of cervical headaches]. Psychiatr Neurol Med Psychol (Leipz). 1977 Nov;29(11):661-71. German. PMID: 605187.

Lin LZ, Yu YN, Fan JC, et al. Increased stiffness of the superficial cervical extensor muscles in patients with cervicogenic headache: a study using shear wave elastography. Front Neurol. 2022;13:874643. DOI 10.3389/fneur.2022.874643.

López-Soto PJ, Bretones-García JM, Arroyo-García V, et al. Occipital neuralgia: a noninvasive therapeutic approach. Rev Lat Am Enfermagem. 2018;26:e3067. DOI 10.1590/1518-8345.2621.3067.

Mark BM. Cervicogenic headache differential diagnosis and clinical management: literature review. Cranio. 1990;8(4):332-8. DOI 10.1080/08869634.1990.11682219.

Martelletti P, van Suijlekom H. Cervicogenic headache: practical approaches to therapy. CNS Drugs. 2004;18(12):793-805. DOI 10.2165/00023210-200418120-00004.

May TS, Chronic daily headache linked to prior head or neck injury. Medscape Medical News. American Academy of Neurology 59th Annual Meeting: Session S05.002. Presented May 1, 2007/ http://www.medscape.com/viewarticle/556271_

Medvedeva LA, Avakian GN, Zagorul'ko OI, et al. [Autonomous component in cervicocranial pains and grounds for its pathogenetic treatment]. Zh Nevrol Psikhiatr Im S S Korsakova. 2010;110(12):13-6. Russian. PMID: 21311481.

Meloche JP, Bergeron Y, Bellavance A, et al. Painful intervertebral dysfunction: Robert Maigne's original contribution to headache of cervical origin. Headache 1993;33:328-34.

Meyer PM, Gustowski SM. Osteopathic manipulative treatment to resolve head and neck pain after tooth extraction. J Am Osteopath Assoc. 2012;112(7):457-60.

Michler RP, Bovim G, Sjaastad O. Disorders in the lower cervical spine. A cause of unilateral headache? A case report. Headache. 1991 Sep;31(8):550-1. DOI 10.1111/j.1526-4610.1991.hed3108550.x.

Moustafa IM, Diab A, Shousha T, et l. Does restoration of sagittal cervical alignment improve cervicogenic headache pain and disability: A 2-year pilot randomized controlled trial. Heliyon. 2021;7(3):e06467. DOI 10.1016/j.heliyon.2021.e06467.

Nardone R, Ausserer H, Bratti A, et al. Trigemino-cervical reflex abnormalities in patients with migraine and cluster headache. Headache. 2008 Apr;48(4):578-85. DOI 10.1111/j.1526-4610.2008.00529.x.

Nilsson N, Christensen HW, Hartvigsen J. The effect of spinal manipulation in the treatment of cervicogenic headache. J Manipulative Physiol Ther. 1997;20(5):326-30.

Nilsson N. A randomized controlled trial of the effect of spinal manipulation in the treatment of cervicogenic headache. J Manipulative Physiol Ther. 1995;18(7):435-40.

Nöbel M, Feistel S, Ellrich J. ATP-sensitive muscle afferents activate spinal trigeminal neurons with meningeal afferent input in rat – pathophysiological implications for tension-type headache. J Headache Pain. 2016;17:75. https://doi.org/10.1186/s10194-016-0668-z.

Norton TC, Oakley PA, Harrison DE. Improving the cervical lordosis relieves neck pain and chronic headaches in a pediatric: a Chiropractic Biophysics® (CBP®) case report with a 17-month follow-up. J Phys Ther Sci. 2022;34(1):71-75. DOI 10.1589/jpts.34.71.

Page P. Cervicogenic headaches: an evidence-led approach to clinical management. Int J Sports Phys Ther. 2011;6(3):254-66.

Park SK, Yang DJ, Kim JH, et al. Analysis of mechanical properties of cervical muscles in patients with cervicogenic headache. J Phys Ther Sci. 2017;29(2):332-335. DOI 10.1589/jpts.29.332.

Pöllmann W, Keidel M, Pfaffenrath V. Kopfschmerzen und die Halswirbelsäule. Eine kritische Ubersicht [Headache and the cervical spine. A critical review]. Nervenarzt. 1996;67(10):821-36. German. DOI 10.1007/s001150050060.

Rana MV. Managing and treating headache of cervicogenic origin. Med Clin North Am. 2013 Mar;97(2):267-80. DOI 10.1016/j.mcna.2012.11.003.

Rome P. Waterhouse JD. Neurodynamics of vertebrogenic somatosensory activation and Autonomic Reflexes - a review: Part 9 Cervicogenic headaches. Asia-Pacific Chiropr J. 2021;1.4. apcj.net/papers-issue-2-4/#RomeWaterhouseCervicogenicHeadaches.

Rubio-Ochoa J, Benítez-Martínez J, Lluch E, et al. Physical examination tests for screening and diagnosis of cervicogenic headache: A systematic review. Man Ther. 2016;21:35-40. DOI 10.1016/j.math.2015.09.008.

Shivachev Y, Dimitrov A. Chiropractic as a system of manual techniques. Varna Medical Forum. 2021;10(2):133-136. DOI: http://dx.doi.org/10.14748/vmf.v10i2.7890 and https://journals.mu-varna.bg/index.php/vmf/article/view/7890.

Sillevis R, Shamus E, Regalado P, et al. Correlation and reliability of the atlas position on x-ray in subjects with and without cervicogenic headache: A retrospective study. Annals Med Surg Case Reports. 2021;3(1):1-7.

Sillevis R, Wyss K. The management of a positional default of atlas in a patient with cervicogenic headache: A case report. Clinical Case Studies. 2015;1(10):218-23.

Sjaastad O, Bovim G. Cervicogenic headache. The differentiation from common migraine. An overview. Funct Neurol. 1991;6(2):93-100.

Sjaastad O, Fredriksen T, Pareja JA, et al. Coexistence of cervicogenic headache and migraine without aura (?). Funct Neurol. 1999;14(4):209-18.

Stovner LJ, Kolstad F, Helde G. Radiofrequency denervation of facet joints C2-C6 in cervicogenic headache: a randomized, double-blind, sham-controlled study. Cephalalgia. 2004;24(10):821-30. DOI 10.1111/j.1468-2982.2004.00773.x.

Tuchin PJ. A case of chronic migraine remission after chiropractic care. J Chiropr Med. 2008;7(2):66-70. DOI 10.1016/j.jcme.2008.02.001.

van Duijn J, van Duijn AJ, Nitsch W. Orthopaedic manual physical therapy including thrust manipulation and exercise in the management of a patient with cervicogenic headache: a case report. J Man Manip Ther. 2007;15(1):10-24. DOI 10.1179/106698107791090114.

van Suijlekom JA, de Vet HC, van den Berg SG, et al. Interobserver reliability of diagnostic criteria for cervicogenic headache. Cephalalgia. 1999;19(9):817-23. DOI 10.1046/j.1468-2982.1999.1909817.x.

Vernon H, Steiman I, Hagino C. Cervicogenic dysfunction in muscle contraction headache and migraine: a descriptive study. J Manipulative Physiol Ther. 1992;15(7):418-29.

Vernon HT. The effectiveness of chiropractic manipulation in the treatment of headache: an exploration in the literature. J Manipulative Physiol Ther. 1995;18(9):611-7.

Vernon HT. Spinal manipulation and headaches of cervical origin. J Manipulative Physiol Ther. 1989;12(6):455-68.

Vernon H, Jansz G, Goldsmith CH, et al. A randomized, placebo-controlled clinical trial of chiropractic and medical prophylactic treatment of adults with tension-type headache: results from a stopped trial. J Manipulative Physiol Ther. 2009;32(5):344-51. DOI 10.1016/j.jmpt.2009.04.004. Erratum in: J Manipulative Physiol Ther. 2009;32(9):804.

Vincent MB. Cervicogenic headache: clinical aspects. Clin Exp Rheumatol. 2000;18(2 Suppl 19):S7-10.

Vincent MB. Cervicogenic headache: a review comparison with migraine, tension-type headache, and whiplash. Curr Pain Headache Rep. 2010;14(3):238-43. DOI 10.1007/s11916-010-0114-x.

Vincent MB. Cervicogenic headache: the neck is a generator: con. Headache. 2010;50(4):706-9. DOI 10.1111/j.1526-4610.2010.01643.x.

Vincent MB. Headache and neck. Curr Pain Headache Rep. 2011;15(4):324-31. DOI 10.1007/s11916-011-0195-1.

Vincent M, Bovim G. Cefaléia cervicogênica: relato de um caso [Cervicogenic headache: report of a case]. Arq Neuropsiquiatr. 1991 Mar;49(1):95-101. Portuguese. DOI 10.1590/s0004-282x1991000100015.

Wagner FM. Die somatische Dysfunktion der Halswirbelsäule und ihr komplexes klinisches Bild : Grundlagen der manualmedizinischen Diagnostik von Zervikobrachialgie und zervikozephalem Syndrom [Somatic dysfunction of the cervical spine and its complex clinical picture : The fundamentals of diagnostics of cervicobrachialgia and cervicocephalic syndrome through manual medicine]. Orthopade. 2022;51(4):263-273.

Watson DH, Drummond PD. Head pain referral during examination of the neck in migraine and tension-type headache. Headache. 2012;52(8):1226-35. DOI 10.1111/j.1526-4610.2012.02169.x.

Weber Hellstenius SA. Recurrent neck pain and headaches in preadolescents associated with mechanical dysfunction of the cervical spine: a cross-sectional observational study with 131 students. J Manipulative Physiol Ther. 2009;32(8):625-34. DOI 10.1016/j.jmpt.2009.08.025.

West J, Phillips RB. Chiropractic management of a patient with persistent headache. J Chiropr Med. 2013;12(4):281-7. DOI 10.1016/j.jcm.2013.08.006.

Whittingham W, Ellis WB, Molyneux TP. The effect of manipulation (toggle recoil technique) for headaches with upper cervical joint dysfunction: a pilot study. J Manipulative Physiol Ther. 1994;17(6):369-75.

Yi X, Cook AJ, Hamill-Ruth RJ. Cervicogenic headache in patients with presumed migraine: missed diagnosis or misdiagnosis? J Pain. 2005;6(10):700-3. DOI 10.1016/j.jpain.2005.04.005.

Zito G, Jull G, Story I. Clinical tests of musculoskeletal dysfunction in the diagnosis of cervicogenic headache. Man Ther. 2006;11(2):118-29. DOI 10.1016/j.math.2005.04.007.

Headaches

Cervicogenic migraine

'Neck pain is a frequent complaint among patients with migraine. The heterogeneity among the studies emphasize important aspects to consider in future research of neck pain in migraine to improve our understanding of the driving mechanisms of neck pain in a major group of migraine patients.' (Al Khazali et al, 2022)

Al-Khazali HM, Younis S, Al-Sayegh Z, et al. Prevalence of neck pain in migraine: A systematic review and meta-analysis. Cephalalgia. 2022;42(7):663-73. DOI 10.1177/03331024211068073.

Anarte E, Ferreira Carvalho G, et al. Can physical testing be used to distinguish between migraine and cervicogenic headache sufferers? A protocol for a systematic review. BMJ Open. 2019 Nov 10;9(11):e031587. DOI 10.1136/bmjopen-2019-031587.

Anarte-Lazo E, Carvalho GF, Schwarz A, et al. Differentiating migraine, cervicogenic headache and asymptomatic individuals based on physical examination findings: a systematic review and meta-analysis. BMC Musculoskelet Disord. 2021;22(1):755. DOI 10.1186/s12891-021-04595-w.

Antonaci F, Rossi E, Voiticovschi-Iosob C, et al. Frontal infrared thermography in healthy individuals and chronic migraine patients: reliability of the method. Cephalalgia. 2019;39(4):489-96.

Ashina S, Bendtsen L, Lyngberg AC, et al. Prevalence of neck pain in migraine and tension-type headache: a population study. Cephalalgia. 2015;35(3):211-9. DOI 10.1177/0333102414535110.

Avnon Y, Nitzan M, Sprecher E, et al. Autonomic asymmetry in migraine: augmented parasympathetic activation in left unilateral migraineurs. Brain. 2004;127(9): 2099–2108. https://doi.org/10.1093/brain/awh236.

Bartsch T. Migraine and the neck – new insights from basic data. Curr Pain Heacache Rep. 2005;9(3):191-6.

Bartsch T, Goadsby PJ. Central mechanisms of peripheral nerve stimulation in headache disorders. Prog Neurol Surg. 2011;24:16-26. DOI 10.1159/000323008.

Carvalho GF, Luedtke K, Pinheiro CF, et al. Migraine with aura is related to delayed motor control reaction and imbalance following external perturbations. Front Neurol. 2021;12:755990. DOI 10.3389/fneur.2021.755990.

Carvalho GF, Schwarz A, Szikszay TM, et al. Physical therapy and migraine: musculoskeletal and balance dysfunctions and their relevance for clinical practice. Brazilian J Physical Therapy. 2020; 24(4):306-17.

Cattley P, Tuchin PJ. Chiropractic management of migraine without aura. A case study. Australas Chiropr Osteopathy. 1999;8(3):85-90.

Chaibi A, Tuchin PJ. Chiropractic spinal manipulative treatment of migraine headache of 40-year duration using Gonstead method: a case study. J Chiropr Med. 2011;10(3):189-93. DOI 10.1016/j.jcm.2011.02.002.

Hubka MJ. Cervicogenic dysfunction in muscle contraction headache and migraine: a descriptive study. J Manipulative Physiol Ther. 1993;16(6):428-31.

Liang Z, Galea O, Thomas L, Jet al. Cervical musculoskeletal impairments in migraine and tension type headache: A systematic review and meta-analysis. Musculoskelet Sci Pract. 2019 Jul;42:67-83. DOI 10.1016/j.msksp.2019.04.007.

Liang Z, Thomas L, Jull G, et al. Cervical musculoskeletal impairments in migraine. Arch Physiother. 2021 Dec 8;11(1):27. DOI 10.1186/s40945-021-00123-0.

Nardone R, Ausserer H, Bratti A, et al. Trigemino-cervical reflex abnormalities in patients with migraine and cluster headache. Headache. 2008 Apr;48(4):578-85. DOI 10.1111/j.1526-4610.2008.00529.x.

Nelson CF, Bronfort G, Evans R, et al. The efficacy of spinal manipulation, amitriptyline and the combination of both therapies for the prophylaxis of migraine headache. J Manipulative Physiol Ther. 1998;21(8):511-9.

Rodrigo D, Acin P, Bermejo P. Occipital nerve stimulation for refractory chronic migraine: results of a long-term prospective study. Pain Physician. 2017;20(1):E151-E159.

Satpute K, Bedekar N, Hall T. Headache symptom modification: the relevance of appropriate manual therapy assessment and management of a patient with features of migraine and cervicogenic headache - a case report. J Man Manip Ther. 2020;28(3):181-8. DOI 10.1080/10669817.2019.1662637.

Schwarz A, Luedtke K, Schöttker-Königer T. Only cervical vertebrae C0-C2, not C3 are relevant for subgrouping migraine patients according to manual palpation and pain provocation: secondary analysis of a cohort study. BMC Musculoskelet Disord. 2022 Apr 22;23(1):379. DOI 10.1186/s12891-022-05329-2.

Sjaastad O, Bovim G. Cervicogenic headache. The differentiation from common migraine. An overview. Funct Neurol. 1991;6(2):93-100.

Sjaastad O, Fredriksen T, Pareja JA, et al. Coexistence of cervicogenic headache and migraine without aura (?). Funct Neurol. 1999;14(4):209-18.

Tuchin PJ. A case of chronic migraine remission after chiropractic care. J Chiropr Med. 2008;7(2):66-70. DOI 10.1016/j.jcme.2008.02.001.

Vernon H, Steiman I, Hagino C. Cervicogenic dysfunction in muscle contraction headache and migraine: a descriptive study. J Manipulative Physiol Ther. 1992;15(7):418-29.

Vincent MB. Cervicogenic headache: a review comparison with migraine, tension-type headache, and whiplash. Curr Pain Headache Rep. 2010;14(3):238-43. DOI 10.1007/s11916-010-0114-x.

Watson DH, Drummond PD. Cervical referral of head pain in migraineurs: effects on the nociceptive blink reflex. Headache. 2014;54(6):1035-45. DOI 10.1111/head.12336..

Watson DH, Drummond PD. Head pain referral during examination of the neck in migraine and tension-type headache. Headache. 2012;52(8):1226-35. DOI 10.1111/j.1526-4610.2012.02169.x.

Yi X, Cook AJ, Hamill-Ruth RJ, et al Cervicogenic headache in patients with presumed migraine: missed diagnosis or misdiagnosis? J Pain. 2005;6(10):700-3. DOI 10.1016/j.jpain.2005.04.005.

Neurological conditions

Cordano C, Armezzani A, Veroni J, et al. Osteopathic Manipulative Therapy and Multiple Sclerosis: A Proof-of-Concept Study. J Am Osteopath Assoc. 2018;118(8):531-536. DOI 10.7556/jaoa.2018.121.

Flanagan MF. The role of the craniocervical junction in craniospinal hydrodynamics and neurodegenerative conditions. Neurol Res Int. 2015;2015:794829.

Halimi M, Leder A, Mancini JD. Integration of osteopathic manual treatments in management of cervical dystonia with tremor: A case series. Tremor Other Hyperkinet Mov (N Y). 2017;7:435. DOI 10.7916/D8NP24XB.

Rajaii RM, Cox GJ, Schneider RP. Role of osteopathic manipulative treatment in the management of stiff person syndrome. J Am Osteopath Assoc. 2015;115(6):394-8. DOI 10.7556/jaoa.2015.081.

Terrell ZT, Moudy SC, Hensel KL, et al. Effects of osteopathic manipulative treatment vs. osteopathic cranial manipulative medicine on Parkinsonian gait. J Osteopath Med. 2022;122(5):243-251. DOI 10.1515/jom-2021-0203.

Wolf K, Krinard T, Talsma J, et al. OMT for patients with multiple sclerosis. J Am Osteopath Assoc. 2017;117(12):e141. DOI 10.7556/jaoa.2017.153.

Obstetrics and gynaecology

' ....women who consulted with a chiropractor or consumed herbal teas were less likely to report a premature birth.... ' (Steel et al, 2014)

Pierce LM, Reyes M, Thor KB, Dolber PC, Bremer RE, Kuehl TJ, Coates KW. Immunohistochemical evidence for the interaction between levator ani and pudendal motor neurons in the coordination of pelvic floor and visceral activity in the squirrel monkey. Am J Obstet Gynecol. 2005;192(5):1506-15. DOI 10.1016/j.ajog.2004.10.607.

Rapkin AJ. Vasomotor symptoms in menopause: physiologic condition and central nervous approaches to treatment. Am J Obstet Gynecol 2007;196(2):97-106.

Ruffini N, D'Alessandro G, Pimpinella A, et al. The role of osteopathic care in gynaecology and obstetrics: an updated systematic review. Healthcare (Basel). 2022;10(8):1566. DOI 10.3390/healthcare10081566.

Siccardi M, Valle C. Uterine artery impedence changes after vertebral manipulation techniques on the lumbosacral junction: a randomized controlled pilot trial in non-pregnant women. XIII World Congress of Perinatal Medicine. Belgrade Oct 26-29, 2017.

Tettambel MA. An osteopathic approach to treating women with chronic pelvic pain. J Am Osteopath Assoc. 2005;105(9 Suppl 4):S20-2.

Pregnancy

'Chiropractic care is a commonly used treatment modality for musculoskeletal pain in pregnancy. Low back pain, pelvic pain, and other neuromuscular complaints are prevalent in pregnancy and contribute to significant maternal discomfort in many women……. This article provides an evidence-based review of the epidemiology of chiropractic use in obstetrics, commonly treated conditions, related physiology of pregnancy, and safety of spinal manipulation.' (Conner et al. 2021)

Chang WC, Livneh H, Yen CT, et al Decreased risk of low back pain during pregnancy associated with the use of orthopedic manual therapy: a nested case-control study. Front Med (Lausanne). 2022;9:887877. DOI 10.3389/fmed.2022.887877.

Conner SN, Trudell AS, Conner CA. Chiropractic care for the pregnant body. Clin Obstet Gynecol. 2021;64(3):602-10.

Franke H, Franke JD, Belz S, et al. Osteopathic manipulative treatment for low back and pelvic girdle pain during and after pregnancy: A systematic review and meta-analysis. J Bodyw Mov Ther. 2017;21(4):752-762. DOI 10.1016/j.jbmt.2017.05.014.

Hall H, Cramer H, Sundberg T, et al. The effectiveness of complementary manual therapies for pregnancy-related back and pelvic pain: A systematic review with meta-analysis. Medicine (Baltimore). 2016;95(38):e4723.

Hastings V, McCallister AM, Curtis SA, et al. Efficacy of osteopathic manipulative treatment for management of postpartum pain. J Am Osteopath Assoc. 2016;116(8):502-9. DOI 10.7556/jaoa.2016.103.

Hensel KL, Buchanan S, Brown SE, et al. Pregnancy research on osteopathic manipulation optimizing treatment effects: the PROMOTE study, Am J Obstetrics Gynec. 2015;212(1):108.e1-108.e9. ISSN 0002-9378. https://doi.org/10.1016/j.ajog.2014.07.043.

Khorsan R, Hawk C, Lisi AJ, Kizhakkeveettil A. Manipulative therapy for pregnancy and related conditions: a systematic review. Obstet Gynecol Surv. 2009;64(6):416-27. DOI 10.1097/OGX.0b013e31819f9ddf.

Kramp ME. Combined manual therapy techniques for the treatment of women with infertility: a case series. J Am Osteopath Assoc. 2012;112(10):680-4.

Lavelle JM. Osteopathic manipulative treatment in pregnant women. J Am Osteopath Assoc. 2012;112(6):343-6. DOI 10.7556/jaoa.2012.112.6.343.

Martingano D, Canepa H, Fararooy S, et al. Somatic dysfunction in the diagnosis of uncommon ectopic pregnancies: surgical correlation and comparison with related pathologic findings. J Am Osteopath Assoc. 2017;117(2):86-97. DOI 10.7556/jaoa.2017.019.

Oswald C, Higgins CC, Assimakopoulos D. Optimizing pain relief during pregnancy using manual therapy. Can Fam Physician. 2013;59(8):841-2.

Ruffo A, Blumer J. Reducing Caesarean delivery rates and length of labor by addressing pelvic shape. J Am Osteopath Assoc. 2018;118(7):489-90.

Schwerla F, Rother K, Rother D, et al. Osteopathic manipulative therapy in women with postpartum low back pain and disability: a pragmatic randomized controlled trial. J Am Osteopath Assoc. 2015 Jul;115(7):416-25.

Smith M, Galbraith W, Blumer J. Reducing low back and posterior pelvic pain during and after pregnancy using OMT. J Am Osteopath Assoc. 2018 Jul 1;118(7):487-8. DOI 10.7556/jaoa.2018.108.

Steel A, Adams J, Sibbritt D, Broom A, et al. Relationship between complementary and alternative medicine use and incidence of adverse birth outcomes: an examination of a nationally representative sample of 1835 Australian women. Midwifery. 2014;30(12):1157-65. DOI 10.1016/j.midw.2014.03.015.

Steel A, Adams J, Sibbritt D, et al. The influence of complementary and alternative medicine use in pregnancy on labor pain management choices: results from a nationally representative sample of 1,835 women. J Altern Complement Med. 2014;20(2):87-97.

Uchida S,Kagitani FJ. Autonomic nervous regulation of ovarian function by noxious somatic afferent stimulation. J Physiol Sci. 2015;65(1):1-9.

Uchida S, Kagitani F, Hotta H, et al Cutaneous mechanical stimulation regulates ovarian blood flow via activation of spinal and supraspinal reflex pathways in anesthetized rats. Jpn J Physiol. 2005;55(5):265-77. https://www.jstage.jst.go.jp/article/jjphysiol/advpub/0/advpub_0_0510310014/_pdf.

Weis CA, Pohlman K, Draper C, det al. Chiropractic Care for Adults With Pregnancy-Related Low Back, Pelvic Girdle Pain, or Combination Pain: A Systematic Review. J Manipulative Physiol Ther. 2020;43(7):714-731. DOI 10.1016/j.jmpt.2020.05.005.

Zerdecki L, Passmore S. Chiropractic evaluation and management of the pregnant patient: an update from recent literature. Midwifery Today Int Midwife. 2008;(87):28-9, 67-8.

Dysmenorrhea

'Manipulative therapy could be considered as adjunct therapy in the relief of pain in primary dysmenorrhea.' (Abaraoqu et al, 2017)

Abaraogu UO, Igwe SE, Tabansi-Ochiogu CS, et al. A systematic review and meta-analysis of the efficacy of manipulative therapy in women with primary dysmenorrhea. Explore (NY). 2017;13(6):386-92.

Arumugam A, Milosavljevic S, Woodley S, et al. Effects of external pelvic compression on form closure, force closure, and neuromotor control of the lumbopelvic spine--a systematic review. Man Ther. 2012;17(4):275-84.

Barassi G, Bellomo RG, Porreca A, et al. Somato-Visceral effects in the treatment of dysmenorrhea: neuromuscular manual therapy and standard pharmacological treatment. J Altern Complement Med. 2018;24(3):291-299. DOI 10.1089/acm.2017.0182.

Brennan PC. The effect of spinal manipulation on pain and prostaglandin levels in dysmenorrheic women with primary dysmenorrhea. J Manipulative Physiol Ther 1992;15(5):279-85.

Chapman JD. Progress in scientifically proving the benefits of OMT in treating symptoms of dysmenorrhea. J Am Osteopath Assoc. 1993;93(2):196.

Emo A, Blumer J. Neuromuscular manipulation improves pain intensity and duration in primary dysmenorrhea. J Am Osteopath Assoc. 2018 ;118(7):488-89. DOI 10.7556/jaoa.2018.109.

Gurav R, Nahar S. Effect of lumbar spine manipulation on menstrual distress. Int J Physioth Res, 2020;8(2):3389-93.

Hellman KM, Datta A, Steiner ND, et al. Identification of experimental bladder sensitivity among dysmenorrhea sufferers. Am J Obstet Gynecol. 2018;219(1):84.e1-84.e8.

Holtzman DA, Petrocco-Napuli KL, Burke JR. Prospective case series on the effects of lumbosacral manipulation on dysmenorrhea. J Manipulative Physiol Ther. 2008;31(3):237-46. DOI 10.1016/j.jmpt.2008.02.005.

Molins-Cubero S, Rodríguez-Blanco C, Oliva-Pascual-Vaca A, et al. Changes in pain perception after pelvis manipulation in women with primary dysmenorrhea: a randomized controlled trial. Pain Med. 2014;15(9):1455-63. DOI 10.1111/pme.12404.

Moloney S, Talsma J, Pierce-Talsma S. Osteopathic manipulative medicine considerations in pelvic pain. J Am Osteopath Assoc. 2019;119(11):e42-e43. DOI 10.7556/jaoa.2019.130.

Najafi S, Sanati E, Rezaei-Moghaddam F, et al. Evaluating efficacy of spinal manipulation on primary dysmenorrhea. J Physical Med Rehab Electrodiag. 2019;1(4): 156-64. DOI https://doi.org/10.22122/pmre.v1i4.26.

Origo D, Piloni S, Tarantino AG. Secondary dysmenorrhea and dyspareunia associated with pelvic girdle dysfunction: A case report and review of literature. J Bodyw Mov Ther. 2021;27:165-168. DOI 10.1016/j.jbmt.2021.03.013.

Özgül S, Üzelpasaci E, Orhan C, et al. Short-term effects of connective tissue manipulation in women with primary dysmenorrhea: A randomized controlled trial. Complement Ther Clin Pract. 2018;33:1-6.

Park S-G, Song S-H, Jung J-H, et al. The effect of sacroiliac joint manual therapy on heart rate viability in women with primary dysmenorrhea. Phys Ther Rehab Sci. 2020;9:252-60. https://www.jptrs.org/journal/view.html?doi=10.14474/ptrs.2020.9.4.252

Respiratory

'Results of this study indicate that there are afferent fibers in the phrenic nerve above the heart, but not below the heart, that excite cells in the C1-C2 segments of the spinal cord. Most cells also were excited by noxious stimuli applied to their somatic receptive fields. Thus, the phrenic nerve may provide a pathway for referral of pain to the neck and jaw from thoracic structures.' (Razook et al, 1995)

Previous studies show that the respiratory movement pattern or phrenic nerve activity are reflexively changed by cutaneous and muscle afferents, which are processed at the spinal level and do not involve supraspinal sites. (Decima & Von Euler, 1969; Eldridge et al; 1981; Koizumi et al, 1961; Remmers, 1970) '*TRINs* [Thoracic Respiratory Interneuron] *receiving peripheral proprioreceptive and noxious somatic inputs could play a role in respiratory proprioreceptive reflexes and spinal processing of noxious information*.' (Qin et al, 2002, p. 2219)

Respiratory Function/Dysfunction

Bordoni B, Marelli F, Morabito B, Sacconi B. Manual evaluation of the diaphragm muscle. Int J Chron Obstruct Pulmon Dis. 2016;11:1949-56.

Dağ F, Taş S, Çimen ÖB. Pulmonary functions in patients with chronic neck pain: a case-control study. J Manipulative Physiol Ther. 2022:S0161-4754(22)00091-4. DOI 10.1016/j.jmpt.2022.07.002.

Dimitriadis Z, Kapreli E, Strimpakos N, et al. Pulmonary function of patients with chronic neck pain: a spirometry study. Respir Care. 2014 Apr;59(4):543-9. DOI 10.4187/respcare.01828.

Dimitriadis Z, Kapreli E, Strimpakos N, et al Respiratory dysfunction in patients with chronic neck pain: What is the current evidence? J Bodyw Mov Ther. 2016;20(4):704-14. DOI 10.1016/j.jbmt.2016.02.001.

Engel R, Grace S, Broadbent S. The effect of manual therapy and exercise on age-related lung function: study protocol for a randomised controlled trial. Trials. 2019;20(1):163. DOI 10.1186/s13063-019-3257-z.

Fernández-López I, Peña-Otero D, Atín-Arratibel MLÁ, et al. Effects of manual therapy on the diaphragm in the musculoskeletal system: A systematic review. Arch Phys Med Rehabil. 2021;102(12):2402-15. DOI 10.1016/j.apmr.2021.03.031.

Fırat T, Sağlam M, Vardar Yağlı N, et al. Acute effects of manual therapy on respiratory parameters in thoracic outlet syndrome. Turk Gogus Kalp Damar Cerrahisi Derg. 2019;27(1):101-6.

Kahlaee AH, Ghamkhar L, Arab AM. The association between neck pain and pulmonary function: a systematic review. Am J Phys Med Rehabil. 2017;96(3):203-10.

Kapreli E, Vourazanis E, Billis E, et al. Respiratory dysfunction in chronic neck pain patients. A pilot study. Cephalalgia. 2009;29(7):701-10. DOI 10.1111/j.1468-2982.2008.01787.x.

Kapreli E, Vourazanis E, Strimpakos N. Neck pain causes respiratory dysfunction. Med Hypotheses. 2008;70(5):1009-13. DOI 10.1016/j.mehy.2007.07.050.

Lima IS, Florêncio de Moura Filho O, et al. Chest and neck mobilization effects on spirometric responses in healthy subjects. J Manipulative Physiol Ther. 2011;34(9):622-6. DOI 10.1016/j.jmpt.2011.08.004.

López-de-Uralde-Villanueva I, Sollano-Vallez E, Del Corral T. Reduction of cervical and respiratory muscle strength in patients with chronic nonspecific neck pain and having moderate to severe disability. Disabil Rehabil. 2018;40(21):2495-2504. DOI 10.1080/09638288.2017.1337239.

McGuiness, J. Vicenzino, B, Wright, A. Influence of a cervical mobilization technique on respiratory and cardiovascular function. Man Ther. 1997;2:216-20.

Qin C, Chandler MJ, Foreman RD, et al. Upper thoracic respiratory interneurons integrate noxious somatic and visceral information in rats. J Neurophysiol. 2002;88(5):2215-23. DOI 10.1152/jn.00120.2002.

Razook JC, Chandler MJ, Foreman RD. Phrenic afferent input excites C1-C2 spinal neurons in rats. Pain. 1995;63(1):117-125. DOI 10.1016/0304-3959(95)00026-O.

Stępnik J, Kędra A, Czaprowski D. Short-term effect of osteopathic manual techniques (OMT) on respiratory function in healthy individuals. PLoS One. 2020 ;15(6):e0235308. DOI 10.1371/journal.pone.0235308.

Swender DA, Thompson G, Schneider K, et al. Osteopathic manipulative treatment for inpatients with pulmonary exacerbations of cystic fibrosis: effects on spirometry findings and patient assessments of breathing, anxiety, and pain. J Am Osteopath Assoc. 2014;114(6):450-8.

Tatsios PI, Grammatopoulou E, Dimitriadis Z, et al. The effectiveness of spinal, diaphragmatic, and specific stabilization exercise manual therapy and respiratory-related interventions in patients with chronic nonspecific neck pain: systematic review and meta-analysis. Diagnostics (Basel). 2022;12(7):1598.

Vicenzino, B, Cartwright, T, Collins, D, et al. Cardiovascular and respiratory changes produced by lateral glide mobilization of the cervical spine. Man Ther. 1998;3:67–71

Wirth B, Amstalden M, Perk M, et al. Respiratory dysfunction in patients with chronic neck pain - influence of thoracic spine and chest mobility. Man Ther. 2014;19(5):440-4.

Asthma

'Finally, the evidence for a significant role for nociceptors in triggering inflammation and in the pathophysiology of some diseases (for example, arthritis, asthma) is reviewed.' (Bruce 1996)

Balon J, Aker PD, Crowther ER, et al. A comparison of active and simulated chiropractic manipulation as adjunctive treatment for childhood asthma. N Engl J Med. 1998;339(15):1013-20. DOI 10.1056/NEJM199810083391501.

Blum CL. Role of chiropractic and sacro-occipital technique in asthma treatment. J Chiropr Med. 2002;1(1):16-22. DOI 10.1016/S0899-3467(07)60023-8.

Bockenhauer SE, Julliard KN, Lo KS, et al. Quantifiable effects of osteopathic manipulative techniques on patients with chronic asthma. J Am Osteopath Assoc. 2002;102(7):371-5; discussion 375.

Bronfort G, Evans RL, Kubic P, et al. Chronic pediatric asthma and chiropractic spinal manipulation: a prospective clinical series and randomized clinical pilot study. J Manipulative Physiol Ther. 2001;24(6):369-77.

Bruce L. Efferent function of nociceptors. In: Belmonte C, Cervero F. Eds. Neurobiology of Nociceptors. Oxford: Oxford Academic. 1996. online edn, 22 Mar. 2012. https://doi.org/10.1093/acprof:oso/9780198523345.003.0017.

Guiney PA, Chou R, Vianna A, et al. Effects of osteopathic manipulative treatment on pediatric patients with asthma: a randomized controlled trial. J Am Osteopath Assoc. 2005;105(1):7-12.

Heneghan NR, Adab P, Balanos GM, et al. Manual therapy for chronic obstructive airways disease: a systematic review of current evidence. Man Ther. 2012;17(6):507-18. DOI 10.1016/j.math.2012.05.004.

Kukurin GW. Chronic pediatric asthma and chiropractic spinal manipulation: a prospective clinical series and randomized clinical pilot study. J Manipulative Physiol Ther. 2002;25(8):540-1. DOI 10.1067/mmt.2002.127067.

Nielsen NH, Bronfort G, Bendix T, et al. Chronic asthma and chiropractic spinal manipulation: a randomized clinical trial. Clin Exp Allergy. 1995;25(1):80-8. DOI 10.1111/j.1365-2222.1995.tb01006.x.

COAD/COPD

'Combined application of MET (Muscle Energy Technique) to accessory respiratory muscles and cervical spine and to thoracic spine improved pulmonary functions, chest wall mobility, and health-related quality of life and reduced dyspnea and disease exacerbations in patients with mild to moderate COPD.' (Bains et al, 2022)

Bains D, Chahal A, Shaphe MA, et al Effects of muscle energy technique and joint manipulation on pulmonary functions, mobility, disease exacerbations, and health-related quality of life in chronic obstructive pulmonary disease patients: a quasiexperimental study. Biomed Res Int. 2022;2022:5528724. DOI 10.1155/2022/5528724.

Beal MC, Morlock JW. Somatic dysfunction associated with pulmonary disease. J Am Osteopath Assoc. 1984;84(2):179-83.

Bordoni B. Lymphatic pump manipulation in patients with chronic obstructive pulmonary disease. Cureus. 2019;11(3):e4232. DOI 10.7759/cureus.4232.

Cirak Yb, Yilmaz Yelvar GD, Durustkan Elbasi N. Effectiveness of 12-week inspiratory muscle training with manual therapy in patients with COPD: A randomized controlled study. Clin Respir J. 2022;16(4):317-328. DOI 10.1111/crj.13486.

Dougherty PE, Engel RM, Vemulpad S, et al. Spinal manipulative therapy for elderly patients with chronic obstructive pulmonary disease: a case series. J Manipulative Physiol Ther. 2011;34(6):413-7. DOI 10.1016/j.jmpt.2011.05.004.

Engel RM, Gonski P, Beath K, et al. Medium term effects of including manual therapy in a pulmonary rehabilitation program for chronic obstructive pulmonary disease (COPD): a randomized controlled pilot trial. J Man Manip Ther. 2016;24(2):80-9. DOI 10.1179/2042618614Y.0000000074.

Engel RM, Vemulpad SR, Beath K. Short-term effects of a course of manual therapy and exercise in people with moderate chronic obstructive pulmonary disease: a preliminary clinical trial. J Manipulative Physiol Ther. 2013;36(8):490-6. DOI 10.1016/j.jmpt.2013.05.028.

Engel RM, Wearing J, Gonski P, et al. The effect of combining manual therapy with exercise for mild chronic obstructive pulmonary disease: study protocol for a randomised controlled trial. Trials. 2017;18(1):282. DOI 10.1186/s13063-017-2027-z.

Roh JA, Kim KI, Jung HJ. The efficacy of manual therapy for chronic obstructive pulmonary disease: A systematic review. PLOS ONE 2021;16(5): e0251291. https://doi.org/10.1371/journal.pone.0251291

Noll DR, Degenhardt BF, Johnson JC, et al. Immediate effects of osteopathic manipulative treatment in elderly patients with chronic obstructive pulmonary disease. J Am Osteopath Assoc. 2008;108(5):251-9.

Wearing J, Beaumont S, Forbes D, et al. The use of spinal manipulative therapy in the management of chronic obstructive pulmonary disease: a systematic review. J Altern Complement Med. 2016;22(2):108-14.

Zanotti E, Berardinelli P, Bizzarri C, et al. Osteopathic manipulative treatment effectiveness in severe chronic obstructive pulmonary disease: a pilot study. Complement Ther Med. 2012;20(1-2):16-22. DOI 10.1016/j.ctim.2011.10.008.

Respiratory examination

Bordoni B, Escher AR. Palpation of the respiratory system in osteopathic manual medicine: from the trachea to the lungs. Cureus. 2021 Sep 17;13(9):e18059.

Influenza

Baroni F, Mancini D, Tuscano SC, et al. Osteopathic manipulative treatment and the Spanish flu: a historical literature review. J Osteopath Med. 2021;121(2):181-190.

Mueller DM. The 2012-2013 influenza epidemic and the role of osteopathic manipulative medicine. J Am Osteopath Assoc. 2013;113(9):703-7.

Whooping cough

Liem T. Osteopathic manipulative treatment for pertussis in the 19th and 20th Centuries: A structured historical literature review. J Am Osteopath Assoc. 2019;119(2):116-25. DOI 10.7556/jaoa.2019.018.

Pneumonia

Noll DR, Degenhardt BF, Fossum C, et al. Clinical and research protocol for osteopathic manipulative treatment of elderly patients with pneumonia. J Am Osteopath Assoc. 2008;108(9):508-16. Erratum in: J Am Osteopath Assoc. 2008;108(11):670.

Noll DR, Degenhardt BF, Johnson JC. Multicenter osteopathic pneumonia study in the elderly: subgroup analysis on hospital length of stay, ventilator-dependent respiratory failure rate, and in-hospital mortality rate. J Am Osteopath Assoc. 2016;116(9):574-87. DOI 10.7556/jaoa.2016.117.

Noll DR, Shores J, Bryman PN, et al. Adjunctive osteopathic manipulative treatment in the elderly hospitalized with pneumonia: a pilot study. J Am Osteopath Assoc. 1999;99(3):143-6, 151-2. DOI 10.7556/jaoa.1999.99.3.143.

Yao S, Hassani J, Gagne M, et al. Osteopathic manipulative treatment as a useful adjunctive tool for pneumonia. J Vis Exp. 2014;(87):50687. DOI 10.3791/50687.

Yang M, Yan Y, Yin X, et al. Chest physiotherapy for pneumonia in adults. Cochrane Database Syst Rev. 2013;(2):CD006338. DOI 10.1002/14651858.CD006338.pub3.)

Acupuncture & Chinese orthopaedic manipulation

A somatovisceral model

Like spinal manipulation, the somatovisceral model of acupuncture would appear to have an afferent and an efferent element directed through somato-autonomic, somatosensory and somatovisceral reflex physiology. As it is also ultimately directed at signs and symptoms, it is classified here as an efferent reflex. (Takeshige et al, 1992; Cheng, 2014; Yu et al, 2014; Langren 2020)

Of interest is the apparent association of acupuncture as a positive therapy for a range of conditions including functional dyspepsia. (Han et al, 2014; Kim et al, 2015; Ko et al, 2016; Hong et al, 2017) The title of the paper by Hong et al suggests that it has an association with manipulation, is manual, and has somatovisceral considerations.

Chen CY, Chern RS, Liao MH, et al. The possible neuronal mechanism of acupuncture: morphological evidence of the neuronal connection between groin A-Shi Point and uterus. Neurobiol Mech Acup. 2013; https://doi.org/10.1155/2013/429186

Cheng KJ. Neurobiological mechanisms of acupuncture for some common illnesses: a clinician's perspective. journal of acupuncture and meridian studies. J Acup Medid Studies. 2014;7(3):105-14.

Han G, Ko SJ, Park JW, et al. Acupuncture for functional dyspepsia: study protocol for a two-center, randomized controlled trial. Trials. 2014;15:89. DOI 10.1186/1745-6215-15-89.

Hong SH, Ding SS, Wu F, et al. Efficacy and safety of manual acupuncture manipulations with different frequencies on epigastric pain syndrome (EPS) in functional dyspepsia (FD) patients: study protocol for a randomized controlled trial. Trials. 2017;18(1):102. DOI 10.1186/s13063-017-1845-3.

Kim KN, Chung SY, Cho SH. Efficacy of acupuncture treatment for functional dyspepsia: A systematic review and meta-analysis. Complement Ther Med. 2015;23(6):759-66. DOI 10.1016/j.ctim.2015.07.007.

Ko SJ, Park K, Kim J, et al. Effect of acupuncture and its influence on cerebral activity in functional dyspepsia patients: study protocol for a randomized controlled trial. Trials. 2016;17:183. DOI 10.1186/s13063-016-1296-2.

Landgren K, Kvorning N, Hallström I. Acupuncture reduces crying in infants with infantile colic: a randomised, controlled, blind clinical study. Acup Med. 2010;28(4):174-9.

Lin TB, Fu TC. Effect of electroacupuncture on blood pressure and adrenal nerve activity in anesthetized rats. Neurosci Lett. 2000:285(1):37-40.

Longhurst JC, Tjen-A-Looi S. Acupuncture regulation of blood pressure: two decades of research. Int Rev Neurobiol. 2013;111:257-71.

Ma Q. Somatic-autonomic reflexes of acupuncture. Med Acup.2020;32(6):362-6. https://www.liebertpub.com/doi/10.1089/acu.2020.1488

Park M, Kim S. A modern clinical approach of the traditional Korean Saam acupuncture. Evidence-based Complementary Alternat Med. 2015;.2015,1-8. PMC4619944. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4619944/pdf/ECAM2015-703439.pdf.

Qu L-X, Xing L-Y, Gao S, et al. Traditional Chinese spinal orthopedic manipulation. TME. 2020;3(2):69-78. [1Zhongda Hospital, School of Medicine, Southeast University, Nanjing 210009, China]

Raĭtses VS, Shliakhovenko AA, Emel'ianenko IV. Vliianie akupunktury na vyzvannye potentsialy ventromedial'nogo gipotalamusa pri razdrazhenii vistseral'nykh i somaticheskikh nervov [The effect of acupuncture on the evoked potentials of the ventromedial hypothalamus during stimulation of the visceral and somatic nerves]. Fiziol Zh SSSR Im I M Sechenova. 1991;77(2):17-21. Russian. PMID: 1652512.

Takeshige C, Sato T, Mera T, et al. Descending pain inhibitory system involved in acupuncture analgesia. Brain Res Bull. 1992;29(5):617-34. DOI 10.1016/0361-9230(92)90131-g.

Ting H, Liao JM, Lin CF, et al. Pressor effect on blood pressure and renal nerve activity elicited by electroacupuncture in intact and acute hemorrhage rats. Neurosci Lett. 2002;327(1):5-8.

Uchida S, Kagitani F, Hotta H. Neural mechanisms of reflex inhibition of heart rate elicited by acupuncture-like stimulation in anesthetized rats. Auton Neurosci. 2010;157(1-2):18-23. DOI 10.1016/j.autneu.2010.03.021.

Xing L, Qu L, Chen H, et al. Clinical effect of traditional Chinese spinal orthopedic manipulation in treatment of Functional Abdominal Pain Syndrome. Complement Ther Med. 2017;32:19-24. DOI 10.1016/j.ctim.2017.03.009.

Yu L, Li L, Qin Q, et al. Electroacupuncture inhibits visceral nociception via somatovisceral interaction at subnucleus reticularis dorsalis neurons in the rat medulla. Front Neurosci. 2018;12:775. DOI 10.3389/fnins.2018.00775.

Yu Z, Luo L, Li Y, et al. Different manual manipulations and electrical parameters exert different therapeutic effects of acupuncture. J Tradit Chin Med. 2014;34(6):754-8. DOI 10.1016/s0254-6272(15)30092-3.

Biomarkers

Inflammation, Infection, Metabolic, Grisel's Syndrome

'Inflammation plays a major role in the pathogenesis of CLBP; namely, in the degeneration of disc, endplate, facet joints, and pathological processes of muscle fascia, nerve, and other tissue. As such, inflammation is also presumed to be involved in the pathogenesis of CLBP and related pain.' (Li et al, 2021)

Vertebral articular degenerative histopathological changes may occur with trauma and with reduced function of the joint. It seems that zygapophyseal joints are particularly prone to this. (Giles & Singer, 1997; Lu et al 2005; Kallakuri et al, 2012; Ita et al 2017)

Articular hypomobility or fixation has been demonstrated to lead to inflammation through trauma, stress/tension or irritation, ultimately degeneration may follow. (Cramer et al 2004;

Bakkum et al, 2007; Henderson et al, 2007a; 2007b; Cramer et al, 2010) Conversely, facet hypermobility (e.g. instability) may also activate noxious sensory input of a different nature. (Goode et al, 2019)

It would follow that both hypomobile (e.g. fixation) and hypermobile (unstable) vertebral segments have the potential to contribute noxious sensory stimulation by becoming generators of noxious sensory input. (Gellhorn et al, 2013) The disruption of the third vertebral joint, the intervertebral disc, is also a possible c ontributor. (Inoue et al, 2019)

Mechanical insult to body tissue can lead to an inflammatory response. It is perhaps more sensitive in vertebral articulations which can lead to degenerative changes. Depending on the type, duration, pre-existing condition and nature of severity, all are factors in triggering a noxious mechanoreceptor sensory response.

The inflammatory response comprises: pain (*dolor*), heat (*calor*), redness (*rubor*), swelling (*tumor*), and reduced function (*function leasa*). These factors can influence greater permeability of blood vessels, increased extracellular fluid in the region and increased white blood cells to the damaged tissue The hypomobility factor that has a significant noxious effect on mechanoreceptors and pain may vary considerably being acute or low grade and chronic. (Claesson-Welsh, 2015; Ciaccia, 2011)

The damaged articular and surrounding tissue may be ligamentous, surface synovial membrane and collagen fibres of the facet, as well as the collagen fibres in the hyaline cartilage of the intervertebral discal joint, plus the biochemical changes that are associated. The sensory elements activated are complex (Perolat et al, 2018, Giles & Singer, 1997)

Under the somatosensory model of vertebral subluxation, the inflammatory response would provide considerable noxious and nociceptive input enough to initiate afferent reflex responses leading to an efferent response in the form of somato-autonomic, somato-somatic, somatoparasympathetic, somatovascular and somatovisceral reflexes. and to induce spinal intrinsic muscle response severity and chronicity. (Hirsch et al, 1963; Jaumard et al, 2011; Morrison et al, 2013; Jang et al, 2020)

A further possible complication of facet inflammation associated with articular dysfunction appears to be the effect on the nerve root in the intervertebral foramen. It has been found that at least in rats, '*When inflammation was induced in a facet joint, inflammatory reactions spread to nerve roots, and leg symptoms were induced by chemical factors. These results support the possibility that facet joint inflammation induces radiculopathy*.' (Tachihara et al, 2007)

It is suggested that the mechanical stimuli provided through a CSM may modify neuropeptide expression by immediately increasing the serum concentration of nociception-related biomarkers (oxytocin, neurotensin, orexin A, but not cortisol) in the blood of female subjects with non-specific mechanical neck pain. (Lohman et al 2019)

Extended reference compilation

Articular inflammation

Bakkum BW, Henderson CN, Hong SP, et al. Preliminary morphological evidence that vertebral hypomobility induces synaptic plasticity in the spinal cord. J Manipulative Physiol Ther. 2007;30(5):336-42. DOI 10.1016/j.jmpt.2007.04.007.

Barker S, Mujallid R, Bayanzay K. Atlantoaxial subluxation secondary to SARS-CoV-2 infection: A rare orthopedic complication from COVID-19. Am J Case Rep. 2022 Jul 19;23:e936128. DOI 10.12659/AJCR.936128.

Brennan PC. The effect of spinal manipulation on pain and prostaglandin levels in dysmenorrheic women with primary dysmenorrhea. J Manipulative Physiol Ther 1992;15(5):279-85.

Ciaccia L. Fundamentals of inflammation. Yale J Biol Med. 2011 Mar;84(1):64–5. Epub 2011 Mar.

Claesson-Welsh L. Vascular permeability--the essentials. Ups J Med Sci. 2015;120(3):135-43. DOI 10.3109/03009734.2015.1064501.

Cramer GD, Fournier JT, Henderson CN, Wolcott CC. Degenerative changes following spinal fixation in a small animal model. J Manipulative Physiol Ther. 2004;27(3):141-54. DOI 10.1016/j.jmpt.2003.12.025.

Cramer GD, Henderson CN, Little JW, et al. Zygapophyseal joint adhesions after induced hypomobility. J Manipulative Physiol Ther. 2010;33(7):508-18. DOI 10.1016/j.jmpt.2010.08.002.

Fengler H, Franz R. Morphological studies of the articular surface after intermittent impulsive loading in animal experimentation. Acta Univ Carol Med (Praha). 1986;32(5-6):273-9.

Gellhorn AC, Katz JN, Suri P. Osteoarthritis of the spine: the facet joints. Nat Rev Rheumatol. 2013;9(4):216-24. DOI 10.1038/nrrheum.2012.199.

Giles LGF, Singer KP. Facet arthropathy. In: Clinical anatomy and management of low back pain. Oxford: Butterworth Heinemann.1997:285-7.

Goode AP, Cleveland RJ, Schwartz TA, et al. Relationship of joint hypermobility with low Back pain and lumbar spine osteoarthritis. BMC Musculoskelet Disord. 2019;20(1):158. DOI 10.1186/s12891-019-2523-2.

Henderson CN, Cramer GD, Zhang Q, et al. Introducing the external link model for studying spine fixation and misalignment: part 1--need, rationale, and applications. J Manipulative Physiol Ther. 2007;30(3):239-45. DOI 10.1016/j.jmpt.2007.01.006.

Henderson CN, Cramer GD, Zhang Q, et al. Introducing the external link model for studying spine fixation and misalignment: part 2, Biomechanical features. J Manipulative Physiol Ther. 2007;30(4):279-94. DOI 10.1016/j.jmpt.2007.03.002.

Hirsch C, Ingelmark Be, Miller M. The anatomical basis for low back pain. Studies on the presence of sensory nerve endings in ligamentous, capsular and intervertebral disc structures in the human lumbar spine. Acta Orthop Scand. 1963;33:1-17.

Inoue N, Orías AAE, Segami K. Biomechanics of the lumbar facet joint. Spine Surg Relat Res. 2019 Apr 26;4(1):1-7. DOI 10.22603/ssrr.2019-0017.

Ita ME, Crosby ND, Bulka BA, et al. Painful cervical facet joint injury is accompanied by changes in the number of excitatory and inhibitory synapses in the superficial dorsal horn that differentially relate to local tissue injury severity. Spine (Phila Pa 1976). 2017;42(12):E695-E701.

Ita ME, Zhang S, Holsgrove TP, et al. The Physiological Basis of Cervical Facet-Mediated Persistent Pain: Basic Science and Clinical Challenges. J Orthop Sports Phys Ther. 2017;47(7):450-461. DOI 10.2519/jospt.2017.7255.

Jaumard NV, Welch WC, Winkelstein BA. Spinal facet joint biomechanics and mechanotransduction in normal, injury and degenerative conditions. J Biomech Eng. 2011;133(7):071010. DOI 10.1115/1.4004493.

Kallakuri S, Li Y, Chen C, Cavanaugh JM. Innervation of cervical ventral facet joint capsule: Histological evidence. World J Orthop. 2012;3(2):10-4. DOI 10.5312/wjo.v3.i2.

Li W, Gong Y, Liu J, et al. Peripheral and central pathological mechanisms of chronic low back pain: a narrative review. J Pain Res. 2021;14:1483-94. https://www.dovepress.com/peripheral-and-central-pathological-mechanisms-of-chronic-low-back-pai-peer-reviewed-fulltext-article.

Licciardone JC, Kearns CM, Hodge LM, et al. Associations of cytokine concentrations with key osteopathic lesions and clinical outcomes in patients with nonspecific chronic low back pain: results from the Osteopathic Trial. J Am Osteopath Assoc. 2012;112(9):596-605. DOI 10.7556/jaoa.2012.112.9.596. Erratum in: J Am Osteopath Assoc. 2017;117(6):350.

Lohman EB, Pacheco GR, Gharibvand L, et al. The immediate effects of cervical spine manipulation on pain and biochemical markers in females with acute non-specific mechanical neck pain: a randomized clinical trial. J Man Manip Ther. 2019;27(4):186-196. DOI 10.1080/10669817.2018.1553696.

Lu Y, Chen C, Kallakuri S, et al. Neurophysiological and biomechanical characterization of goat cervical facet joint capsules. J Orthop Res. 2005;23(4):779-87. DOI 10.1016/j.orthres.2005.01.002.

Morrison I, Perini I, Dunham J. Facets and mechanisms of adaptive pain behavior: predictive regulation and action. Front Hum Neurosci. 2013;7:755.

Perolat R, Kastler A, Nicot B, et al. Facet joint syndrome: from diagnosis to interventional management. Insights Imaging. 2018 Oct;9(5):773-89. DOI 10.1007/s13244-018-0638-x.

Ryu J, Saito S, Yamamoto K. Changes in articular cartilage in experimentally induced patellar subluxation. Ann Rheum Dis. 1997 Nov;56(11):677-81. DOI 10.1136/ard.56.11.677.

Schmidt RF. The articular polymodal nociceptor in health and disease. Prog Brain Res. 1996;113:53–81.

Seaman DR, Faye LJ. The vertebral subluxation complex. In: Gatterman MI. Foundations of chiropractic subluxation.St Louis, Elsevier Mosby. 2e. 2005:195-226.

Tachihara H, Kikuchi S, Konno S,et al. Does facet joint inflammation induce radiculopathy?: an investigation using a rat model of lumbar facet joint inflammation. Spine (Phila Pa 1976). 2007;32(4):406-12.

Watkins LR, Maier SF. Beyond neurons: evidence that immune and glial cells contribute to pathological pain states. Physiol Rev. 2002;82:981–1011.

Inflammation, general

Biomechanical changes of the facet cartilage surfaces are shown to result in varying degrees of inflammation, hence the use of analgesics and anti-inflammatory drugs for biomechanical back pain are essentially directed at an effect rather than a cause. Manipulative remediation of these functional segmental disturbances which may also involve neurological radicular symptoms (radiculitis) appear to alleviate the inflammatory process in the facets. (Ryu et al, 1997; Cramer et al, 2004; Cramer et al, 2010)

Examples of vertebrogenic radiculitis which may be associated are brachial neuritis, sciatica, and occipital neuralgia. In addition, a similar process can be associated with a thoracic outlet syndrome. One of the causes in some cases of sciatic neuritis may also be associated with vertebrogenic dysfunction of the lumbar spine. (Larson, 1972; Dobrusin, 1989; Pollard & Tuchin, 1995; Bergmann & Jongeward, 1998; Bronfort et al, 2004; Apfelbeck, 2005; Santilli et al, 2006; Christensen & Buswell, 2008; Jackson, 2010; Charles, 2011; Shreeve & LaRose, 2011; Emary, 2015; Onifer et al, 2018; Szikszay et al, 2018; Yuschak et al, 2019; Rowlands & Pozun, 2022; de Santana Chagas et al, 2022)

The importance of addressing a painful inflammatory condition with a neural factor is reflected in a paper by Verma et al. While it is based on pharmaceutical intervention, its implication is that of prevention of more complex conditions. They state, '*Both pain and inflammation are protective responses. However, these self-limiting conditions (with well-established negative feedback loops) become pathological if left uncontrolled. Both pain and inflammation can interact with each other in a multi-dimensional manner. These interactions are known to create an array of "difficult to manage" pathologies. This review explains in detail the role of immune system and the related cells in peripheral sensitization and neurogenic inflammation*.' (Verma et al, 2015)

It has been recently recorded that '*Autonomic nervous system dysfunction (AD) is present in approximately half of the patients and may promote autoimmunity by weakening the vagally mediated anti-inflammatory reflex*,' further that evidence suggests that vagus nerve stimulation has a range of '*beneficial effects*'.(Zinglersen et al, 2022) That the vagus nerve may be influenced through cervical spine manipulation and transcutaneously is discussed elsewhere in this series. (Das, 2011; Butt et al, 2020; Merchant et al, 2022)

In further related aspects, studies of molecular changes following spinal manipulation are also emerging with the possibility that there may be associated molecular pathways involved in the healing process. (Kovanur-Sampath et al, 2017; Maltese et al, 2019)

It has been found that '*sensitization of sensory pathways by inflammation or NGF contributes to the development of hypersensitivity in neighbouring organs and cutaneous referral sites and provides a potential mechanism underlying the coexistence of pain syndromes in patients with functional diseases.*' (Bielefeldt et al, 2006)

The biomedical aspects of a VSC were noted by Dishman in 1988 when he stated '*The biochemical and histological components explain some of the pain mechanisms, tissue changes and residual effects of acute and chronic intervertebral fixation…* ' Others have also noted biochemical changes associated with subluxations and with spinal manipulation:

Vascular/biochemical factors

- Biochemical changes (Gatterman, 2005)
- Biochemical dysfunction (Dishman, 1988)
- Blood markers (Kovanur-Sampath et al, 2017; Duarte et al 2022; Lohman et al, 2019)

- Cortisol (Tuchin, 1998); Whelan et al, 2002)
- Hyperemic subluxation (Hill, 1945)
- Histochemical changes (Dishman, 1988)
- Immune response (Lymphatics) (Remien, 2022)
- Inflammatory (Dishman, 1988)
- Mechanical and chemical changes (Pickar, 2002)
- Relative hypoxemia (Dishman, 1988)
- Tumor Necrosis Factor - Alpha (Gevers-Montoro et al, 2022)
- Uncontrolled metabolism (Dishman, 1988)
- Vasomotor changes (Gatterman, 2005)
- Vasoneuroactive substances are released (Dishman, 1988)

Pickar noted in the *Spine Journal* in 2002 that '*Mechanical and chemical changes in the intervertebral foramen caused by a herniated intervertebral disc can affect the dorsal roots and dorsal root ganglia, but it is not known if spinal manipulation directly affects these changes.*' However, in recognising reported positive outcomes to manipulation, he then stated *'One mechanism underlying the effects of spinal manipulation may, therefore, be the manipulation's ability to alter central sensory processing by removing subthreshold mechanical or chemical stimuli from paraspinal tissues.*'

Over 70 years ago, Hill stated in relation to articular infections that '*In the case of the neck, spontaneous hyperemic* (sic) *subluxation of the cervical vertebræ due to sepsis is not uncommon and must always be suspected if there is a history of recent infection.*' (Hill, 1949)

Extended reference compilation

Biochemical Markers

Kovanur-Sampath K, Mani R, Cotter J, et al. Changes in biochemical markers following spinal manipulation-a systematic review and meta-analysis. Musculoskelet Sci Pract. 2017;29:120-31.

Lohman EB, Pacheco GR, Gharibvand L, et al. The immediate effects of cervical spine manipulation on pain and biochemical markers in females with acute non-specific mechanical neck pain: a randomized clinical trial. J Man Manip Ther. 2019;27(4):186-196. DOI 10.1080/10669817.2018.1553696.

Hormonal

Sato A. Neural mechanisms of somatic sensory regulation of catecholamine secretion from the adrenal gland. Adv Biophys 1987;23:39-380.

Sato, A., Sato, Y., Schmidt, RF. Catecholamine secretion and adrenal nerve activity in response to movements of normal and inflamed knee joints in cats. J Physiol 1986;375;611-24

Immune

Chow N, Hogg-Johnson S, Mior S. Assessment of studies evaluating spinal manipulative therapy and infectious disease and immune system outcomes: A systematic review. JAMA Netw Open. 2021;4(4):e215493. DOI 10.1001/jamanetworkopen.2021.

Colombi A, Testa M. The effects induced by spinal manipulative therapy on the immune and endocrine systems. Medicina (Kaunas, Lithuania) 55(8):448. DOI:10.3390/medicina55080448.

Louveau A, Smirnov I, Keyes TJ, et al. Structural and functional features of central nervous system lymphatic vessels. Nature. 2015;523(7560):337-41. DOI10.1038/nature14432 (neuroimmune)

Inflammation Response

Bielefeldt K, Lamb K, Gebhart GF. Convergence of sensory pathways in the development of somatic and visceral hypersensitivity. Am J Physiol Gastrointest Liver Physiol. 2006;291(4):G658-65. DOI 10.1152/ajpgi.00585.2005.

Chow N, Hogg-Johnson S, Mior S. Assessment of studies evaluating spinal manipulative therapy and infectious disease and immune system outcomes: A systematic review. JAMA Netw Open. 2021;4(4):e215493. DOI 10.1001/jamanetworkopen.2021.

Duarte FCK, Funabashi M, Starmer D, et al. Effects of distinct force magnitude of spinal manipulative therapy on blood biomarkers of inflammation: A proof of principle study in healthy young adults. J Manipulative Physiol Ther. 2022;45(1):20-32.

Gevers-Montoro C, Romero-Santiago M, et al. Presence of Tumor Necrosis Factor-Alpha in urine samples of patients with chronic low back pain undergoing chiropractic care: preliminary findings from a prospective cohort study. Front Integr Neurosci. 2022;16:879083. DOI 10.3389/fnint.2022.879083.

Hill LC. Discussion of manipulative treatment. Proceedings of the Royal Society of Medicine. Section of Physical Medicine. 1949;XLII:417-20. https://journals.sagepub.com/doi/pdf/10.1177/003591574904200610.

Hondras M, Brennan PC. The effect of spinal manipulation on pain and prostaglandin levels in women with primary dysmenorrhea: A randomised, full-scale clinical trial. Pain 1999;81:104-14.

Molina-Ortega F, Lomas-Vega R, Hita-Contreras F, et al. Immediate effects of spinal manipulation on nitric oxide, substance P and pain perception. Manual Therapy. 2014;19(5):411-17. DOI10.1016/j.math.2014.02.007.

Ormos G, Mehnishi JN, Bakacs T. Reduction in high blood tumor necrosis factor alpha levels after manipulative therapy in 2 cervicogenic headache patients. J Manipulative Physiol Ther. 2009;32(7):586–91.

Roy RA, Boucher, JP, and Comtois, AS. Inflammatory response following a short-term course of chiropractic treatment in subjects with and without chronic low back pain. J Chiropr Med. 2010;9(3):107-14. https://doi.org/10.1016/j.jcm.2010.06.002.

Schaible HG, von Banchet GS, Boettger MK, et al. The role of proinflammatory cytokines in the generation and maintenance of joint pain. Ann N Y Acad Sci. 2010;1193:60-9.

Teodorczyk-Injeyan JA, Injeyan S, Ruegg R. Spinal manipulative therapy reduces inflammatory cytokines but not substance P production in normal subjects., J Manipulative Physiol Ther. 2006;29(1):14-21. https://doi.org/10.1016/j.jmpt.2005.10.002.

Teodorczyk-Injeyan JA., Triano JJ, Gringmuth R, et al. Effects of spinal manipulative therapy on inflammatory mediators in patients with non-specific low back pain: a non-randomized controlled clinical trial. Chiropr Man Therap. 2021;29(1):3.

Metabolic

Kovanur-Sampath K, Mani R, Cotter J, et al. Changes in biochemical markers following spinal manipulation-a systematic review and meta-analysis. Musculoskelet Sci Pract. 2017;29:120-131. DOI 10.1016/j.msksp.2017.04.004.

Ogura T, Tashiro M, Masud M, et al. Cerebral metabolic changes in men after chiropractic spinal manipulation for neck pain. Altern Ther Health Med. 2011;17(6):12-7.

Plaza-Manzano G, Molina-Ortega F, Lomas-Vega R, et al. Changes in biochemical markers of pain perception and stress response after spinal manipulation. J Orthop Sports Phys Ther. 2014;44(4):231-9. DOI 10.2519/jospt.2014.4996.

Tashiro M, Ogura T, Masud M, et al. Cerebral metabolic changes in men after chiropractic spinal manipulation for neck pain. Altern Ther Health Med. 2011;17(6):12-7.

Molecular

Jang Y, Kim M, Hwang SW. Molecular mechanisms underlying the actions of arachidonic acid-derived prostaglandins on peripheral nociception. J Neuroinflammation. 2020;17(1):30. DOI 10.1186/s12974-020-1703-1.

Kovanur-Sampath K, Mani R, Cotter J, et al. Changes in biochemical markers following spinal manipulation-a systematic review and meta-analysis. Musculoskelet Sci Pract. 2017;29:120-31.

Maltese PE, Michelini S, Baronio M, et al. Molecular foundations of chiropractic therapy. Acta Biomed. 2019;90(10-S):93-102. DOI 10.23750/abm.v90i10-S.8768.

Pain

Christian GF, Stanton GJ, Sissons D, et al. Immunoreactive ACTH, beta-endorphin, and cortisol levels in plasma following spinal manipulative therapy. Spine. 1988;13(12):1411-17.

Luisetto G, Tagliaro D, Spanò D, et al. Plasma levels of beta-endorphin and calcitonin levels before and after manipulative therapy of patients with cervical arthrosis and Barre's syndrome. In: Mazarelli JP, ed. Chiropractic inter-professional research, pp 47-52, Torino Italy, 1982.

Sanders GE, Reinert O, Tepe R, et al. Chiropractic adjustive manipulation on subjects with acute low back pain: Visual analog pain scores and plasma β-endorphin levels. J Manipulative Physiol Ther. 1990;13:391-95.

Vernon HT, Dhami MSI, Howley TP, et al. Spinal manipulation and beta-endorphin: A controlled study of the effect of a spinal manipulation on plasma beta-endorphin levels in normal males. J Manipulative Physiol Ther. 1986;9:115-24.

Immune response

Early recognition of a neurological factor in immunogenesis was noted in the extensive research by published by Gordienko in 1958. The *PubMed* Timeline graph of published papers shows that for 'Nervous system - immune', interest developed from about 1982. (Tobler et al, 1982)

Brennan P, Kokjohn K, Triano J, et al. Immunological correlates of reduced spinal mobility: Preliminary observations in a dog model. Proceedings Intl Conference Spinal Manip. Washington 1991 April;118-21.

Brennan PC, Blankenship S, Sisco V, et al. Elevated human neutrophil chemiluminescence induced by spinal manipulation. In: Whelan WJ. Ed. 72nd Annual Meeting of the Fed of Am Societies for Experimental Biology. Las Vegas. 1988;3151:A838.

Brennan PC, Graham MA, Triano JJ, et al. Lymphocyte profiles in patients with chronic low back pain enrolled in a clinical trial. J Manipulative Physiol Ther. 1994;17(4):219-27.

Brennan PC, Hondras MA. Priming of neutrophils for enhanced respiratory burst by manipulation of the thoracic spine. In: Wolk S. Ed. Proceedings of the 1989 International Conference on Spinal Manipulation. Washington D.C. Foundation for Chiropractic Education and Research. March 1989:160-63.

Brennan PC, Kokjohn K, Kaltinger CJ, et al. Enhanced phagocytic cell respiratory burst induced by spinal manipulation: Potential role of substance P. J Manipulative Physiol Ther 1991;14(7):399-408.

Brennan PC, Triano JJ, McGregor M, et al. Enhanced neutrophil respiratory burst as a biological marker for manipulation forces: Duration of the effect and association with substance P and tumor necrosis factor. J Manipulative Physiol Ther 1992;15(2):83-9.

Cardenas L. Immunohistochemical study of conjunctival nevi and melanomas. Transactions of the Pacific Consortium for Chiropractic Research: A series of communications. Proceedings of the First Annual Conference on Research and Education 1986;28-9, June:A3:1-4.

Chow N, Hogg-Johnson S, Mior S, et al. Assessment of studies evaluating spinal manipulative therapy and infectious disease and immune system outcomes: A systematic review. JAMA Netw Open. 2021;4(4):e215493. DOI 10.1001/jamanetworkopen.2021.5493.

Colombi A, Testa M. The effects induced by spinal manipulative therapy on the immune and endocrine systems. Medicina (Kaunas, Lithuania) 55(8):448. DOI:10.3390/medicina55080448.

Crawford JP, Hickson G, Ward M. Immune complex deposition in the development of acute synovitis in the rabbit knee joint: quantitative, kinetic and morphological aspects. J Manip Physiol Ther 1986;9(4):249-56.

Dustin ML, Colman DR. Neural and immunological synaptic relations. Science. 2002;298(5594):785-9. DOI 10.1126/science.1076386.

Egan TS, Meltzer KR, Standley PR. Importance of strain direction in regulating human fibroblast proliferation and cytokine secretion: a useful in vitro model for soft tissue injury and manual medicine treatments. J Manipulative Physiol Ther. 2007;30(8):584-92.

Elenkov IJ, Wilder RL, Chrousos GP, et al. The autonomic nervous system: An integrative face between two super systems – The brain and the immune system. Pharmacol Rev 2000;52:595-638.

Gordienko AN. Ed. Control of immunogenesis by the nervous system. Rostov-On-Don. 1958.

Graham M, Brennan P. Functional ability of natural killer cells as an outcome measure for chiropractic treatment efficacy. FCER Proceedings Intl Conference Spinal Manipulation. Washington 1991;Apr:84-6.

Haavik H, Niazi IK, Kumari N, Amjad I, Duehr J, Holt K. The potential mechanisms of high-velocity, low-amplitude, controlled vertebral thrusts on neuroimmune function: A narrative review. Medicina (Kaunas). 2021;57(6):536. DOI 10.3390/medicina57060536.

Kivioja J, Ozenci V, Rinaldi L, Kouwenhoven M, Lindgren U, Link H. Systemic immune response in whiplash injury and ankle sprain: elevated IL-6 and IL-10. Clin Immunol 2001;101(1):106-12.

Kokjohn K, Kaltinger C, Lohr G, et al. Enhanced human phagocytic cell respiratory burst following spinal manipulation. Proceedings of Amer Society Microbiology, New Orleans, 1989.Chiropractic Education and Research. March 1989;160-3.

Lohr G, O'Brien J, Nodine D, Brennan P. Natural killer cells as an outcome measure of chiropractic treatment efficacy. Proceedings of the Intern'l Conference on Spinal Manipulation, Washington. May 1990;109-12.

Louveau A, Smirnov I, Keyes TJ, et al., Structural and functional features of central nervous system lymphatic vessels. Nature. 2015 DOI10.1038/nature14432.

Malcangio M. Role of the immune system in neuropathic pain. Scand J Pain. 2019 Dec 18;20(1):33-37. DOI 10.1515/sjpain-2019-0138.

McGregor M, Brennan P, Triano J. Immunological response to manipulation of the lumbar spine. FCER Proceedings Interl Conference Spinal Manipulation. Washington. 1991 Apr;153-155.

Pierce LM, Reyes M, Thor KB, et al.. Immunohistochemical evidence for the interaction between levator ani and pudendal motor neurons in the coordination of pelvic floor and visceral activity in the squirrel monkey. Am J Obstet Gynecol. 2005 May;192(5):1506-15. DOI 10.1016/j.ajog.2004.10.607. PMID: 15902150.

Quatrini L, Vivier E, Ugolini S. Neuroendocrine regulation of innate lymphoid cells. Immunol Rev. 2018 Nov;286(1):120-136. DOI 10.1111/imr.12707. PMID: 30294960; PMCID: PMC6221181.

Saggio G, Docimo S, Pilc J, Norton J, Gilliar W. Impact of osteopathic manipulative treatment on secretory immunoglobulin a levels in a stressed population. J Am Osteopath Assoc. 2011 Mar;111(3):143-7. PMID: 21464262.

Schalow PR, Kimball KA, Schurger FT, et al. Secretory Immunoglobulin A and upper cervical chiropractic: A preliminary prospective, multicenter, observational study. J Chiropr Med. 2021 Sep;20(3):121-127. DOI 10.1016/j.jcm.2021.10.003. Epub 2022 Apr 6. PMID: 35463842; PMCID: PMC9023133.

Steinman L. Connections between the immune system and the nervous system. Proc Natl Acad Sci U S A. 1993 Sep 1;90(17):7912-4. DOI 10.1073/pnas.90.17.7912.

Steinman, L. Elaborate interactions between the immune and nervous systems. Nat Immunol. 2004;5, 575–581. https://doi.org/10.1038/ni1078

Tobler LH, Johnson KP, Buehring GC. Immune response of hamsters to experimental central nervous system infection with measles virus. J Neuroimmunol. 1982 Jun;2(3-4):307-20. DOI 10.1016/0165-5728(82)90063-7. PMID: 7045158.

Udit S, Blake K, Chiu IM. Somatosensory and autonomic neuronal regulation of the immune response. Nat Rev Neurosci. 2022;23:157–171. https://doi.org/10.1038/s41583-021-00555-4

Verma V, Sheikh Z, Ahmed AS. Nociception and role of immune system in pain. Acta Neurol Belg. 2015 Sep;115(3):213-20. DOI 10.1007/s13760-014-0411-y. Epub 2014 Dec 30. PMID: 25547878.

Vivier E, Artis D, Colonna M, et al. Innate lymphoid cells: 10 years on. Cell. 2018 Aug 23;174(5):1054-1066. DOI 10.1016/j.cell.2018.07.017. PMID: 30142344.

Waddell SC, Davison JS, Befus AD, Mathison RD. Role for the cervical sympathetic trunk in regulating anaphylactic and endotoxic shock. J Manipulative Physiol Ther 1991;15(1):10-15.

Wagnon RJ, Sandefur RM, Ratcliff CR. Serum aldosterone changes after specific chiropractic manipulation. Am J Chiropr Med 1988;1(2):66-70.

Walkowski S, Singh M, Puertas J, et al. Osteopathic manipulative therapy induces early plasma cytokine release and mobilization of a population of blood dendritic cells. PLoS One. 2014 Mar 10;9(3):e90132.

Allergy and asthma

'This study is a detailed multi-faceted comparative study to prove a link between the vertebral deformities and the allergy. As a result of the spinal cord investigation of 1,028 allergy patients among 3013, we confirmed that over 98 %of allergy patients had the vertebral misalignment.' (Takeda & Arai, 2003)

Alcantara J, Alcantara JD, Alcantara J. Chiropractic treatment for asthma? You bet!. J Asthma. 2010;47(5):597-8. DOI:10.3109/02770901003668421.

Balon JW, Mior SA. Chiropractic care in asthma and allergy. Ann Allergy Asthma Immunol. 2004;93(2 Suppl 1):S55-60. DOI 10.1016/s1081-1206(10)61487-1.

Brozovich TA. The reduction of asthma symptoms and medications after chiropractic care, (Review). Chiropr J Aust. 2017;45(2):138-43.

Fidelibus J. An overview of neuroimmunomodulation and a possible correlation with musculoskeletal system function. J Manip Physiol Ther. 1989;12:289-92.

Gibbs AL. Chiropractic co-management of medically treated asthma. 2005;8(3):140-4.

Kaminskyj A, Frazier M, Johnstone K, Gleberzon BJ. Chiropractic care for patients with asthma: A systematic review of the literature. J Can Chiropr Assoc. 2010 Mar;54(1):24-32.

Nielsen NH, Bronfort G, Bendix T, Madsen F, Weeke B. Chronic asthma and chiropractic spinal manipulation: a randomized clinical trial. Clin Exp Allergy. 1995 Jan;25(1):80-8. DOI 10.1111/j.1365-2222.1995.tb01006.x.

Owen DE, Rix GDW. The effect of chiropractic manipulation on serum levels of Immunoglobulin M. European J Chiropr 2003;48:55-6.

Takeda Y, Arai S. Relationship between vertebral deformities and allergic diseases. The Internet J Orthop Surg. 2003;2(1). https://ispub.com/IJOS/2/1/8061.

Infection, immune response

Many would be surprised at the volume of medical literature which depict an association of vertebral subluxations with infection, mostly designated at Grisel's Syndrome. (Leach 1984; Spinnato et al, 2021)

In acknowledging vertebral subluxation, Hadley stated in 1976 that '*Spontaneous subluxation at the C1-C2 level either unilateral or bilateral is usually a sequel to an inflammatory process of the throat. It is more common in children, but may occur in adults*.' (Hadley, 1976, p. 132)

This syndrome has also been associated with inflammation (Fath et al, 2018) and following ENT-or other neck surgery. (Hopla et al, 1983; Eadie et al, 1989; Takada et al, 2007; Deichmueller et al, 2010; Bubak et al, 2014; Fath et al, 2018; Karkos et al, 2021) The surgery itself appears to be following conditions such as chronic tonsillitis. It is not clear whether the subluxation is associated with positioning of the head during surgery. It has also been associated with infections (Hopla et al, 1983; Clark et al, 1988; Uğur et al, 2003; Magoun, 2004; Kim et al, 2011; Fath et al, 2018; Lesho et al, 2022; Shen et al, 2022; Barket et al, 2022) and as a cause of torticollis (Hicazi et al, 2002; Babu et al, 2010; Ortiz et al, 2013).

Extended reference compilation

Subluxations and immune response

Babu, A., Knipe, H. Grisel syndrome. Reference article, Radiopaedia.org. 2010. https://radiopaedia.org/articles/grisel-syndrome-2.

Bocciolini C, Dall'Olio D, Cunsolo E, et al. Grisel's syndrome: a rare complication following adenoidectomy. Acta Otorhinolaryngol Ital. 2005;25(4):245-9.

Barker S, Mujallid R, Bayanzay K. Atlantoaxial subluxation secondary to sars-cov-2 infection: a rare orthopedic complication from COVID-19. Am J Case Rep. 2022 19;23:e936128.

Clark WC, Coscia M, Acker JD, et al. Infection-related spontaneous atlantoaxial dislocation in an adult: case report. J Neurosurg. 1988;69(3):455-58 10.

Deichmueller CM, Welkoborsky HJ. Grisel's syndrome's syndrome--a rare complication following "small" operations and infections in the ENT region. Eur Arch Otorhinolaryngol. 2010 Sep;267(9):1467-73. DOI 10.1007/s00405-010-1241-z.

Eadie PA, Moran R, Fogarty EE, et al. Rotatory atlantoaxial subluxation following pharyngoplasty. Br J Plast Surg. 1989 Nov;42(6):722-3. DOI 10.1016/0007-1226(89)90089-1.

Fath L, Cebula H, Santin MN, et al. The Grisel's syndrome: A non-traumatic subluxation of the atlantoaxial joint. Neurochirurgie. 2018;64(4):327-330. DOI 10.1016/j.neuchi.2018.02.001.

Iaccarino C, Francesca O, Piero S, et al. Grisel's Syndrome: Non-traumatic atlantoaxial rotatory subluxation-report of five cases and review of the literature. Acta Neurochir Suppl. 2019;125:279-288. DOI 10.1007/978-3-319-62515-7_40.

Karkos PD, Benton J, Leong SC, et al. Grisel's syndrome in otolaryngology: A systematic review. Int J Pediatr Otorhinolaryngol. 2007;71(12):1823-27.

Kim SY, Choi JW, Choi BY, et al. Atlantoaxial rotary subluxation after tympanoplasty. Otol Neurotol. 2011 Sep;32(7):1108-10. DOI 10.1097/MAO.0b013e3182267ed4.

Hadley LA. Anatomico-roentgenographic studies of the spine. 3rd printing. Springfield, Charles C Thomas.1976;132.

Hopla DM, Mazur JM, Bass RM. Cervical vertebrae subluxation. Laryngoscope. 1983 Sep;93(9):1155-9. DOI 10.1288/00005537-198309000-00008.

Kim SY, Choi JW, Choi BY, et al. Atlantoaxial rotary subluxation after tympanoplasty. Otol Neurotol. 2011;32(7):1108-10. DOI 10.1097/MAO.0b013e3182267ed4.

Leach RA. The chiropractic theories. Principles and clinical applications. 3e. Baltimore: Williams & Wilkins. 1994;209-10, 268.

Lesho E, McKeown A, Laguio-Vila M. The rationale for including osteopathic manipulative treatment in the management of infections: a hermeneutic review. Expert Rev Anti Infect Ther. 2022 Jan;20(1):23-31.

Magoun HI Jr. More about the use of OMT during influenza epidemics. J Am Osteopath Assoc. 2004 Oct;104(10):406-7.

Ortiz GL, Pratts I, Ramos E. Grisel's syndrome: an unusual cause of torticollis. J Pediatr Rehabil Med. 2013;6(3):175-80. DOI 10.3233/PRM-130253.

Shen Y, Yang L, Liu X, et al. Grisel's syndrome associated with mumps: A case report. Front Pediatr. 2022;10:916538.

Sobolewski BA, Mittiga MR, Reed JL. Atlantoaxial rotary subluxation after minor trauma. Pediatr Emerg Care. 2008;24(12):852-6. DOI 10.1097/PEC.0b013e31818ea0d3.

Spinnato P, Zarantonello P, Guerri S, et al. Atlantoaxial rotatory subluxation/fixation and Grisel's syndrome in children: clinical and radiological prognostic factors. Eur J Pediatr. 2021 Feb;180(2):441-447. DOI 10.1007/s00431-020-03836-9.

Takada G, Asato H, Umekawa K, et al. Atlantoaxial rotatory fixation after microtia reconstruction surgery. Plast Reconstr Surg Glob Open. 2021;9(8):e3760. DOI 10.1097/GOX.0000000000003760.

Uğur HC, Cağlar S, Unlu A, et al. Infection-related atlantoaxial subluxation in two adults: Grisel syndrome or not? Acta Neurochir (Wien). 2003;145(1):69-72.

Biopsychosocial factor

The potential for stress and tension to contribute to muscular hypertonicity particularly of the neck and shoulders resulting in limited spinal motion and a segmental fixated subluxation is acknowledged. Once established, the discomfort from such a lesion and/or its symptoms may lead to increased stress, tension and muscular hypertonicity and a reduction in cervical motion. Pre-existing segmental lesions and postural deviations may render a patient vulnerable to recurrent or exacerbation of some symptoms due to hypertonicity from such factors. (Schell et al, 2008)

The effect of pain may lead to other physical and psychological conditions. This would provide further rationale and justify the manipulative model of care and at times, explain some of the seemingly unrelated symptoms. Tomic stated that '*Pain influenced some aspects of body pain, physical function, and physical and mental disability. Being associated with disability and pain, cervical dystonia decreases the quality of life in many aspects. Disability also influenced depression and anxiety, which were present in half of study patients*'. (Tomic et al, 2016)

Historically, chiropractic management of some mental health conditions has been noted for many years and involved institutional care of adult as well as children, both at dedicated facilities. The *Kentuckiana Children's Center* in Louisville is one such institution. (Barnes, 1997) Other institutions were the 600 bed *Spears Chiropractic Sanitarium and Hospital* in Denver, Colorado, and the *Clear View Sanitarium* in Davenport, Iowa. (West Mesa Wellness, 2016)

In 2021, Kawasaki et al studied the effect of posture on the mental responses and the sympathetic nervous system. Although not involving spinal manipulation, it did associate a biomechanical model with cognitive loading. They stated that '*This finding supports a view that perturbation-induced electrodermal response (EDR) in stance sometimes represents multiple mental responses. The amplitude of the EDR had a positive and significant correlation with fear, indicating that perturbation-induced EDR in stance partially represents perturbation-induced fear of fall*'. (Kawaski et al, 2021)

It is noted that while there appears to be a correlation between psychological and social disturbances with spinal pain, conventional care has not pursued a manipulatory model for addressing the apparent spinal pain element as one etiological factor in those cases. To this extent, Hancock et al queried whether the 'bio' element had been overshadowed by an overemphasis on the psychological aspect. One wonders if is the lack of efficacy in treating back pain that has generated this psychosomatic emphasis. (Hancock et al, 2011)

Extended reference compilation

Biopsychosocial

Abraham C, Sloan SNB, Coker C, et al. Osteopathic manipulative treatment as an intervention to reduce stress, anxiety, and depression in first responders: A pilot study. Mo Med. 2021;118(5):435-41.

Baarbe J, Holmes M, Murphy H, et al. Influence of subclinical neck pain on the ability to perform a mental rotation task: A 4-week longitudinal study with a healthy control group comparison. J Manipulative Physiol Ther. 2016;39(1):23-30.

Bakkum BW, Nolan DB. The Fountain Head Chiropractic Hospital: the dream that almost came true. J Chiropr Humanit. 2010;17(1):47-54.

Barnes T. Kentuckiana children's centre: a 40-year history. J Chiropr Humanit. 1997;7:18-22.

Batley S, Aartun E, Boyle E, et al. The association between psychological and social factors and spinal pain in adolescents. Eur J Pediatr. 2019;178(3):275-286. DOI 10.1007/s00431-018-3291-y.

Bottaro R, Faraci P. The association between upper (spinal – au) disorders and psychological well-being and its implication in text neck syndrome: a systematic review. Clin Neuropsychiatry. 2022;19(5):280-7.

Brockman S. The role of chiropractic manipulation in promoting an individual's perception of psychological wellbeing. Clin Chiropr 2007;10(1):8-23.

Burleson MH, Quigley KS. Social interoception and social allostasis through touch: Legacy of the Somatovisceral Afference Model of Emotion. Soc Neurosci. 2021;16(1):92-102. DOI 10.1080/17470919.2019.

Burton AK, Tillotson K, Main C, et al. Psychosocial predictors of outcome in acute and sub-acute low back trouble. Spine. 1995;20:722-8.

Cade A, Jones K, Holt K, et al. The effects of spinal manipulation on oculomotor control in children with Attention Deficit Disorder: a pilot and feasibility study. Brain Sciences. 2021;11(8), 1047. https://doi.org/10.3390/brainsci11081047.

Calcagni N, Gana K, Quintard B. A systematic review of complementary and alternative medicine in oncology: Psychological and physical effects of manipulative and body-based practises. PLoS One. 2019;14(10):e223564. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0223564.

Carrano FR, Frazer A. Vagal nerve stimulation for treatment-resistant depression. neurotherapeutics. 2017;14(3):716-727. DOI 10.1007/s13311-017-0537-8.

Chu ECP, Ng M. Long-term relief from tension-type headache and major depression following chiropractic treatment. J Family Med Prim Care. 2018;7(3):629-631. DOI 10.4103/jfmpc.jfmpc_68_18.

Ciccione DS, Just N. Pain expectancy and work disability in patients with acute and chronic pain: A test of the fear avoidance hypothesis. J Pain. 2001;2:181-94.

Dario AB, Kamper SJ, Williams C, et al. Psychological distress in early childhood and the risk of adolescent spinal pain with impact. Eur J Pain. 2022 Feb;26(2):522-530. DOI 10.1002/ejp.1878.

Desmoulin GT, Szostek JS, Khan AH, et al. Spinal intervention efficacy on correcting cervical vertebral axes of rotation and the resulting improvements in pain, disability and psychosocial measures. J Musculoskeletal Pain. 2012;20(1):31-40.

Dixon L, Fotinos K, Sherifi E. Effect of osteopathic manipulative therapy on generalized anxiety disorder. J Am Osteopath Assoc. 2020;120(3):133-143. DOI 10.7556/jaoa.2020.026.

Dolphens M, Vansteelandt S, Cagnie B, et al. Multivariable modelling of factors associated with spinal pain in young adolescence. Eur Spine J. 2016 Sep;25(9):2809-21. DOI 10.1007/s00586-016-4629-7.

Einion A. Biofield and manipulative therapies for emotional wellbeing and fertility. Fertility, Pregnancy, and Wellness. 2022;249-63. https://www.sciencedirect.com/science/article/pii/B9780128183090000253.

Emmet D, Nuño V, Pierce-Talsma S. OMT to address the physiologic effects of stress. J Am Osteopath Assoc. 2018 Feb 1;118(2):e11. DOI 10.7556/jaoa.2018.028.

Fornari M, Carnevali L, Sgoifo A. Single osteopathic manipulative therapy session dampens acute autonomic and neuroendocrine responses to mental stress in healthy male participants. J Am Osteop Assoc. 2017;117:559-567. DOI 10.7556/jaoa.2017.110

Gliedt, J.A., Schneider, M.J., Evans, M.W, et al. The biopsychosocial model and chiropractic: a commentary with recommendations for the chiropractic profession. Chiropr Man Ther. 2017;25, 16. https://doi.org/10.1186/s12998-017-0147-x.

Green BN, Johnson CD, Haldeman S, et al. A scoping review of biopsychosocial risk factors and co-morbidities for common spinal disorders. PloS One. 2018;13(6):e0197987. DOI 10.1371/journal.pone.0197987.

Haanstra T, Miller J. Dutch chiropractors' perceptions on including psychological factors in the evaluation and management of patients: A survey. Clin Chiropr 2011;14(3):112-121. https://www.sciencedirect.com/science/article/abs/pii/S1479235411000927.

Hancock MJ, Maher CG, Laslett M, et al. Discussion paper: what happened to the 'bio' in the bio-psycho-social model of low back pain? Eur Spine J. 2011;20(12):2105-10. DOI 10.1007/s00586-011-1886-3.

Harreby M, Neergaard K, Hesselsøe G, et al. Are radiologic changes in the thoracic and lumbar spine of adolescents' risk factors for low back pain in adults? A 25-year prospective cohort study of 640 school children. Spine (Phila Pa 1976). 1995;20(21):2298-302.

Holder JM, Duncan Robert C, et al. Increasing retention rates among the chemically dependent in residential treatment: Auriculotherapy and (in a separate study) subluxation-based chiropractic care. J Molecular Psych. 2001;6(Supple 1):15.

Indahl A, Haldorsen EH, Holm S, et al. Five-year follow-up study of a controlled clinical trial using light mobilization and an informative approach to low back pain. Spine. 1998;23:2625-30.

Kawasaki T, Oda H, Sawagachi Y et al. Sympathetic response to postural perturbation in stance. Front Hum Neurosci. 2021;15:7633582.

Kelly D, Murphy B, and Backhouse D. Use of a mental rotation reaction-time paradigm to measure the effects of upper cervical adjustments on cortical processing: a pilot study. J Manipulative Physiol Ther. 2000;23:246-51.

Kent C. Chiropractic and mental health: a brief overview. J Philos Princip Prac Chiropr. 2013; Oct 24. https://www.researchgate.net/publication/320373922_Chiropractic_and_Mental_Health_A_Brief_Overview.

Kent C. Chiropractic and mental health: history and review of putative neurobiological mechanisms. J Neurol Psychiatr Brain Res. 2018. JNPB-103. https://www.researchgate.net/publication/326925849.

Kiani AK, Maltese PE, Dautaj A, et al. Neurobiological basis of chiropractic manipulative treatment of the spine in the care of major depression. Acta Biomed. 2020 Nov 9;91(13-S):e2020006. DOI 10.23750/abm.v91i13-S.10536.

Levenson RW. Emotion and the autonomic nervous system: introduction to the special section. Emotion Review. 2014;6(2):91-2.

Liebenson CS, Yeomans SG. Yellow flags: Early identification of risk factors of chronicity in acute patients. J Rehabil Outcomes Meas. 2000;4(2):31-40.

Liebenson, C, Yeomans S. Assessment of psychosocial risk factors of chronicity- "yellow flags". in Rehabilitation of the Spine: A Practitioners Manual, C. Liebenson. Ed. 2007, Lippencott Williams & Wilkins: Baltimore. p 183-202.

Linton SJ. A review of psychological risk factors in back and neck pain. Spine. 2000;25:1148-56.

Lopez-Lopez A, Alonso Perez JL, González Gutierez JL, et al. Mobilization versus manipulations versus sustained apophyseal natural glide techniques and interaction with psychological factors for patients with chronic neck pain: randomized controlled trial. Eur J Phys Rehabil Med. 2015;51(2):121-32.

Manceaux AG, Pelicier Y, Beltran Ret al Cénesthopathie grave provoquée par une luxation d'une vertèbre cervicale et guérie par manipulation vertébrale [Severe cenesthopathia caused by dislocation of cervical vertebra & recovery by vertebral manipulation]. Rev Otoneuroophtalmol. 1956;28(7):442-5.

Monti DA, Stoner ME, Zivin G, et al. Short term correlates of the Neuro Emotional Technique for cancer-related traumatic stress symptoms: A pilot case series . J Cancer Surviv. 2007;1:161-6.

Norman GJ, Berntson GG, Cacioppo JT. Emotion, somatovisceral afference, and autonomic regulation. Emotion Rev. 2014;6(2):113-23.

Radanov BP, Dvorak J, Valach L. Cognitive deficits in patients after soft tissue injury of the cervical spine. Spine 1992;17(2):127-31.

Rees CS, Smith AJ, O'Sullivan PB, et al. Back and neck pain are related to mental health problems in adolescence. BMC Public Health. 2011 May 25;11:382. DOI 10.1186/1471-2458-11-382.

Schaible HG. Spinal mechanisms contributing to joint pain. Novartis Found Symp. 2004;260:4-22; discussion 22-7, 100-4, 277-9.

Schell E, Theorell T, Hasson D, et al. Stress biomarkers' associations to pain in the neck, shoulder and back in healthy media workers: 12-month prospective follow-up. Eur Spine J. 2008;17(3):393-405. DOI 10.1007/s00586-007-0554-0.

Şimşek TT, Bol H, Şimşek IE, et al. The effects of osteopathic treatment on constipation in children with cerebral palsy: a pilot study. J Manipulative Physiol Ther. 2009;32(8):648-53.

Spain V. Efficacy of manual therapy on frequency and intensity of pain, anxiety and depression in patients with tension-type headache. A randomized controlled clinical trial. Int J Osteopath Med. 2016;22:11–20.

Stallknecht SE, Strandberg-Larsen K, Hestbæk L, et al. Spinal pain and co-occurrence with stress and general well-being among young adolescents: a study within the Danish National Birth Cohort. Eur J Pediatr. 2017;176(6):807-814. DOI 10.1007/s00431-017-2915-y.

Tomic S, Petkovic I, Pucic T, et al. Cervical dystonia and quality of life. Acta Neurol Belg. 2016;116(4):589-92.

Tuckey B, Srbely J, Rigney G, et al. impaired lymphatic drainage and interstitial inflammatory stasis in chronic musculoskeletal and idiopathic pain syndromes: Exploring a novel mechanism. Front Pain Res (Lausanne). 2021;2:691740. DOI 10.3389/fpain.2021.691740.

Vallone SA, Barnes TA, Whittman R, et al. Dr Lorraine M Goldman – leading an eloquent life at Kentuckiana Children's Centre. Chiropr Hist. 2007;27(2):21-33.

Vallone SA, Miller J, Larsdotter A, et al. Chiropractic approach to the management of children. Chiropr Man Ther. 2010;18(16): https://doi.org/10.1186/1746-1340-18-16.

Watson KD, Papageorgiou AC, Jones GT, et al. Low back pain in schoolchildren: the role of mechanical and psychosocial factors. Arch Dis Child. 2003;88(1):12-7. DOI 10.1136/adc.88.1.12.

West Mesa Wellness. Did you know chiropractors ran hospitals? Oct 12, 2016. https://westmesawellness.wordpress.com/2016/10/12/did-you-know-chiropractors-ran-hospitals/.

Williams NH, Hendry M, Lewis R, et al: Psychological response in spinal manipulation (PRISM): A systematic review or psychological outcomes in randomized controlled trials. Complement Ther Med. 2007;15, 271-83.

Myophysiology and Myopathophysiology

'Persistent excitation irritation in that segment of the spinal cord and disorganization of deep short back muscle function are associated with over-stretching of richly innervated soft tissues of the same dislocating segment.' (Gongal'skiĭ & Andreenko, 1992)

The involvement of both the intrinsic and skeletal muscles are integral to the subluxation complex along with the sensory response from with ligaments, capsules and facets. They are involved with a sensory and a mechanical response, a diagnostic symptom and can be a form of protopathic response. (Yamashita et al, 1990; Vernon, 2012; Holm et al, 2002; Kang et al, 2002; Cavanaugh, 2006)

Sensitive palpation of hypertonicity of the intrinsic muscles at a segmental level can be detected. Depending on duration and severity, hypertonicity of the larger postural muscles may also become apparent. In acute cases splinting or guarding of the major spinal muscles may occur. (Doherty, 2020)

In addition, Haavik and colleagues noted the substantial sensory input from the intrinsic muscles at the level of segmental dysfunction, the integrated role of the brain, and the significance of vertebral adjustments in modifying the disturbance. (Haavik et al, 2021)

Intrinsic muscle hypertonicity in particular, would naturally compromise and lead to a loss of motion in adjacent segments because of their origin and insertions.

The larger paraspinal muscles may also react to the mechanical changes and lead to postural compensation and antalgia in acute cases.

In another component of the subluxation complex (myopathology or myopathophysiology), Edwards et al proposed that autonomic variables can be influenced by afferent muscle spindle activation, particularly from the posterior muscles of the neck. Further, that cardiorespiratory variables rely on interaction between the somatic and autonomic systems, essentially somatosympathetic reflexes. (Edwards et al, 2007)

Muscles innervated from the affected segmental level may experience kinesiological weakness which may be determined by muscle testing, as:

- Intrinsic muscular hypertonicity
- Postural muscle hypertonicity
- Muscular splinting/guarding
- Segmental compensation
- Postural compensation (global)
- Antalgia
- Degrees of atonia – loss of individual muscle strength
- Stress
- Prolonger physical activity

- Lack of physical activity

A 2020 study by Wong et al noted that '*Lumbar spine manipulation can result in immediate lower-limb isometric strength increases. While healthy people with normal muscle strength may improve minimally, joint manipulation for people with knee and hip weakness who are otherwise healthy can result in large effect size strength gains*.' (Wong et al, 2020)

Extended reference compilation

Myopathophysiological studies

Amonoo-Kuofi HS. The density of muscle spindles in the medial, intermediate and lateral columns of human intrinsic postvertebral muscles. J Anat 1983;136:509-19.

Cavanaugh JM, Lu Y, Chen C, Kallakuri S. Pain generation in lumbar and cervical facet joints. J Bone Joint Surg Am. 2006;88 Suppl 2:63-7. DOI 10.2106/JBJS.E.01411.

Çirak YB, Yurdaişik I, Elbaşi ND, et al. Effect of sustained natural apophyseal glides on stiffness of lumbar stabilizer muscles in patients with nonspecific low back pain: Randomized controlled trial. J Manipulative Physiol Ther. 2021;44(6):445-54.

Dougherty P. Somatosensory systems. Neuroscience Online. Oct 2020. https://nba.uth.tmc.edu/neuroscience/m/s2/chapter02.html.

Edwards IJ, Dallas ML, Poole SL, et al. The neurochemically diverse intermedius nucleus of the medulla as a source of excitatory and inhibitory synaptic input to the nucleus tractus solitarii. J Neurosci 2007;27(31):8324-8333.

Fritz JM, Koppenhaver SL, Kawchuk GN, et al. Preliminary investigation of the mechanisms underlying the effects of manipulation: exploration of a multivariate model including spinal stiffness, multifidus recruitment, and clinical findings. Spine (Phila Pa 1976). 2011;36(21):1772-81.

Fryer G, Morris T, Gibbons P. Paraspinal muscles and intervertebral dysfunction: part one. J Manipulative Physiol Ther. 2004;27(4):267-74. DOI 10.1016/j.jmpt.2004.02.006.

Gao J, Caldwell J, Wells M, et al. Ultrasound shear wave elastography to assess tissue mechanical properties in somatic dysfunction: A feasibility study. J Am Osteopath Assoc. 2020 Aug 5. DOI 10.7556/jaoa.2020.108.

Gongal'skiĭ VV, Andreenko TV. Izmeneniia myshechnoĭ tkani pri vertebrogennykh miofastsial'nykh sindrdomakh [Changes in muscle tissue in vertebrogenic myofascial syndromes]. Neirofiziologiia. 1992;24(3):298-306. Russian. PMID: 1513404. https://link.springer.com/article/10.1007/BF01057166.

Haavik H, Kumari N, Holt K, et al. The contemporary model of vertebral column joint dysfunction and impact of high-velocity, low amplitude controlled thrusts on neuromuscular function. Europ J Applied Physiol. 2021;121:2675-2720. https://doi.org/10.1007/s00421-021-04727-z

Haavik H, Niaza IK, Jochumsen M, et al. Impact of spinal manipulation on cortical drive to upper and lower limb muscles. Brain Sci. 2017;7(1),2. https://doi.org/10.3390/brainsci7010002

Holm S, Indahl A, Solomonow M. Sensorimotor control of the spine. J Electromyogr Kinesiol. 2002 Jun;12(3):219-34. DOI 10.1016/s1050-6411(02)00028-7.

Indahl A, Kaigle AM, Reikeras O, et al. Interaction between the porcine lumbar intervertebral disc, zygapophyseal joints, and paraspinal muscles. Spine. 1997;22(24):2834-40.

Kang YM, Choi WS, Pickar JG. Electrophysiologic evidence for an intersegmental reflex pathway between lumbar paraspinal tissues. Spine (Phila Pa 1976). 2002;27(3):E56-63. DOI 10.1097/00007632-200202010-00005.

Lantz CA.The vertebral subuxation complex PART 2: The neuropathological and myopathological components. Chiropr Res J. 1990;1(4):19-38.

Mehyar F, Santos M, Wilson SE, et al. Immediate effect of lumbar mobilization on activity of erector spinae and lumbar multifidus muscles. J Manipulative Physiol Ther. 2017;16(4):271-8.

Murphy BA, Dawson NJ, Slack JR. Sacroiliac joint manipulation decreases the H-reflex. Electromyog Clin Neurophysiol. 1995;35(2):87-94.

Navid MS, Niazi IK, Lelic D, et al. Chiropractic Spinal Adjustment Increases the Cortical Drive to the Lower Limb Muscle in Chronic Stroke Patients. Front Neurol. 2022;12:747261. DOI 10.3389/fneur.2021.747261.

Niazi, I.K., Türker, K.S., Flavel, S. et al. Changes in H-reflex and V-waves following spinal manipulation. Exp Brain Res. 2015;233:1165-73. https://doi.org/10.1007/s00221-014-4193-5.

Nogueira N, Oliveira-Campelo N, Lopes A, et al. The acute effects of manual and instrument-assisted cervical spine manipulation on pressure pain threshold, pressure pain perception, and muscle-related variables in asymptomatic subjects: a randomized controlled trial. J Manipulative Physiol Ther. 2020;43(3):179-88.

Pickar JG, Bolton PS. Spinal manipulative therapy and somatosensory activation. J Electromyogr Kinesiol. 2012;22(5):785-94. DOI 10.1016/j.jelekin.2012.01.015.

Pickar JG, Sung PS, Kang YM, et al. Response of lumbar paraspinal muscles spindles is greater to spinal manipulative loading compared with slower loading under length control. Spine J. 2007;7(5):583-95.

Potter L, McCarthy C, Oldham J. Physiological effects of spinal manipulation: a review of proposed theories. Physical Ther Rev. 2005;10(3):163-79.

Prochazka A. Sensory control of normal movement and of movement aided by neural prostheses. J Anat. 2015 Aug;227(2):167-77. DOI 10.1111/joa.12311.

Reed WR, Pickar JG, Sozio RS, et al. Characteristics of paraspinal muscle spindle response to mechanically assisted spinal manipulation: A preliminary report. J Manipulative Physiol Ther. 2017;40(6):371-80. DOI 10.1016/j.jmpt.2017.03.006.

Reed WR, Pickar JG. Paraspinal muscle spindle response to intervertebral fixation and segmental thrust level during spinal manipulation in an animal model. Spine. 2015, 40, E752–E759.

Robinault L, Holobar A, Crémoux S, et al. The effects of spinal manipulation on motor unit behavior. Brain Sci. 2021;11(1):105. DOI 10.3390/brainsci11010105.

Sillevis R, Hogg R. Anatomy and clinical relevance of sub occipital soft tissue connections with the dura mater in the upper cervical spine. PeerJ. 2020;8:e9716. DOI 10.7717/peerj.9716.

Sung PS, Kang YM, Pickar JG. Effect of spinal manipulation duration on low threshold mechanoreceptors in lumbar paraspinal muscles: a preliminary report. Spine (Phila Pa 1976). 2005;30(1):115-22.

Thabe H. Electromyography as a tool to document diagnostic findings and therapeutic results associated with somatic dysfunctions in the upper cervical spinal joints and sacroiliac joints. Man Med. 1986;2:53-8.

Van Buskirk RL. Nociceptive reflexes and the somatic dysfunction: A model. J Amer Osteop Ass 1990;90(9):792-809.

Vernon, H. What is different about spinal pain? Chiropr Man Ther 2012;20,22. https://doi.org/10.1186/2045-709X-20-22.

Wilson LB. Spinal modulation of the muscle pressor reflex of the decerebrate cat: response of spinal interneurons to natural stimulation of neck vestibular receptors. J Neurophysiol 1984;51:567-77.

Wong CK, Conway L, Fleming G, et al. Immediate effects of a single spinal manipulation on lower-limb strength in healthy individuals: a critically appraised topic. J Sport Rehabil. 2020;30(1):161-5.

Yamashita T, Cavanaugh JM, el-Bohy AA, et al. Mechanosensitive afferent units in the lumbar facet joint. J Bone Joint Surg Am. 1990;72(6):865-70.

Clinical association

The superficial categorising of vertebrogenic conditions addressed by spinal manipulation as Type O, Type M, or MSK classifications where neural disruption is claimed as being confined to affecting only musculoskeletal conditions (Type M), is physiologically irrational. Where there is a demonstrated pathophysiological somatovisceral reflex effect upon vascular (Type V) and visceral/organic conditions (Type O), such categorisation is inappropriate.

Leach neutralises the distraction by offering a Type N (neurological) which would more accurately covers the conditions as all subluxations involve a neurological component to one degree or another. (Leach, 1994, p121)

It is suggested here that the apparent association between certain functional visceral conditions and physiologically disturbed vertebrae is pathophysiologically feasible and supported by substantial independent evidence. Further, as one of the key elements of a subluxation complex, this rationale is based on activated somatosensory, somatovascular, somatovisceral and somatoautonomic reflexes. These pathophysiological phenomena are recognised neural mechanisms and are offered as the explanatory link to a range of conditions.

Given that a subluxation is a disturbed somatic structure, it can activate noxious mechanosensory receptors with pain, headaches, and sciatica, being basic examples. Many medical, chiropractic and osteopathic studies report the apparent association which seems ratified by positive clinical outcomes noted in the literature.

Diagnosis of subluxations is a science-based skill. A thorough case history is the first step followed by a general physical, orthopaedic and neurological examination. When indicated, a spinal examination would be conducted to assess segmental integrity. This may incorporate motion palpation to assess segmental fixations or hypermobile segments, individual vertebral alignment, and muscle tone particularly of the intrinsic muscles. (Bourdillon & Day, 1988; Manakomi & Das, 2022)

Pain or a degree of it, are likely to be the most common factor which often causes a patient to seek manipulative care in the first place.

There appears to be a distinct overlap between somatovisceral pain syndromes and clear diagnosis of visceral conditions. Murtagh highlights this in his designation of masquerades or mimicked conditions. (p223 Table 25.1) Records of a 1963 study by Bechgaard lists 75 cases of nine different conditions presenting at hospital admission, where 85% were released with a diagnosis of segmental pain syndrome. (Kaltenborn 2009) Similarly, a study by Bruckner (1987) found similar symptoms resolved through spinal manipulation, finding that the condition was '*common*'. (Bechgaard, 1963; Kaltenborn, 2009; Murtagh & Rosenblatt, 2011)

The aim is to diagnose the existence of a subluxation at a spinal level which may correlate with the symptoms and signs. Such an association could justify manual intervention by way of an adjustment directed towards correcting the subluxation, neutralising associated neural aberrations, and normalising associated signs, symptoms, articular, muscle, vascular or organic dysfunctions. In other words, seeking to normalise associated pathophysiology.

The adage of listening to the patient and they will essentially tell you the diagnosis applies in the manual therapies. Non-textbook cases may present to a clinic. Some rather unusual signs and symptoms can offer guidance as to the type, location and nature of an associated subluxation. (Rome & McKibbin, 2011)

Manipulative care has been shown to provide pain relief in a range of conditions promoting patient comfort. Chiropractic care scored the highest pain relief rating (7.33 out of 10), scoring higher than the relief provided by either nerve blocks (6.75) or opioid analgesics (6.37). (Jensen et al, 2005)

It can be noted that in oncology manipulative care is particularly directed at patient comfort, symptomatic relief, pain relief, and mobility. (Steel et al, 2018; Schneider & Gilford, 2001; Pujol & Monti, 2007; Laoudikou & McCarthy, 2020)

Extended reference compilation

Regarding a clinical association with manipulation

Bechgaard P. The pain syndrome in the thoracic portion and the importance of its differential diagnosis. Nord Med. 1963;69:675-80.

Bourdillom JF, Day EA. Spinal manipulation. Norwalk. Appleton & Langer. 1988;40-57.

Bruckner FE, Allard SA, Moussa NA. Benign thoracic pain. J Royal Soc Med. 1987;80(5):286-9.

English-Word Information. https://wordinfo.info/unit/1726.

Jensen MP, Abresch RT, Carter GT, McDonald CM. Chronic pain in persons with neuromuscular disease. Arch Phys Med Rehab. 2005;86(6):1155-63. (Accessed on https://chiro.org/ChiroZine/ABSTRACTS/Chronic_Pain_in_Persons.shtml).

Kaltenborn FM. The Spine. 5e. Norway, Norli, Universitetsgaten, 2009:107.

Kent C, Gentempo P. Dysponesis: chiropractic in a word. https://insightcla.com/dysponesis-chiropractic-in-a-word/.

Leach RA. The chiropractic theories: Principles and clinical application. 3e. Baltimore; Williams and Wilkins. 1994;373-94.

Munakomi S, Das JM. Cervical subluxation. [Updated 2022 Nov 27]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK559144.

Murtagh J, Rosenblatt J. In:Murtach's general practice. 5e. North Ryde. McGraw-Hill Aust.2011:223.

National Cancer Institute. Manipulative and body-based practice. National Institutes of Health US. https://www.cancer.gov/publications/dictionaries/cancer-terms/def/manipulative-and-body-based-practice

National Cancer Institute. National Institute of Health. https://www.cancer.gov/about-cancer/treatment/cam.

Rome PL, McKibbin MR. Towards defining unclassified symptoms: eclectic conditions presenting in two chiropractic clinics. Chiropr J Aust. 2011;41(3):83-94.

Medical oncology and manipulation

The *National Cancer Institute* of the US discusses a range of alternative and complementary health models and lists chiropractic therapy under *Complementary and Alternative Medicine* which it describes as '*A type of therapy in which the therapist moves or manipulates one or more parts of the patient's body. It may be used to treat pain, stress, anxiety, and depression, and for general well-being. Examples include chiropractic treatments, physical therapy, and massage therapy. Also called manual healing and physical touch methods*.' (National Cancer Institute, undated)

Cancer Research UK also lists chiropractic as a possible model for helping to manage some of the symptoms associated with cancer by stating '*People with cancer see a chiropractor to help control pain, headaches and tension. There is some scientific evidence that chiropractic treatment might help relieve headaches and back pain.*' (National Cancer Institute, Undated; Cancer Research UK, Undated)

While manipulative techniques may be used on cancer patients, it is principally directed at the amelioration of symptoms rather than for the treatment of neoplastic conditions. Yao et al stated that subject to certain limitations '*Manual therapy was an effective intervention, which may have immediate effect on cancer pain and may improve physical function and global well-being*.' (Yao et al, 2021)

Extended reference compilation

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Alcantara J, Alcantara JD, Alcantara J. The chiropractic care of patients with cancer: a systematic review of the literature. Integr Cancer Ther. 2012;11(4):304-12. DOI 10.1177/1534735411403309.

Arienti C, Bosisio T, Ratti S, et al. Osteopathic manipulative treatment effect on pain relief and quality of life in oncology geriatric patients: a nonrandomized controlled clinical trial. Integr Cancer Ther. 2018 Dec;17(4):1163-71.

Cancer Research UK. https://www.cancerresearchuk.org/about-cancer/cancer-in-general/treatment/complementary-alternative-therapies/individual-therapies/chiropractic-care.

Daniels B. Chiropractic treatment of cancer pain. In: Herndon CM.(ed.) Pain. 2022;online edn, Oxford Academic. , 1 Mar. 2022:49-58. https://doi.org/10.1093/med/9780197542873.003.0006.

Kanga I, Steiman I. Chiropractic management of a patient with breast cancer metastases to the brain and spine: a case report. J Can Chiropr Assoc. 2015;59(3):269-78.

Laoudikou MT, McCarthy PW. Patients with cancer. Is there a role for chiropractic? J Can Chiropr Assoc. 2020;64(1):32-42.

Menefee LA, Monti DA. Nonpharmacologic and complementary approaches to cancer pain management. J Am Osteopath Assoc. 2005;105(11 Suppl 5):S15-20.

Molassiotis A, Fernandez-Ortega P, Pud D, et al. Use of complementary and alternative medicine in cancer patients: a European survey. Annals of Oncology. 2005;16(4):655-63. 10. https://www.annalsofoncology.org/article/S0923-7534(19)47732-6/fulltext

Pujol LA, Monti DA. Managing cancer pain with nonpharmacologic and complementary therapies. J Am Osteopath Assoc. 2007;107(12 Suppl 7):ES15-21.

Schneider J, Gilford S. The chiropractor's role in pain management for oncology patients. J Manipulative Physiol Ther. 2001;24(1):52-7.

Steel A, Tricou C, Monsarrat T. et al. The perceptions and experiences of osteopathic treatment among cancer patients in palliative care: a qualitative study. Support Care Cancer. 2018 Oct;26(10):3627-3633. DOI 10.1007/s00520-018-4233-y.

Yao C, Cheng Y, Zhu Q, et al. Clinical evidence for the effects of manual therapy on cancer pain: a systematic review and meta-analysis. Evid Based Complement Alternat Med. 2021;2021:6678184. DOI 10.1155/2021/6678184.

To be continued

This series will conclude as Part 6 by reporting evidence supportive of Principle 5, that '*a Chiropractor's manual intervention to correct subluxations is associated with changes to dysfunction and neural pathophysiology*'. These changes are shown to ameliorate symptoms and restore physiology.

We consider this principle critical to understanding the Vertebral Subluxation Complex.

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See also

Rome PL. Waterhouse JD. The Vertebral Subluxation premise: Part 1: The medical literature regarding nomenclature. Asia-Pacific Chiropr J. 2023;4.1. URL apcj.net/papers-issue-4-1/#RWVSCPremisePart1.

Rome PL. Waterhouse JD. The Vertebral Subluxation premise: Principle 1 continued, The medical literature regarding nomenclature and onset. Asia-Pacific Chiropr J. 2023;4.2. URL apcj.net/papers-issue-4-2/#RWVSCPrinciple1b

Rome PL. Waterhouse JD. The Vertebral Subluxation premise: Principle 2, the somatic vertebrogenic element. Asia-Pacific Chiropr J. 2023;4.2. URL apcj.net/papers-issue-4-2/#RWVSCPrinciple2

Rome PL. Waterhouse JD. The Vertebral Subluxation premise: Principle 3, altered physiological functions. Asia-Pacific Chiropr J. 2023;4.2. URL apcj.net/papers-issue-4-2/#RWVSCPrinciple3