Explore 000 (2019) 1–6

Contents lists available at ScienceDirect

Explore

journal homepage: www.elsevier.com/locate/jsch

# Remission of anosmia in a patient receiving chiropractic care: A case report

David G. Russell

*317 Pakuranga Rd, Pakuranga, Auckland, 2010, New Zealand*

ARTICLE INFO

*Keywords:*
Chiropractic
Anosmia
Older Adult
Aged
Quality of Life
Vertebral Subluxation Complex

ABSTRACT

*Objective:* To chronicle the remission of anosmia in a 79-year-old female receiving chiropractic care using the Activator Methods Chiropractic Technique (AMCT) protocol.
*Clinical features:* A 79-year-old white female with a 4-year history of medically diagnosed anosmia. Postural alterations, reduction in cervical ranges of motion (ROM), and absent cranial nerve I function were found in conjunction with vertebral subluxation throughout the spine and mild to severe degenerative changes throughout the spine present on radiographic studies.
*Intervention & Outcomes:* Chiropractic care using AMCT was provided for the assessment and correction of vertebral subluxations. The patient reported subjective improvement in olfaction, physical functioning and life enjoyment, and demonstrated objective improvement in posture, cervical ROM, cranial nerve I function.
*Conclusion:* A course of chiropractic care, following the AMCT protocol, was associated with remission of anosmia.



## Introduction

Anosmia is characterized by permanent or temporary complete loss of the sense of smell (olfaction).[1] Prevalence of impaired olfaction is reported to range from 5% to 24.5% of the adult population.[2–4] Anosmia is less common, reported to be as low as 0.3% to 0.8% of the adult population.[3,5] It is recognized that impairment in olfaction is potentially difficult to diagnose and under reported.[4–10] Olfactory impairment increases with age, and has been reported as being prevalent in up to 62.5% of those aged 80 and over.[2,4]

Anosmia is most commonly the result of a chronic disease process, upper respiratory tract infection, nasal congestion, head trauma, stroke, neurodegenerative disorder, or current cigarette smoker.[4,10–13] More rarely anosmia is congenital or postoperative.[14,15] Postoperative anosmia is typically short-term in nature, lasting only weeks.[15]

Anosmia can have significant impact on life satisfaction, quality of life (QoL) and safety.[3,7,9,10,15–17] Reduction in QoL can lead to episodes of depression.[10,17] Anosmia poses concerns for health and safety through inability to identify potentially spoilt food, and harmful chemicals and gases.[3,7,9,10,16] Van Toller uses Maslow's hierarchy of human needs to highlight the importance of sense of smell in relation to physiological, safety, belonging, esteem, cognitive and aesthetic needs.[17]

An aim of chiropractic care is to optimize health and wellbeing through the enhancement of the nervous system function by removing nerve interference caused by vertebral subluxation.[18] A vertebral subluxation represents an altered state of afferent input which can lead to maladaptive changes in central neural plasticity resulting in dysfunction.[18,19] There is a current paucity of literature describing the chiropractic management of patients with anosmia.[20–23] The purpose of this case study is to report the response of a 79-year-old female with anosmia to Activator Methods Chiropractic Technique (AMCT) for the assessment and correction of vertebral subluxation.

## Case report

### History

A 79-year-old Caucasian female presented with a 4-year history of neck pain and self-reported postural alterations feeling "stooped" and "lacking flexibility". The neck pain was rated as constantly 4 out of 10 on a 10-point pain scale, increasing to 6 out of 10 when moving, and affected her ability to sleep. The patient reported a constant headache located at the front of her head, and low back discomfort that has been present "for years".

The patient had a history of breast and lung cancer and cardiac surgery. She had a breast cancer (infiltrating duct carcinoma) removal and partial mastectomy of the left breast and the right breast, 18 and 3 years prior to presenting for chiropractic care. Lung adenocarcinomas were removed over 2 separate surgeries, and she had a pacemaker installation and ablation 4 years prior to presenting for

*E-mail address:* dgrchiro@gmail.com

https://doi.org/10.1016/j.explore.2019.07.012
1550-8307/

chiropractic care. Immediately following cardiac ablation surgery, the patient reported "complete loss of smell and significantly impaired taste". Anosmia was diagnosed by an Ear, Nose and Throat (ENT) medical specialist, who prescribed steroids without effect. The patient has now had a 4-year history of anosmia, and has check-ups with the specialist at 12-month intervals.

The patient subjectively rated her physical health as 5 out of 10 and mental health as 10 out of 10 at her initial presentation on a 10-point numeric rating scale where 1 is worst and 10 is best. Additionally, she was assessed using the self-reported Health Wellness and Quality of Life (HWQL) instrument, which measures 5 domains.[24,25] The self-reported assessment scores were physical functioning (50%), mental and emotional state (73%), stress evaluation (88%), life enjoyment (61%), and overall QoL (74%) (Fig. 1).

*Examination*

Posture examination, performed by observation, revealed a markedly higher left hip, shoulder and occiput, with right head rotation and forward head carriage. Cervical spine ranges of motion (ROM), using bubble inclinometry,[26] revealed flexion of 40°, extension of 40° (with 6 out of 10 pain reported on active motion), left lateral flexion of 8° and right lateral flexion of 10°.

Cranial nerve I (olfactory) testing confirmed anosmia, previously diagnosed by the patient's ENT specialist. Orange, vanilla, coffee and peppermint scents were used for testing olfaction. No other cranial nerve or vital sign assessments were performed.

Initial chiropractic examination for vertebral subluxation was performed using commonly used direct clinical indicators including intersegmental motion palpation, specific soft tissue palpation, joint play/end feel, leg length inequality and Derifield.[27] The examination revealed a right leg length inequality, positive right Derifield (short leg appearing longer when knees flexed to 90°), left sacral restriction (Restriction in left leg extension) and left fast cervical syndrome (balancing of short leg on right head rotation). Static palpation revealed hypertonicity of the right Levator Scapula, left Superior Oblique, left Scaleneus Medius, bilateral Quadratus Lumborum and paraspinal muscles at C7-T6 on the right and T1-4 on the left. Spinal palpation revealed reduced joint play (end-feel) at C1-2, C5, T1-5, L2, and the right sacroiliac joint, and inter-segmental motion restriction of C1 on the right and C2 on the left, and C5 on extension.

Thermography and surface EMG (sEMG) studies were performed using the Insight Millennium instrument. Paraspinal thermography is used as an indirect measure of autonomic nervous system function (dysautonomia) to assess the impact of vertebral subluxation or joint dysfunction on the nervous system.[28,29] Thermography revealed varying degrees of autonomic abnormality at C1, C6-T1 and T10. Surface EMG is used to measure paraspinal muscle dysfunction, a manifestation of vertebral subluxation, and a neuromuscular response to chiropractic care.[30,31] Surface EMG revealed areas of hyperactivity at C3, with hypoactivity recorded generally throughout the spine (Fig. 2).

Full spine radiographic studies were reported by a radiologist. The report described slight loss of C5-6 alignment, severe degeneration at the right C3-4 and C4-5 and left C5-6 interlaminar joints with associated foraminal narrowing at these levels. The thoracic kyphosis was increased with mild degenerative changes throughout. The lumbar lordosis was mildly exaggerated with severe facet joint degeneration at L5-S1, mild degeneration was noted at L2-3 and L4-5. Radiographic findings were reported by a medical radiologist.

Base on the patients' presentation and examination, a clinical impression of anosmia, biomechanical neck pain and vertebral subluxation was derived.

*Intervention and outcomes*

Chiropractic care was initially administered twice weekly over a period of 5-weeks using AMCT protocol. AMCT protocol uses a functional leg-length analysis combined with provocative maneuvers (isolation, pressure and stress tests) to determine involved spinal levels, and a hand-held instrument to deliver a specific, high-velocity, low-amplitude thrust for the correction of vertebral subluxation.[32]

From the 3rd visit during the course of chiropractic care the patient reported awareness of various scents (including chlorine, onions, eucalyptus and floral perfume). At the 9th visit she became aware of tastes (chocolate, licorice and tomato). Her neck pain and headaches were reported as reduced from the 2nd visit and resolved

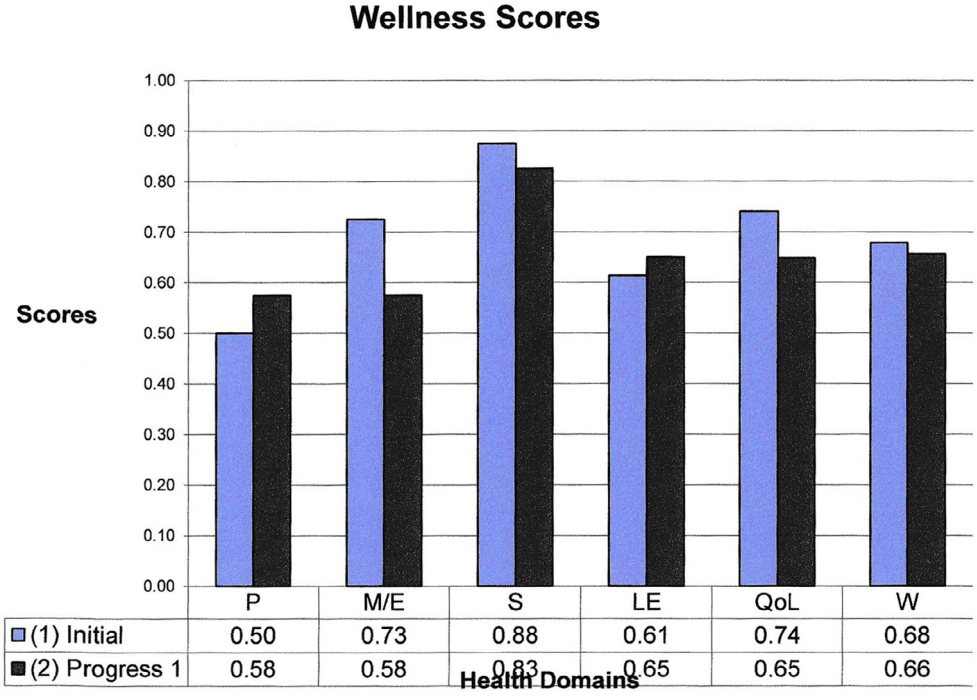


**Fig. 1.** HWQL comparative results pre and post chiropractic care.

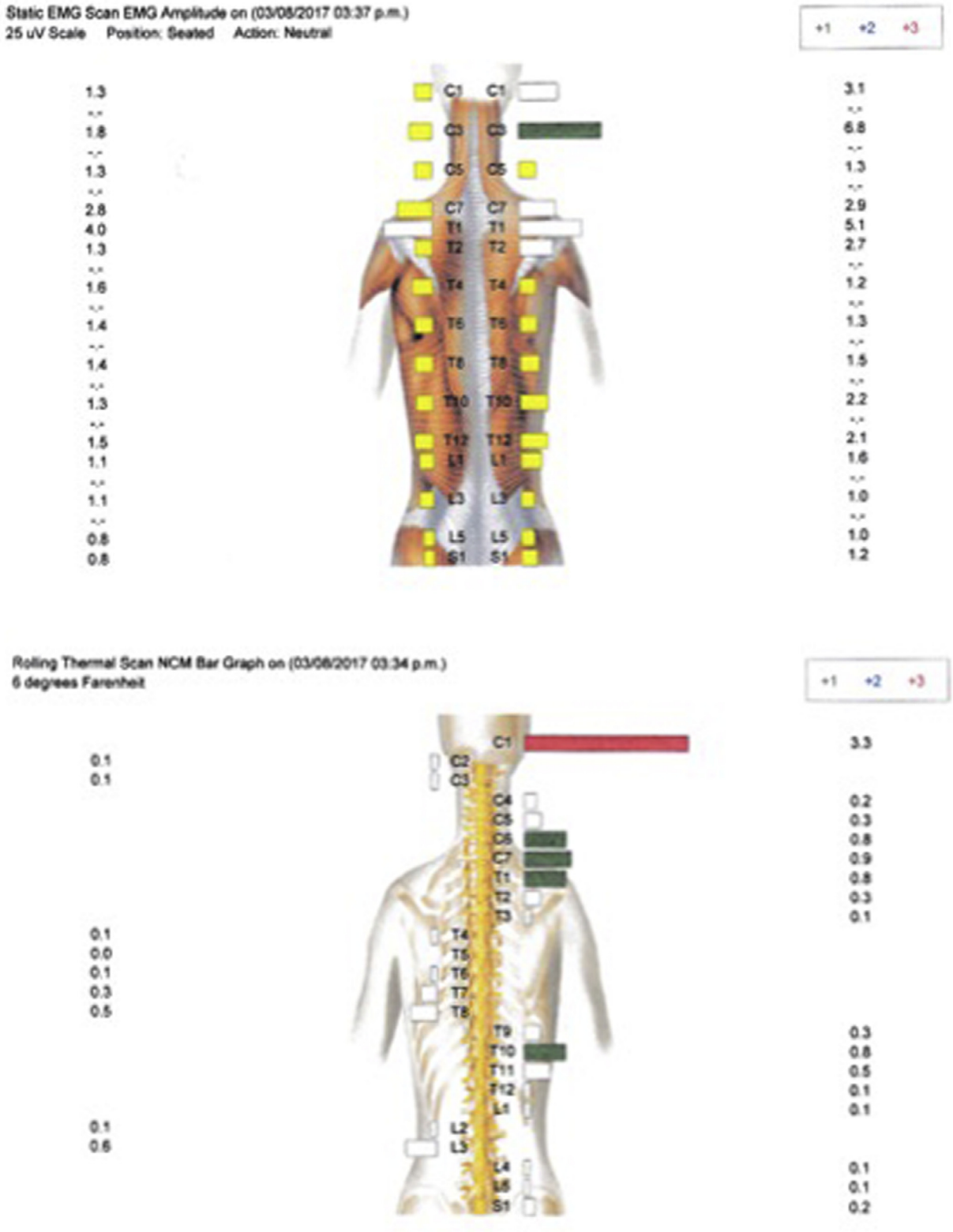


**Fig. 2.** sEMG and Thermography assessment results prior to a course of chiropractic care.

by the 8th visit. Her sleeping patterns had improved from the 6th visit. Low back discomfort remained consistent throughout the course of care. For a compete summary of patient subjective reports see Table 1.

A progress examination was performed on the 10th visit which included patient self-reported physical and mental health, and HWQL assessment, and posture, spinal ROM, cranial nerve, vertebral subluxation, thermography and sEMG examinations. Patient perceived physical health rating improved from 5 to 8 out of 10, mental health remaining 10 out of 10. Although positive subjective outcomes were reported, there was a general reduction in domains measured with the HWQL survey revealing a decline in most tested domains, only the physical and life enjoyment domains improving, 8% and 4% respectfully (Fig. 1).

**Table 1**
Adjustment and subjective report summary by visit.

| Visit | Levels adjusted | Patient Subjective Report |
|---|---|---|
| 1 | R med knee, R PI, T12 R, T6 R, C1 R, C0 R | |
| 2 | R med knee, L AS, L5 R, T12 R, T6 R, C7 R, C2 L, C0 R | Slept well, neck not as sore and able to turn head with less neck pain. Low back discomfort is persistent. |
| 3 | L4 L, L2 L, T10 L, T8 R, T4 L, C5 R, C2 L, C0 R | Feels like she is able to smell faint smells. |
| 4 | L4 L, L2 L, T8 L, C5 L, C2 L | Generally feeling good. |
| 5 | L AS, R PI, L4 L, T8 R, T6 R, C1 R, C0 R | I'm recognising specific smells (chlorine in water while showering, fragrance from cleaning products) that I haven't in over 3 years, and neck only occasionally aches at night, low back discomfort is persistent. |
| 6 | L AS, R PI, L5 R, T12 R, T1 R, C5 R, C1 R | Smelling things more frequently. Able to smell more specific smells (cooking meat, onions, and "dog poo" that the dog rolled in). I am also sleeping better at night. |
| 7 | R sup pubis, T6 L, C3 L, C1 R | Able to smell the perfume (rose scent) on a house guest, generally sense of smell is becoming more consistent. |
| 8 | L AS, R PI, C1 R, C0 R | Has a runny nose due to the cold weather. No new smells noticed, but can still smell previously reported scents regularly. Neck has remained free of pain and sleeping well, low back discomfort is persistent. |
| 9 | L med knee, R PI, T6 L, C1 R | Able to identify eucalyptus scent, and for the first time has been able to taste foods (chocolate, liquorice and tomatoes). Neck has remained free of pain and still sleeping well. |
| 10 | L AS, T12 R, T1 rib L | Some left shoulder pain. Low back discomfort is persistent. Is noticing more floral scents (such as perfume). |

Posture examination revealed pelvic and occipital levelling and reduced right head rotation. Cervical spine ROM revealed flexion of 40°, extension of 40° (now without pain), left lateral flexion of 18° (10° increase) and right lateral flexion of 20° (10° increase).

Cranial nerve I (olfactory) testing revealed patient awareness and positive identification of orange, vanilla, coffee and peppermint scents. Additionally, awareness without positive identification of coconut, lavender scents was reported.

Chiropractic examination revealed balanced leg length with no Derifield, sacral restriction or cervical syndrome apparent. Static palpation revealed only right, and paraspinal muscles at C7 on the left and T1 on the right. No obvious restriction in joint play or inter-segmental motion was indicated on spinal palpation. The number of vertebral and extremity subluxations that were adjusted based on the AMCT protocol reduced over the course of care. The number of sites adjusted each visit ranged from 8 to 3. The most commonly adjusted level was C1. For a compete summary of chiropractic care see Table 1.

Thermography revealed varying degrees of autonomic abnormality at C5, C7-T1, T6 and T9. Surface EMG revealed areas of hyperactivity at C1, T1, L5 and S1, and reduction in areas of hypoactivity (Fig. 3). These results represent an overall reduction in dysautonomia and change in paraspinal neuromuscular function.[28–31]

## Discussion

This case chronicles a course of chiropractic care associated with the remission of anosmia. Additionally, improvement in self-reported physical functioning and life enjoyment, posture, cervical ROM, and reduction in vertebral subluxation was found.

Treatment for anosmia is varied, and prognosis is etiology dependant.[8] Conductive types of anosmia, due to instances such as local disease process and nasal polyps, have good prognoses after pharmaceutical or surgical intervention.[8] Sensory-neural types of anosmia have far poorer prognoses, with no recognized pharmacological approach to treatment.[8,33] Treatment approaches include Transcranial Magnetic Stimulation,[34] Zinc, vitamin A and vitamin D supplementation,[7,8,33] steroid treatment,[11,33] smoking cessation,[8,33] olfactory training[8,35] and acupuncture.[8,36] Evidence of the efficacy for these treatment protocols is limited.[8,11,33–36]

There is very limited evidence in the chiropractic literature describing the chiropractic management of patients presenting with anosmia.[7,20–23] Four individual case reports describe improvement in anosmia following chiropractic care (3 upper cervical chiropractic care, 1 Network Spinal Analysis) over varied timeframes (4-weeks to 5-month and 18-day).[20–23] In all 4 case reports patients also presented with musculoskeletal complaints, and correction of vertebral subluxation was associated with improvements in anosmia.[20–23] No other intervention was reported in conjunction with chiropractic care.[20–23]

This case report is the first, to the authors knowledge, to report the use of AMCT for the assessment and correction of vertebral subluxation in the case of a patient presenting with anosmia. In all other reported cases anosmia was self-reported and not formally assessment by a medical specialist.[20–23] In previously reported cases of anosmia improving following a course of chiropractic care, only 2 cases had cranial nerve 1 assessed by the consulting chiropractor,[21,22] and only one confirming improvement with follow-up cranial nerve 1 assessment.[22] Thermography was used as an objective measure of dysautonomia in 2 previously reported cases, however no follow-up assessment was reported to compare with the current case report.[21,22] Surface EMG was used as an objective measure of paraspinal muscle function in 1 previously reported case with comparable improvements to the current case.[23] Only one other reported case used a formal measure of QoL, using the SF-36 instrument, however no follow-up assessment was reported for comparison.[22]

In regard to the current case it is hypothesized that anosmia resulted from a reaction to general anesthetic and the effects this has on the brain neuronal and chemosensory systems which can lead to sensory receptor dysfunction.[15,37,38] It has been reported that general anesthetic has a central effect on GABA neurotransmitters involved with the olfactory memory system and reception. Since GABA is the primary inhibitory neurotransmitter of the brain involving synapses in olfactory bulbs, the relationship between the general anesthetics and postoperative olfactory memory impairment can be attributed to general anesthetic use. In many cases this impairment is only a short term effect. It is hypothesized that the reduction of the effects of vertebral subluxation (both biomechanical and neurophysiological) following chiropractic care may have contributed to improved neuroplastic changes in the brain.[39–42] Following chiropractic care it is possible that the changes in nerve and brain function, that are thought to help restore homeostasis, may have improved impaired olfactory function.

The Australian Spinal Research Foundation conceptually define vertebral subluxation as *"a diminished state of being, comprising of a state of reduced coherence, altered biomechanical function, altered neurological function and altered adaptability."*[43] A vertebral subluxation has been recognized as a complex of functional and/or structural changes in the articulations of the spine and pelvis that compromise neural integrity and may influence organ system function and general health.[44] Vertebral subluxation correction is achieved through chiropractic adjustments that are a typically manually performed.

Overall positive results were seen in anosmia and aspects of patient-perceived QoL. There is limited current research investigating the effects of chiropractic care on anosmia. However, the outcome of this case report is congruent with previously published studies reporting the effects of chiropractic care on anosmia.[20–23] More research is needed to investigate the role chiropractors may play in helping similar patients so as to inform clinical practice and future higher-level research designs.

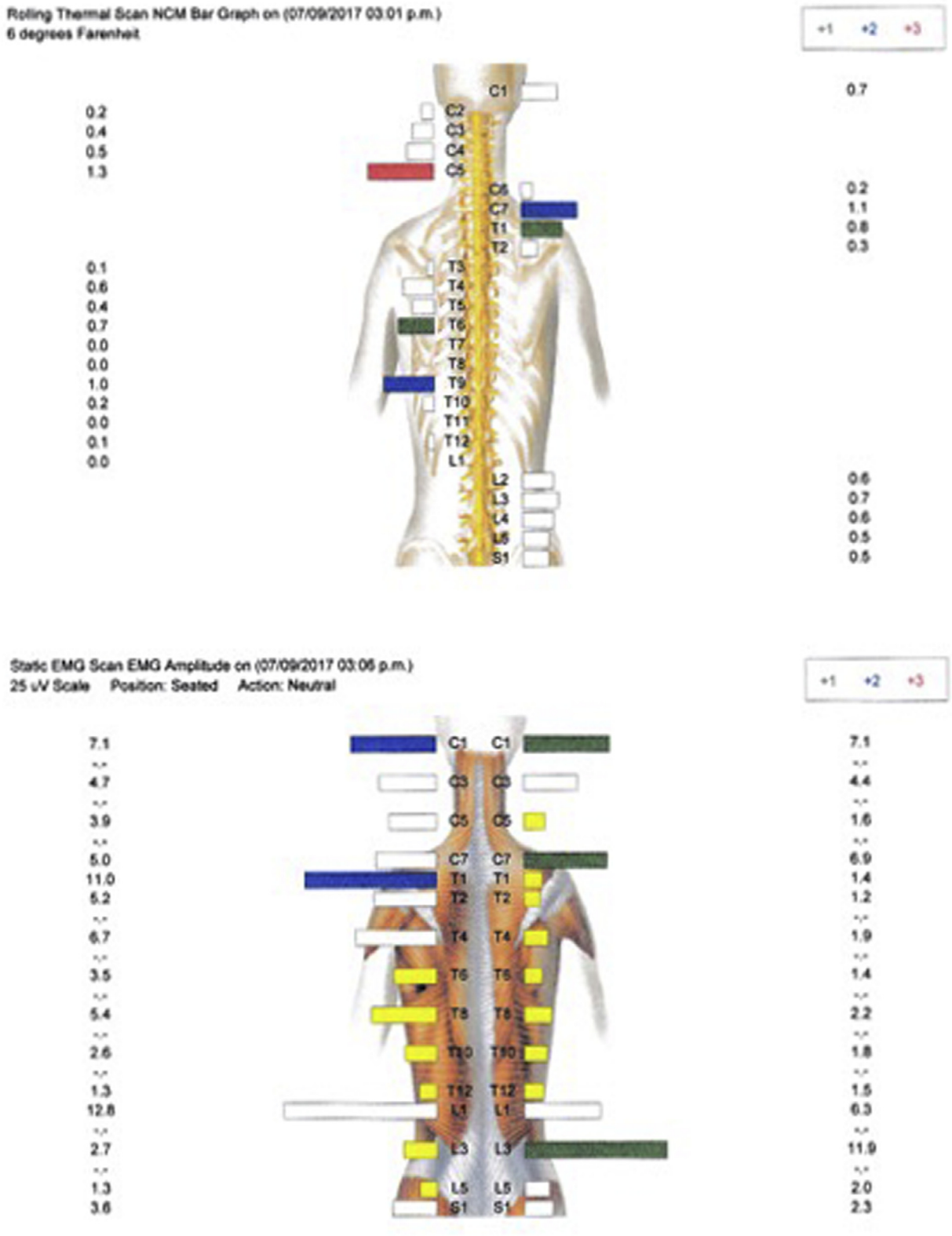


**Fig. 3.** Thermography and sEMG assessment results prior to a course of chiropractic care.

*Limitations*

This is a single case report. Due to the inherent limitations, being an isolated case not controlled for external factors, spontaneous remission and natural progression, the findings cannot be generalized or causation of vertebral subluxation implied. To further gauge the effectiveness of care, further studies are needed.

Initial specialist olfaction assessment reports were not supplied to the chiropractor; the information was based only on patient recollection of the specialist's reports. It is unclear exactly what assessments were performed by the specialist at the patients initial and regular check-ups. Follow up assessments of olfaction were not performed by the specialist at the time of preparing this report. Assessments indicating remission of anosmia were made through subjective reporting by

the patient and cranial nerve I testing using peppermint, vanilla, orange, coconut and coffee scents by the attending chiropractor.

Posture assessment was only visually observed by the chiropractor pre and post the course of chiropractic care. No formal objective measure was used to assess posture, which may be open to scrutiny.

Thermography and sEMG has been shown to be unfavorable in determining the site of chiropractic intervention. The use of thermography and sEMG in the current study was not to determine the site of vertebral subluxation. Thermography and sEMG was used to objectively measure dysautonomia and paraspinal neuromuscular dysfunction that may be a manifestation of vertebral subluxation, and changes as a result of chiropractic care.[28–31]

The HWQL instrument has had some psychometric evaluation pertaining to validity, reliability, and responsiveness; however, more psychometric properties could be analyzed.[24] The negative changes in self-reported HWQL may be explained by the concept of 'response shift' where a patient has somewhat accommodated for their state of health and, once improvements occur after intervention, they recalibrate their internal standards.[45]

## Conclusion

A course of chiropractic care, using AMCT for the assessment and correction of vertebral subluxation, was associated with remission of anosmia, improvement in self-reported physical functioning and life enjoyment, posture and cervical ROM.

## Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.explore.2019.07.012.

## References


1 Flint PW, Haughey B, Lund V, et al. Physiology of olfaction. *Cummings Otolaryngology: Head & Neck Surgery*. 6th ed. Philadelphia, Pa: Saunders Elsevier; 2015.
2 Welge-Lussen A, Dorig P, Wolfensberger M, Krone F, Hummel T. A study about frequency of taste disorders. *J Neurol*. 2011;258:386–392.
3 Mullol J, Alobid A, Marino-Sanchez F, et al. Furthering the understanding of olfaction, prevalence of loss of small and risk factors: a population-based survey. *BMJ Open*. 2012;2: e001256.
4 Murphy C, Schubert CR, Cruickshanks KJ, Klein BE, Klein R, Nondahl DM. Prevalence of olfactory impairment in older adults. *JAMA*. 2002;288:2307–2312.
5 Hoffman HJ, Ishii EK, MacTurk RH. Age-related changes in the prevalence of smell/taste problems among the United States adult population. Results of the 1994 disability supplement to the national health interview survey (NHIS). *Ann N Y Acad Sci*. 1998;855:716–722.
6 Landis BN, Konnerth CG, Hummel T. A study on the frequency of olfactory dysfunction. *Laryngoscope*. 2004;114:1764–1769.
7 Kruse RA, Cambron JA. A possible correlation between vitamin d deficiency and loss of smell: 2 case reports. *J Chiropr Med*. 2011;10:310–315.
8 Cho SH. Clinical diagnosis and treatment of olfactory dysfunction. *Hanyang Med Rev*. 2014;34:107–115.
9 Keller A, Malaspina D. Hidden consequences of olfactory dysfunction: a patient report series BMC ear. *Nose and Throat Disorders*. 2013;13:8.
10 Henkin RI, Levy LM, Fordyce A. Taste and smell function in chronic disease: a review of clinical and biochemical evaluations of taste and smell dysfunction in over 5000 patients at the taste and smell clinic in Washington, DC. *Am J Otolaryngol*. 2011;34:477–489.
11 Jiang RS, Wu SH, Liang KL, Shiao JY, Hsin CH, Su MC. Steroid treatment of posttraumatic anosmia. *Eur Arch Otorhinolaryngol*. 2010;267:1563–1567.
12 Temmel AF, Quint C, Schickinger-Fischer B, Klimek L, Stoller E, Hummel T. Characteristics of olfactory disorders in relation to major causes of olfactory loss. *Arch Otolaryngol Head Neck Surg*. 2002;128(6):635–641.
13 Nordin S, Brämerson A. Complaints of olfactory disorders: epidemiology, assessment and clinical implications. *Curr Opin Allergy Clin Immunol*. 2008;8 (1):10–15.
14 Qu Q, Liu J, Ni D, et al. Diagnosis and clinical characteristics of congenital anosmia: case series report. *J Otolaryngol Head Neck Surg*. 2010;39(6):723–731.
15 Elterman KG, Mallampati SR, Kaye AD, Urman RD. Postoperative alterations in taste and smell. *Anesth Pain Med*. 2014;4(4):e18527.
16 Gaines AD. Anosmia and hyposmia. Allergy Asthma Proc. 2010;31:185–189.
17 Van Toller S. Assessing the impact of anosmia: review of a questionnaire's findings. *Chem. Senses*. 1999;24:705–712.
18 Haavik H, Holt K, Murphy B. Exploring the neuromodulatory effects of vertebral subluxation and chiropractic care. *Chiropr J Australia*. 2010;40(1):37–44.
19 Henderson CNR. The basis for spinal manipulation: chiropractic perspective of indications and theory. *J Electromyogr Kinesiol*. 2012;22:632–642.
20 Filosa DA. Remission of anosmia and ageusia following chiropractic adjustments. *Res Forum*. 1988;4(2):43–45.
21 Blom G. Resolution of anosmia and ageusia following knee chest upper cervical specific chiropractic care: a case report. *J Upper Cervical Chiropractic Res*. 2014;16:14–16.
22 Ball R. Resolution of anosmia and other symptoms in a patient with a primary central nervous system tumor following upper cervical chiropractic care. *J Upper Cervical Chiropractic Res*. 2017;3:31–39.
23 Carney CL, MacCarthy M, Girdis C. Resolution of post-traumatic anosmia following network spinal analysis Care: a case study. *A Vertebral Subluxation Res*. 2017:8–14.
24 Blanks R, Schuster T, Dobson M. A retrospective assessment of network care using a survey of self-rated health, wellness and quality of life. *J Vertebral Subluxation Res*. 1997;1:15–27.
25 Marino M, Langrell P. Longitudinal assessment of chiropractic care using a survey of self-rated health, wellness and quality of life: a preliminary study. *J Vertebral Subluxation Res*. 1999;3:1–9.
26 Lachtman DS, Bartha DA, Beltran MM, et al. Rater reliability and concurrent validity of single and dual bubble inclinometry to assess cervical lateral flexion. *J Manipulative Physiol Ther*. 2015;38(8):572–580.
27 Holt K, Russell D, Cooperstein R, Young M, Sherson M, et al. Interexaminer reliability of a multidimensional battery of tests used to assess for vertebral subluxation. *Chiropr J Aust*. 2018;46(1):100–117.
28 McCoy M, Campbell I, Stone P, Fedorchuk C, Wijayawardana S, Easley K. Intra-examiner and inter-examiner reproducibility of paraspinal thermography. *PLoS ONE*. 2011;6(2):e16535.
29 Mansholt BA, Vining RD, Long CR, Goertz CM. Inter-examiner reliability of the interpretation of paraspinal thermographic pattern analysis. *J Can Chiropr Assoc*. 2015;59(2):157–164.
30 Currie SJ, Myers CA, Durso C, Enebo BA, Davidson BS. The neuromuscular response to spinal manipulation in the presence of pain. *J Manipulative Physiol Ther*. 2016;39 (4):288–293.
31 Kelly S, Boone WR. The clinical application of surface electromyography as an objective measure of change in the chiropractic assessment of patient progress: a pilot study. *J. Vertebral Subluxation Res*. 1998;2(4):1–7.
32 Fuhr A, Menke M. Status of activator methods chiropractic Technique, theory and practice. *J Maniplative Physiol Ther*. 2005;28(2):e1–e20.
33 Geyer M, Nilssen. Evidence-based management of a patient with anosmia. *Clinical Otalaryngology*. 2008;33:466–469.
34 Henkin RI, Potolicchio SJ, Levy LM. Improvement in smell and taste dysfunction after repetieitve transcranial magnetic stimulation. *Am J Otolaryngol*. 2011;33:38–46.
35 Hummel T, Rissom K, Reden J, Hahner A, Weidenbecher M, Huttenbrink KB. Effects of olfactory training in patients with olfactory loss. *Laryngoscope*. 2009;119:496–499.
36 Wevitavidanalage M. Anosmia treated with acupuncture. *Acupuncture Med*. 2003;21(4):153–154.
37 Saravanan B, Kundra P, Mishra SK, Surianarayanan G, Parida PK. Effect of anaesthetic agents on olfactory threshold and identification - A single blinded randomised controlled study. *Indian J Anaesth*. 2018;62(8):592–598.
38 Henkin RI. Drug-induced taste and smell disorders: incidence, mechanisms and management related primarily to treatment of sensory receptor dysfunction. *Drug Saf*. 1994;11(5):318–377. 1994.
39 Pickar JG. Neurophysiological effects of spinal manipulation. *Spine J*. 2002;2 (5):357–371.
40 Haavik-Taylor H, Murphy B. Cervical spine manipulation alters sensorimotor integration: a somatosensory evoked potential study. *Clin Neurophysiol*. 2007;118:391–402.
41 Taylor H, Murphy B. Altered central integration of dual somatosensory input after cervical spine manipulation. *J Manipulative Physiol Ther*. 2010;33(3):178–188.
42 Haavik H, Niazi I, Holt K, Murphy B. Effects of 12 weeks of chiropractic care on central integration of dual somatosensory input in chronic pain patients: a preliminary study. *J Manipulative Physiol Ther*. 2017;40(3):127–138.
43 The Australian Spinal Research Foundation. *The Vertebral Subluxation: Conceptual Definition For Research and Practice*. The Australian Spinal Research Foundation; 2017:6. [Online] Available at: https://spinalresearch.com.au/wp-content/uploads/2017/06/The-Vertebral-Subluxation.pdf.
44 Association of Chiropractic Colleges. Update - The Association of chiropractic colleges position paper # 1. July 1996.
45 Finkelstein JA, Quaranto BR, Schwartz CE. Threats to internal validity of spinal surgery outcome assessment: recalibration response shift or implicit theories of change? *Appl Res Quality of Life*. 2014;9:215–232.