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Balance Impairment in Patients with Cervicogenic Headache: A Narrative Review

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Abstract:
Background: A cervicogenic headache (CGH) presents as unilateral pain that starts in the neck and is referred from bony structures or soft tissues of the neck. In patients with cervicogenic headache, balance alterations may be associated with peripheral mechanisms, specifically altered neck proprioceptive afferents stemming from a high density of mechanoreceptors that connect centrally and reflexively to the visual, vestibular, and central nervous systems.
Purpose: This review was conducted to through light on balance impairment in patients with cervicogenic headache.
Methods: A comprehensive search of Science Direct, PubMed, and Google Scholar was conducted using keywords such as cervicogenic headache, postural control and sensorimotor control. Articles published from January 2017 to the date of launch were included, search for literature was limited to English language. oral presentations, conference papers, unpublished articles, and abstracts from smaller scientific investigations were excluded.
Conclusions: Balance impairment is associated with cervicogenic headache due to altered cervical proprioception and sensorimotor dysfunction, according to the reviewed literature. People with these deficits may have balance issues and fall more often. This emphasizes the importance of postural assessments and targeted rehabilitation strategies like proprioceptive training and vestibular rehabilitation for patients with cervicogenic headache.
Key words: cervicogenic headache, postural control, sensorimotor control, balance impairment, proprioception

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Introduction:
A cervicogenic headache (CGH) is characterized by one-sided pain originating in the neck, which is referred from the bony structures or soft tissues of the cervical region. A prevalent chronic and frequent headache typically initiates following neck movement. A diminished range of motion (ROM) of the neck typically accompanies this condition. CGH is exacerbated by prolonged or atypical cervical spine movement[1].
Forty seven percent of people in the world suffer from headaches. Cervicogenic headaches make up 15 to 20 percent of all headaches and affect women four times more than men[2]. Chronic, one-sided neck pain in CGH patients that spread to the occipital and parietotemporal areas is caused by the confluence of the upper three cervical spinal nerves with the trigeminal nerve in the trigeminocervical nucleus[3].
Balance control is essential for maintaining postural stability and engaging in safe mobility tasks. It is described as the capacity to keep the body's center of gravity within bases of support with the least horizontal postural sway[4].
Reduction in postural stability observed in individuals suffering from cervicogenic headache can be anticipated, as it arises from modified proprioceptive input originating from the cervical spine. Furthermore, changes in the structure and function of the neck muscles associated with cervicogenic headache can influence proprioceptive discharge, leading to disruptions in sensorimotor control[5].

Pathophysiology of Cervical Headache:
The pain linked to CGH is conveyed via the trigeminocervical nucleus. This anatomical connection connects the cervical spine to the head, facilitating the transfer of pain impulses from the neck to the head. The merging of sensory impulses from the upper three cervical nerve roots may result in misperception of neck pain as headache pain[6].

The C2–3 and C3–C4 zygapophyseal joints are the most common cause of cervicogenic headaches, accounting for about 70% of all cases. Long-term, bad poses cause these structures to wear out too quickly, which leads to arthritic changes in the joints. This affects the nerves in the upper neck, so pain in the head or face is thought to be pain in the neck[1].

Previous research has suggested various potential mechanisms for CGH. One theory claimed that pain signals ascend via the ipsilateral spinocervicothalamic tract, thereby stimulating the trigeminal cervical complex. There is a possibility that kinesthetic impairment in the lower cervical spine causes increased activity in the upper cervical spine, which in turn causes overstimulation of the trigeminal complex. This indicates that the lower cervical sinuvertebral nerves may be linked to cervicogenic headaches[7].

The branch of the sinuvertebral nerve may extend up to three segments below its origin, enabling nociception from the lower cervical segment to affect the higher cervical level, perhaps leading to cervicogenic headache[8].

Balance Control: mechanism and importance

Balance control is a complex process that requires the integration of various systems to sustain stability and balance[9]. It refers to the capacity to sustain the body's center of gravity while minimizing horizontal postural sway. Increased sway typically indicates an issue within the neuromuscular system, leading to impaired balance and a heightened risk of falls[10].

Balance control relies on three interdependent subsystems: the osteoarticular (bones and joints), neuromuscular (muscles and nerves), and sensory systems (sight, proprioception, and vestibular input[11]. regarding afferent signals from those three systems, people adjust their balance through feedback and feedforward mechanisms when their body position or base of support changes.

Role of the visual, vestibular, and somatosensory systems:

Vision provides the brain with spatial and environmental information to assess visual stimuli for color, linear outlines, edges, and motion, allowing it to understand the environment and adjust posture and movement. Visual system problems, such as basic visual impairments or visual-perceptual dysfunction, can impair balance and spatial orientation. Visual, vestibular, and somatosensory inputs must be integrated for balance regulation and postural stability[12].

The vestibular system, which consists of the otoliths and semicircular canals, detects head motions such as rotation, inclination, linear translation, and gravitational forces. Through the vestibular nerve, sensory input from these structures is transmitted to the vestibular nuclei, which are responsible for the coordination of eye, head, and bodily movements to integrate vestibular, visual, and somatosensory signals, these nuclei have extensive connections with high cortical areas. This integration is essential for maintaining balance, postural control, and gaze stability[13].The vestibulo-ocular reflex (VOR) is crucial for the maintenance of gaze, as it prevents visual deviation (oscillopsia) by directing the eyes in the opposing direction of head movements. Collectively, these processes ensure precise coordination of movement and equilibrium in defiance of gravity[14].

Cervical proprioception is the sense of where the head or neck is in space and how it can move. There are a lot of sensory fibers in the neck muscles, especially in the deeper parts of the suboccipital muscles. They have the highest number of receptors in the cervical spine, which makes central and automatic links to the systems that control balance, vision, and posture. So, detailed information from the neck area is needed for precise control of movement[15].

Balance Control Deficits in Patients with cervicogenic headache:

Tavakkoli & Bahrpeyma, (2023), stated that precise motor responses set by sensory information from joints and muscle spindles control neck position and movement. People with cervical headache can have limited cervical range of motion (ROM), lower muscular endurance, and poor proprioception which results in reflexive muscular inhibition. This might promote inappropriate activation of cervical muscles. Therefore, show more mistakes in proprioceptive tests than those without symptoms. These deficiencies imply that changed neuromuscular control is important for the continuation of cervicogenic headache and might influence postural stability as well as movement coordination.[5]

A systematic review and meta-analysis were conducted by **Carvalho, et al., (2022),** to examine balance impairments in patients with cervical headaches. The evidence suggests that these patients exhibit notable alterations in both static and dynamic balance. The results demonstrate that postural control deficits frequently occur in individuals with headaches, highlighting the need for additional research on the relationship between different headache types, including cervical headaches, and balance disturbances. This underscores the importance of integrating postural control into headache management approaches.[16]

Deficits in balance control, which are linked to neck pain and proprioception, are seen in individuals with cervicogenic headaches as reported by **Emam, et al., (2024),** who showed in particular, the extent to which proprioceptive training enhances postural stability, as measured by tests such as center of pressure (COP) velocity and standing on foam with eyes closed. With greater gains in the experimental group compared to the control group, it's reasonable to assume that improving proprioceptive awareness may significantly impact postural control in these individuals, thereby alleviating related pain and impairment.[17]

Friedman & Smith, (2018), found patients with cervical headaches often exhibit forward head position and extended shoulders because of postural control abnormalities, which may result in postural musculature weakening

and reduced endurance. This emphasizes how postural deficits exacerbate headache symptoms and alter proprioceptive inputs by contributing to increased muscle tone and cervical joint dysfunction.[18]
Sremakaew, et al., (2018) elaborated that Individuals with cervicogenic headache demonstrate notable balance deficits while standing and walking. Research indicates that these individuals exhibit a larger sway area than healthy controls, especially when standing on a soft surface, regardless of whether their eyes are open or closed. This indicates that balance impairment in CGH is dependent on the condition, exhibiting more significant in challenging circumstances.[19]

Assessment of Postural Control in Cervical Headache Patients:

In recent decades, a variety of tools and assessments have been utilized to assess balance performance. The ability to maintain one's center of mass (COM) within a predetermined base of support (BOS) is assessed using static balancing tests. Some examples of such tests are the legged stance time, functional reach, postural stress, romberg, sharpened romberg, and balance component of the fugl-meyer sensorimotor assessment[20].
However, these assessments fail to capture the dynamic aspect of balance necessary to execute functional and dynamic tasks. The dynamic balance assessment involves the displacement of COM and BOS. Dynamic balance has been assessed with tests such as tandem walking, the Timed Up-and-Go Test and obstacle courses. In addition, dynamic and static maneuvers are assessed using the Sensory Organization Test, Tinetti's Performance-Oriented Mobility Assessment, and Berg Balance Scale[21].

Challenges and Limitations:

[22] revealed that research on how vestibular dysfunction and cervical proprioception produce postural instability in CGH patients are scarce, indicating more inquiry is necessary to totally comprehend these links. Furthermore, [23] discovered that numerous techniques are used to evaluate balance impairment, thereby generating contradicting findings and restrictions on comparability throughout many studies.

Conclusion:

The literature reviewed suggested balance impairment with cervical proprioceptive dysfunction and sensorimotor dysfunction in cervicogenic headache. People with these deficits can have difficulties with balance and fall more frequently. This elaborates the importance of postural evaluation and specific rehabilitative techniques as proprioceptive training and vestibular rehabilitation in patients with cervicogenic headache. studies to date used different means of assessment and small sample sizes, making conclusions difficult to draw. Future studies using standardized methods and longitudinal studies may help identify the causes of postural control impairments and cervicogenic headache which may improve treatment and patient outcomes as a result.

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Reference:

1. Al Khalili Y, Ly N, Murphy PB. Cervicogenic Headache. In: StatPearls. Treasure Island (FL): StatPearls Publishing Copyright © 2024, StatPearls Publishing LLC.; 2024.

2. Emam MA, Fatma ;, Amin S, Doaa ;, Amin I, Azmy R. The Effect of Cervicogenic Headache on the Myoelectrical Activities of Suboccipital Muscles, Range of Motion and Functional Activities of the Neck at Different Ages. Med J Cairo Univ [Internet]. 2019 Mar 1 [cited 2025 Jan 9];87(March):571–80. Available from: https://mjcu.journals.ekb.eg/article_52423.html

3. Shimohata K, Hasegawa K, Onodera O, Nishizawa M, Shimohata T. The Clinical Features, Risk Factors, and Surgical Treatment of Cervicogenic Headache in Patients With Cervical Spine Disorders Requiring Surgery. Headache. 20170605th ed. 2017;57(7):1109–17.

4. Victor BA, R A, I SA, B GK. Enhancing Dynamic Balance and Postural Stability in Stroke Patients: The Impact of Immersive Virtual Reality Training. Cureus [Internet]. 2024 Aug 6 [cited 2025 Mar 4];16(8):e66299. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC11376469/

5. Tavakkoli M, Bahrpeyma F. Elastic Modulus of Suboccipital Muscles, Cervical Range of Motion, and Forward Head Posture in Cervicogenic Headache. J Biomed Phys Eng [Internet]. 2023 [cited 2025 Jan 7];13(5):463–70. Available from: https://pubmed.ncbi.nlm.nih.gov/37868938/

6. RM, - SST. A Cross-sectional Study on the Prevalence of Cervicogenic Headache amongst University Students. International Journal For Multidisciplinary Research [Internet]. 2024 Jul 12 [cited 2025 Mar 2];6(4). Available from: https://scispace.com/papers/a-cross-sectional-study-on-the-prevalence-of-cervicogenic-3rzohdt6bw

7. Hu JQ, Zhang J, Ru B, Cai WJ, Liu WL, Guo R, et al. Computed tomography-guided radiofrequency ablation of cervical intervertebral discs for the treatment of refractory cervicogenic headache: A retrospective chart review. Headache. 20220721st ed. 2022;62(7):839–47.

8. Amir G, Edwin K, Tejas K, Kee K. Cervicogenic Headache Hypothesis and Anterior Cervical Decompression as a Treatment Paradigm. In: Mick PC, editor. Minimally Invasive Spine Surgery [Internet]. Rijeka: IntechOpen; 2021. p. Ch. 1. Available from: https://doi.org/10.5772/intechopen.95931

9. Patti A, Fischetti F, Sahin FN, Bianco A. Editorial: Postural control, exercise physiology and the balance training—type of exercises, mechanisms and insights. Front Physiol [Internet]. 2023 Feb 17 [cited 2025 Mar 3];14. Available from: https://scispace.com/papers/editorial-postural-control-exercise-physiology-and-the-2lw4nfaa

10. Rongsawad K, Worawan L, Jirarojprapa K, Kaewkham S, Khattiwong S. 72 Test-Retest Reliability and Minimal Detectable Change for Postural Sway by using Sway Meter in Elderly Subjects. Age Ageing [Internet]. 2019 Dec 20 [cited 2025 Mar 3];48(Supplement_4):iv18–27. Available from: https://scispace.com/papers/72-test-retest-reliability-and-minimal-detectable-change-for-42313ue689

11. Dimulescu DM, Chiriți G. POSTURAL CONTROL IMPAIRED IN MYOARTHROKINETIC AND NEURO-SENSORY DISORDERS. Romanian Journal of Medical Rehabilitation Physical Medicine and Balneoclimatology [Internet]. 2024 Apr 30;1(1):53–9. Available from: https://www.inrmfb.ro/wp-content/uploads/2024/07/10_RJMRPMB-1_2024-Dana-Maria-DIMULESCU.pdf

12. Sahebozamani M, Salari A, Daneshjoo A, Karimi Afshar F. Assessment of Balance Recovery Strategies during Manipulation of Somatosensory, Vision, and Vestibular System in Healthy and Blind Women. JRSR. 2019;6:123–9.

13. Tuthill JC, Azim E. Proprioception. Current Biology. 2018;28:R194–203.

14. Dimulescu DM, Chiriți G. Postural control impaired in myoarthrokinetic and neuro-sensory disorders. Romanian Journal of Medical Rehabilitation Physical Medicine and Balneoclimatology [Internet]. 2024 Apr 30 [cited 2025 Mar 3];1(1):53–9. Available from: https://scispace.com/papers/postural-control-impaired-in-myoarthrokinetic-and-neuro-51bevsl59f

15. Tuthill JC, Azim E. Proprioception. Current Biology. 2018 Mar 5;28(5):R194–203.

16. Carvalho GF, Becnel AR, Miske C, Szikszay TM, Adamczyk WM, Luedtke K. Postural control impairment in patients with headaches—A systematic review and meta-analysis. Headache. 2022 Mar 1;62(3):241–70.

17. Emam MA, Hortobágyi T, Horváth AA, Ragab S, Ramadan M. Proprioceptive Training Improves Postural Stability and Reduces Pain in Cervicogenic Headache Patients: A Randomized Clinical Trial. J Clin Med [Internet]. 2024 Nov 11 [cited 2025 Jan 14];13(22). Available from: https://typeset.io/papers/proprioceptive-training-improves-postural-stability-and-2ann30jr5ymj

18. Friedman M, Smith K. Manual Physical Therapy and Cervical Joint Position Training for Manual Physical Therapy and Cervical Joint Position Training for Cervicogenic Dizziness Following Whiplash-Associated Disorder: Cervicogenic Dizziness Following Whiplash-Associated Disorder: A Case Report A Case Report Abstract Submission-CSM 2018 Title Manual physical therapy and cervical joint position training for cervicogenic dizziness following whiplash-associated disorder: A case report. [cited 2025 Mar 3]; Available from: https://soar.usa.edu/pt

19. Sremakaew M, Sungkarat S, Treleaven J, Uthaikhup S. Impaired Standing Balance in Individuals with Cervicogenic Headache and Migraine. J Oral Facial Pain Headache [Internet]. 2018 Jul [cited 2025 Mar 3];32 3(3):321–8. Available from: https://doi.org/10.11607/ofph.2029

20. Parsa M, Rahimi A, Noorizadeh Dehkordi S. Studying the correlation between balance assessment by Biodex Stability System and Berg Scale in stroke individuals. J Bodyw Mov Ther. 20190517th ed. 2019;23(4):850–4.

21. Qamar MN. Clinical Analysis of Balance Deficits in Individuals with Knee Osteoarthritis. Journal of American Medical Science and Research [Internet]. 2024 Oct 15 [cited 2025 Mar 4];3(2):28–32. Available from: https://scispace.com/papers/clinical-analysis-of-balance-deficits-in-individuals-with-1u31hsa713a3

22. Apaydın AS, Söylemez E, Güneş M, Söylemez TG, Apaydın ZK. CERVICAL PROPRIOCEPTION AND VESTIBULAR FUNCTIONS IN PATIENTS WITH NECK PAIN AND CERVICOGENIC HEADACHE: A COMPARATIVE STUDY. Journal of Turkish Spinal Surgery. 2024 Jul 1;35(3):113–8.

23. Sremakaew M, Sungkarat S, Treleaven J, Uthaikhup S. Impaired Standing Balance in Individuals with Cervicogenic Headache and Migraine. J Oral Facial Pain Headache. 2018 Jul;32(3):321–8.