Therapy Examination and Intervention Process for Patients with Cervicogenic Dizziness

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Abstract: There is a growing body of evidence supporting the pathophysiology and physical therapy management of patients with CGD (Cervicogenic Dizziness); however, it is still not widely adopted in clinical practice. Cervicogenic dizziness is often the result of a sensory mismatch between the vestibular, somatosensory, and visual afferent inputs. Physical trauma involving the cervical spine, such as whiplash injury, is a common mechanism of injury in CGD patients. Therefore, the purpose of this paper is to discuss the etiology of cervicogenic dizziness, describe the proposed pathophysiology, and introduce the physical therapy examination and intervention process for patients with CGD. In order to determine the origin of the patient's dizziness, the physical therapist must conduct thorough subjective and physical examinations to rule out all competing causes of dizziness. The patient history may include physical trauma involving the head and neck and cervical spine postural faults, which are commonly observed**.** Therefore, treating neck pain among this group of patients is one of the main objectives for physical therapists. Intervention strategies may include: (1) orthopedic manual techniques specific to the cervical spine region, (2) head and neck proprioceptive rehabilitation program, and (3) cervical-ocular motor exercises Cervical spine proprioception impairments can be treated with a specifi proprioceptive rehabilitation program**.** The program can be progressed by doing active head movements rather than passive head movements**.** In conclusion, physical therapy intervention has been shown to be effective in reducing CGD symptoms.
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Introduction

Balance is maintained through a complex interaction between the visual, vestibular, and somatosensory systems.[1,2] Within the central nervous system, multimodal sensory integration facilitates motor responses to coordinate head and body orientation, postural stability, and gaze stability during head movements.[3] In the absence of normal sensory integration, imbalance and dizziness often occur.[3-6] Effective clinical management of dizziness is an integral component of improving balance. Dizziness is a nonspecific symptomatic description resulting from numerous pathologies including orthopedic impairments affecting the cervical spine and, in such cases, is referred to as "cervicogenic dizziness."[1,7] Dizziness is also one of the most common medical problems in many countries, especially in the elderly population.[5,6] Cervicogenic Dizziness (CGD) is a relatively new, emerging area in the medical literature with a growing body of evidence that supports the pathophysiology and physical therapy management of patients with cervicogenic dizziness. Patients with CGD typically describe their dizziness as vertigo, lightheadedness, blurry vision, disequilibrium, and/or nausea. Cervicogenic dizziness has been defined as "a non-specific sensation of altered orientation in space and disequilibrium originating from abnormal afferent activity from the neck."[7] Physical therapy interventions for CGD include orthopedic and vestibular rehabilitation strategies. There is a growing body of evidence supporting the pathophysiology and physical therapy management of patients with CGD; however, it is still not widely adopted in clinical practice. Therefore, the purpose of this paper is to discuss the etiology of cervicogenic dizziness, describe the proposed pathophysiology, and introduce the physical therapy examination and intervention process for patients with CGD.

Etiology of Cervicogenic Dizziness

There are several proposed mechanisms leading to cervicogenic dizziness including mechanical compression of the vertebral artery system, irritation of the cervical sympathetic nervous system, and abnormal proprioceptive input from the upper cervical spine.[1,2,7-9] The vertebral arteries encounter several soft tissue and bony structures capable of producing mechanical compromise.[9] Muscle tightness in the upper cervical spine can potentially occlude the vertebral arteries reducing brainstem perfusion and causing

vertebrobasilar insufficiency (VBI).[7,9,10] In particular, the vertebral arteries travel between the anterior scalene and longus colli muscles as well as under the inferior capitis oblique and intertransversarius muscles.[7] Cervical spine osteophytes and forward head posture are also potential contributors to vertebral artery compression and VBI.[9,10]. Upper cervical spine muscle tightness, bony anomalies, and/or poor cervical spine posture can potentially lead to hypoperfusion of the vertebral and carotid arterial network causing dizziness consistent with cervicogenic dizziness.[1,12,13]

Abnormal proprioceptive input from the vestibular and upper cervical spine can lead to dizziness, unsteadiness, and visual disturbance.[1,2,13,17,19] The somatosensory system detects peripheral stimuli from sensory receptors, including mechanoreceptors located in human skin.[1,2] There are an abundance of mechanoreceptors in the upper cervical spine that primarily transmit impulses through nerve cells originating from C2 dorsal root ganglion.[2,16,17] The upper cervical spine mechanoreceptors also converge in the central cervical nucleus (CCN), which serves as a pathway to the cerebellum for integrating and organizing vestibular, ocular, and proprioceptive sensory input.[2,13,16,17] The CCN also sends coordinated information to the cortex for maintenance of postural equilibrium and body orientation.[1,2,17,18] Cervical spine reflexes contribute to head orientation, eye movement control, and postural stability; cervical collic reflex, the cervical ocular reflex, and cervical spinal reflex, respectively.[1,2] These cervical reflexes work in conjunction with vestibular collic reflex, vestibular ocular reflex, and the vestibular spinal reflex.[1,2,17,19] Another potential source of CGD is Irritation of the cervical sympathetic nervous system.[3,11] Abnormal upper cervical spine proprioceptive input, resulting from ischemia, inflammation, or cervical extensor muscle fatigue has also been implicated in patients with imbalance and CGD.[3,9,14]

Cervical Spine Trauma

Abnormal cervical somatosensory input can alter somatosensory control and negatively impact postural stability and vision.[1] Cervical spine trauma, such as whiplash-associated disorder (WAD), can impair cervical somatosensory function by causing ischemia, inflammation, and stress.[1] Moreover, evidence suggests that direct trauma to the neck can lead to cervical spine muscle fatigue that ultimately modifies the discharge firing rate of sensory receptors, thus affecting joint position of the head and neck as well as postural stability.[3,20-22,24-27] Deficits in oculomotor function have also been described in the literature in patients with WAD.[1,28] Tjell and Rosenhall[28] reported abnormal smooth-pursuit eye movements when the neck was rotated under a stable head in WAD patients. Additionally, greater loss of eye motor control was identified among WAD patients complaining of dizziness.[1,28] Problems of convergence and diplopia have also been associated with WAD patients.[1] It is estimated that approximately 60% of all WAD patients develop dizziness.[1] Abnormalities in motor function of the eyes have also been described in the literature after cervical spine whiplash injuries.[1,20] It is proposed that a sensory mismatch occurs between the multimodal sensory inputs from the upper cervical spine and other systems contributing to postural stability and head orientation. This results in symptoms consistent with CGD.[3-5,14-19] The authors of the current paper also theorize that abnormal sensory input from the upper cervical spine impairs the vestibular ocular reflex, negatively impacting dynamic gaze stability. This theory is made on the basis of existing neural pathways between the upper cervical spine and the vestibular nuclei.[1,2,21,22] Research is in progress to support or refute this theory. [21]

Physical Therapy Evaluation

The physical therapy examination process requires clinical decision-making that is based on the best available evidence. The physical therapy evaluation includes subjective and objective components (Table 1 & 2). Because CGD is one of numerous types of dizziness, the evaluation strategy can be challenging.[1,7] According to Wrisley et al, CGD is a diagnosis of exclusion, meaning that competing causes of dizziness must be ruled out.[7] Physical therapists need to carefully review the past medical history and ask specific questions about the patient's dizziness in order to determine that the dizziness is cervicogenic.[7] Episodic dizziness lasting minutes to hours is a common complaint in patients with CGD.[7] They may also report a general sense of disequilibrium or lightheadedness as well as visual disturbances. Vertigo is rarely a chief complaint in CGD patients.[1,7] Circumstances that frequently produce their dizziness include neck pain.[1,7] The physical examination for CGD patients includes a medical screening component that includes three different phases: screening of the (1) cervical spine stability, (2) cervical vascular system, and (3) central nervous system. If any of these medical screening tests produce positive or abnormal results, the physical therapist must refer the patient to a physician for further medical consultation. Otherwise, the physical therapist continues with the physical examination. The vestibular system is examined to determine whether the dizziness is being caused by the peripheral or central vestibular system.[7] Central and peripheral vestibular system testing is performed to determine if the dizziness is being caused by benign paroxysmal position vertigo (BPPV) or vestibulo-ocular reflex (VOR) hypofunction[9] If BPPV or VOR

hypofunction is found, the appropriate vestibular rehabilitation interventions are implemented.[9] If the peripheral vestibular system examination is positive, appropriate vestibular rehabilitation interventions are implemented. If the central vestibular examination is positive, the physical therapist should refer the patient to a physician for further medical consultation. Otherwise, the physical therapist continues the physical examination.[7]

Physical Therapy Intervention

Physical therapy intervention has been shown to be effective in reducing CGD symptoms (Table 3). According to Wrisley et al[7], CGD symptoms typically increase with neck pain. Therefore, treating neck pain among this group of patients is one of the main objectives for physical therapists. Intervention strategies may include: (1) orthopedic manual techniques specific to the cervical spine region, (2) head and neck proprioceptive rehabilitation program, and (3) cervical-ocular motor exercises. Cervical spine pain and inflammation can be treated with a variety of physical therapy modalities, including cryotherapy, thermotherapy, ultrasound, and cervical spine traction.[1,7] Cervical spine hypomobility is common among CGD patients and may increase symptoms of dizziness.[1,7] However, cervical hypomobility can be treated with joint specific mobilization techniques and tissue/age-specific stretching programs.[1,7] Cervical spine proprioception impairments can be treated with a specific proprioceptive rehabilitation program. The proprioception program includes slow, passive head movements with fixed-target gaze exercises.[22,23] The program can be progressed by doing active head movements rather than passive head movements. Also, the clinician may progress the program by instructing the patient to perform active head movements while maintaining their gaze on a fixed target with their trunk passively or actively moved.[23] Another way of performing the program is to instruct the patient to close their eyes and actively rotate their head, return to the starting position, and open their eyes.[23] If the patient cannot see the target, they can keep their eyes open and continue rotating their head until they can see the target.[22,23] This training provides the patient with information about cervical spine joint position sense and can be performed with restricted peripheral vision using foveal glasses.[1,7,22,23] Input from cervical spine afferent nerves can alter the function of the oculomotor system.[1,7,23]

Thus, oculomotor training is important to reduce potential extraocular muscle weakness.[28] Extraocular motor function can be managed using smooth-pursuit (patient keeps head still while eyes follow a moving target), saccades (patient keeps head still and quickly moves eyes between targets), X1 adaptation exercises (patient moves head from side to side while maintaining the gaze on a stationary target), and X2 adaptation exercises (patient moves head and a hand-held target in opposite directions while maintaining gaze on moving target at all times).[1,22,28] All extraocular exercises can be progressed by increasing the speed of movement, range, duration, and frequency. Also, the exercises could be progressed by gradually decreasing the stability of support and changing from static to dynamic positions.[1,22,28]

Conclusion

Cervicogenic dizziness is often the result of a sensory mismatch between the vestibular, somatosensory, and visual afferent inputs. Physical trauma involving the cervical spine, such as whiplash injury, is a common mechanism of injury in CGD patients. Physical trauma contributes to impairment in the upper cervical spine proprioceptive input leading to symptoms including disequilibrium and dizziness. In order to determine the origin of the patient's dizziness, the physical therapist must conduct thorough subjective and physical examinations to rule out all competing causes of dizziness. The patient history may include physical trauma involving the head and neck and cervical spine postural faults, which are commonly observed. Once CGD has been confirmed, appropriate interventions are implemented to reduce cervical spine pain and inflammation, improve cervical spine proprioception, improve cervico-ocular function, and restore joint and soft tissue range of motion and mobility.

TABLE 1. Physical Therapy Subjective Examination.

PHYSICAL THERAPY: Subjective Examination	
Past Medical History	Medical record review and patient interview.
Dizziness Tempo	Episodic dizziness lasting from several minutes to hours.
Dizziness Symptoms	Oscillopsia, disequilibrium, lightheadedness, vague dizziness.
Dizziness Circumstances	Causal symptomatic relationship to neck position and neck pain.
Dizziness Intensity	Modified visual analog scale 0–10/10 for current and recent range.

TABLE 2. Physical Therapy Physical Examination.

PHYSICAL THERAPY: Physical Examination	
Medical Screening	Cervical Stability: alar ligament test, Sharp-Purser test, lateral shear test. Arterial Patency: modified vertebral artery test. Central Nervous System: upper motor neuron and cerebellar testing.
Vestibular System	BPPV: Hallpike-Dix test and Roll test. VOR Hypofunction: head thrust test, head shaking-induced nystagmus test, dynamic visual acuity test.
Cervicogenic Dizziness	Neck torsion nystagmus test, neck torsion smooth pursuit test, cervical spine joint position error test, cervical spine manual traction test.
Cervical Spine	Posture, active range of motion, accessory motion, palpation.

TABLE 3. Physical Therapy Physical Intervention.

PHYSICAL THERAPY: Physical Intervention	
Cervical Spine Pain and Inflammation	Modalities and traction.
Cervical Spine Mobility	Joint mobilization, soft tissue mobilization, stretching program.
Cervical Spine Proprioception	Postural awareness training. Passive head movements with fixed target gaze. Foveal vision progression in sitting and standing.
Cervical-Ocular Exercises	Free eye-head coupling with pursuits and saccades. X1 and X2 exercises with progressive functional application.

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