# Familial Predisposition in Cervicogenic Disequilibrium, as it Relates to Functional Disturbances and Somatotype – A Case Study

Eugene Serafim, DC, DACRB, CSCS

## ABSTRACT

Dizziness is a nonspecific term that means various things to various people. It falls under a greater category of vertigo, but for our purposes we will concentrate on the subcategory of disequilibrium. This paper will review the origins, testing procedures and common disturbances of the physiologic and neurologic systems that affect balance and contribute to disequilibrium. This study will further concentrate on the familial link between structure and function of the cervical spine and the pathogenesis of cervical disequilibrium in a mother and daughter case study.

## BACKGROUND

Dizziness has a variety of meanings, but it is most often used as a means of describing unsteadiness. Notwithstanding layman's terms, more specific identifiers are required, including lightheadedness, presyncope, disequilibrium and vertigo. The diagnostic triage must include a thorough history, specialized testing, and an orthopedic and neurological workup to discern the specific symptom, correct diagnosis and optimal treatment. Allopathic medicine has traditionally addressed these symptoms pharmaceutically, however a chiropractic rehabilitation approach can be successful in addressing the underlying structural root cause.[1] In the case study cited, a mother/daughter case, both patients benefited from an approach using chiropractic and rehabilitative techniques. While this is not an exhaustive study, these cases provide an insight into the inherited structural or physiological etiology of disequilibrium.

## DISCUSSION

In discussing balance and the loss of it (disequilibrium), we must start with reviewing the components that would affect it. Balance is accomplished through various systems that are integrated in the cerebellum. Proprioception, the vestibular system, visual sensory input and tactile sources combine to facilitate balance and coordination. Proprioception in the cervical spine provides sensory afferent input, which contributes to coordination of the eyes, head and body.

Proprioception in the cervical spine is controlled by a variety of reflexes that include the cervico-collic reflex, the tonic neck reflex and the cervico-occular reflex. Bolton (1998) states that the first reflex stabilizes the head and integrates with the vestibulo-collic reflex (where the neck muscles are acted upon by input from the semi-circular canals). The tonic neck reflex is an

asymmetrical reflex present in newborns that controls the tonic activity of the limbs.[2] In discussing the tonic reflex, research by Hikosaka and Maeda has documented the association of neck afferents originating at the dorsal roots and cervical facets at level C2/C3 and the vestibular nuclei.[3] These reflexes communicate with the vestibulo-ocular reflex. When sensory input is interrupted, it causes a disparity in perceived information received from the vestibular system and cervical proprioceptive or visual systems disequilibrium results.[4] Research conducted by Dejong and Dejong further supports this data.[5]

There are a number of differentials that should be excluded before a diagnosis of cervicogenic disequilibrium can be assigned. Some diagnoses include benign paroxysmal positional vertigo (BPPV), Ménière's disease and vertebrobasilar insufficiency. Discerning between terminologies that patients use to describe dizziness is another important aspect in evaluating a patient with unsteadiness. They include presyncope, disequilibrium, vertigo, dystaxia, ataxia and lightheadedness. To further complicate matters, in its slang form, dizziness has been used to describe those that lack mentation.

**KEY WORDS**

vertigo, cervical disequilibrium, lightheadedness, presyncope, dystaxia, ataxia, proprioception, cervico-collic, tonic neck reflex, cervical-ocular reflex

## INTRODUCTION

Dizziness, in general, is widely complained of and can have a component in virtually any medical condition. For our purposes, we will only consider one symptom of dizziness – cervical disequilibrium. The diagnosis of cervicogenic disequilibrium is largely one of exclusion, thus one should strive to rule out diseases of the inner ear (vestibule-cochlear apparatus), vertebral arteries and the spinal canal. Special attention must be paid to patients with a post-traumatic onset. In those cases, vertebral artery compression and dissection, spinal stenosis, cerebral spinal fluid leak and whiplash should be ruled out or referred to the appropriate provider before initiating a rehabilitation protocol.

Evaluation of any disease begins with a thorough history and treating cervicogenic disequilibrium must include a detailed history. Factors of interest would include the onset, duration, trauma, description, intensity, mechanism, previous treatment, cause, previous history, aggravating factors (positional relation), relieving factors, environmental related triggers, previous episodes, effects on ADL's and functional deficits.

Outcome assessments provide a qualitative baseline to allow for accurate case management. They also measure pain, disability and psychosocial status. Questionnaires that measure pain would include the visual analog scale, McGill and pain drawing. For disability, questionnaires include the neck disability index, the Dizziness Handicap Inventory (DHI), the Henry Ford

Headache Disability Inventory (HDI), Activities-specific Balance Confidence (ABC) Scale, somatic perception and the Physical Activity Readiness Questionnaire (PAR-Q). Psychosocial assessment would include Beck and SCL-90-R.

Orthopedic, functional and neurological testing must be combined to comprehensively evaluate a patient with cervicogenic disequilibrium. The orthopedic testing that would be appropriate includes Jackson's, Bakody's, cervical distraction, Berrie-Lou, Dekline's, Maigne's, Dix-Hallpike maneuver, Barany caloric test, Hoffman's sign, Romberg's, vertebral artery test, rapid alternating movement (diadochokinesis), Lhermitte's and saccadic and smooth pursuits eye movements. Functional testing would include the Berg balance scale, the Clinical Test for Sensory Interaction in Balance[6], posture and gait analysis, platform stabilometry,[7] cervical flexion test,[8] Jull's cervical cranial test (to quantify),[9] T4-T8 mobility test, wall angel,[10] respiration,[11] Hautant's test[12] and rotating stool test.[13] Neurologic testing would include cranial nerves (especially auditory), pathologic reflexes, deep tendon reflexes and sensory dermatomes, as well as gait and station. Diseases of the brainstem (central lesion) affecting the vestibulocochlear nerve will also affect adjacent cranial nerves (VII and IX).

Physical examination should focus on the vitals, with special attention being paid to both the vitals and auscultatory exam to rule out arrhythmias, stenosis, prolapse or congestive issues. Blood pressure should be assessed bilaterally as well, going from sitting to standing and laying down to standing. Specialized testing for dizziness should rule out TIA, vertebrobasilar insufficiency, Ménière's disease, benign paroxysmal positional vertigo and myelopathy. Such specialized testing could include, but should not be limited to, rotary chair testing, transcranial doppler sonography, MRI angiogram,[14] ENG (caloric), audiometry, CSF leakage, hypoglycemia, cardiovascular disorders, cervical and cranial MRI's, electrolyte panel (disturbance of the acid base balance could lead to dizziness),[15] coagulation profile and lipid profile (to evaluate for vertebrobasilar disorders),[16] and serology (to rule out infectious diseases, including syphilis and Lyme disease).[17]

## CASE STUDY #1

A 76-year-old woman reported with a chief complaint of sub-occipital neck pain, headache and stiffness, complicated by dizziness that has a positional relationship. She noticed these symptoms most while flexing her head forward to putt during golf. It presents intermittently and its duration lasts anywhere from three days to three weeks. She reports suffering from stiffness and dizziness for the better part of her adult life. Her sedentary computer occupation worsens her neck pain and stiffness. Movement of the head, especially ballistic, seems to increase her unsteadiness. She experiences feelings of movement from side to side and denies spinning (disequilibrium). She denies any tinnitus or obvious hearing deficit. These problems limit her daily living activities when the unsteadiness is at its worst (difficulty standing). She is also disabled from playing golf during these episodes. She had not sought treatment for this problem in the past.

Disability indexes were assigned and included: neck disability index – 46%, moderate; Dizziness Handicap Inventory; the Henry Ford Headache Disability Inventory – 10 on the emotional subscale and 25 on the functional subscale; Activities-specific Balance Confidence Scale (Powell) – rated at 75% episodically; PAR-Q – cleared; and red flags – yes to over 50 and 70 years old. Psychosocial assessment included Beck – 10 (not depressed or mildly) and Modified Somatic Perception Questionnaire – 13 (high level of somatic complaint). The patient could not relate or report any family or social history that would apply to her complaint. The clinical impression was ataxia, disequilibrium and cervical spasm. Her working diagnosis was cervical disequilibrium related to functional disturbance.

Her evaluation was as follows: Vitals; 5'9", 128 pounds, BP 130/86 on the right, BP 128/80 on the left, pulse – 50 beats per minute, temperature 99.0°F and respiration – 15 breaths per minute. No change in blood pressure was found in sit to stand or lying down to stand. Auscultation of the carotids and inferior vena cava was normal. Observation showed a well formed, aware and alert 76-year-old female. Percussion revealed tender paravertebral musculature at the occiput, cervicothoracic junction and the lumbosacral junction. Palpation revealed myofascial trigger points at the occiput, levator scapulae, sternocleidomastoids (SCM), lumbar erector spinae and gastroc/soleus complex. All findings were bilateral. Cervical spine x-ray examination confirmed a decreased cervical spine lordotic curve and generalized spondylosis from C3-T1. Cervical range of motion was found to be minimally limited in right lateral flexion, extension and right rotation. Lumbar range of motion was minimally limited in flexion and bilateral lateral bending.

Postural analysis yielded rounded shoulders, anterior lean, anterior head carriage, head tilt to the left, decreased cervical lordotic curve, Dowager's hump, decreased lumbar lordotic curve and posterior pelvic tilt. Chiropractic examination revealed shortened/facilitated SCM's, levator scapulae, scapular retractors, hamstrings and gastroc/soleus complex. Lengthened/inhibited muscles included cervical and lumbar erectors, longus coli, knee flexors and pectoralis. Subluxation complexes were found at occiput (inferior) C2 (right rotation restriction), T1 (right lateral flexion restriction), L4 (left rotation restriction) and a right posterior inferior ilium.

Examination began with a neurological exam, including cranial nerves (within normal), sensory dermatomes (within normal), pathological reflexes (absent) and deep tendon reflexes (+2/5 upper and lower bilaterally). Orthopedic examination consisted of cervical compression (negative with pain), Jackson's (negative with pain), cervical distraction (negative), Berrie-Lou (negative), Dekline's (negative), Maigne's (negative), Dix-Hallpike maneuver (positive), Hoffman's sign (absent), Romberg's (positive), the vertebral artery test (negative), rapid alternating movement (diadochokinesis – negative), Lhermitte's (negative), saccadic and smooth pursuits eye movements (negative) and the swivel chair test (negative). Functional testing revealed chin pointing with the supine neck flexion test, disequilibrium with the sit to stand test worsening towards the 5$^{th}$ repetition, a medium fall risk (35/36) on the Berg standing,[18] clinical testing of sensory interaction for balance[19] failing the 5$^{th}$ condition (eyes closed on unstable surface) within five seconds and gait analysis ataxia was noted with a wide stance being used. Functional analysis of respiration revealed paroxysmal breathing patterns.

One legged standing failed at six seconds on the right and four seconds on the left. Other functional activity testing revealed scapular winging and altered scapular abduction. No specialized testing was performed at the time, as no underlying pathology was suspected.

The patient's primary diagnosis was Layer Syndrome, her secondary diagnosis was cervical disequilibrium and her tertiary diagnosis was cervicalgia. Complicating factors included subluxation complex (full spine), cervical spondylosis, myofascial pain syndrome, altered gait, muscle weakness, muscle imbalance and diminished proprioception.

Treatment consisted of passive care for the initial two weeks of care and included electrotherapies, soft tissue work and manipulation three times a week. After the acute care thresholds were passed, transitional care was provided for an additional six weeks. It included facilitated stretching techniques, myofascial trigger point therapy and non-weight bearing short foot protocol on balance pads and pelvic stabilization protocols. Active care was initiated next and included weight bearing proprioceptive protocols, postural retraining (passive and active), as well as home exercises. The active care lasted 12 weeks at a frequency of three times a week.

Outcomes were measured at two week intervals and dictated the transition of her care. Her disability indexes improved consistently and after four weeks were as follows: neck disability index[20] – 32%; the Henry Ford Headache Disability Inventory[21] – 10 on the emotional subscale and 15 on the functional subscale; and Activities-specific Balance Confidence Scale[22] – rated at 50%. The ABC assessment was most profoundly influenced by the active phase of rehabilitation (25% at 6$^{th}$ week of active care). Other benchmarks for advancing stages of care included performance of orthopedic and functional testing.

| | Initial | 2 weeks | 4 weeks | 6 weeks | 8 weeks | 12 weeks |
|---|---|---|---|---|---|---|
| NDI | 42% | 44% | 35% | 26% | 14% | 10% |
| HDI (emotional/functional) | 20/26 | 18/18 | 16/16 | 10/16 | 8/10 | 8/10 |
| DHI (physical/ emotional/functional) | 22/12/18 | 18/12/14 | 16/10/14 | 12/8/10 | 8/8/10 | 8/6/10 |
| ABCI | 24% | 28% | 32% | 45% | 55% | 55% |
| Berg | 35/56 | 35/56 | 40/56 | 50/56 | 50/56 | 52/56 |
| One leg balance | 10 sec R<br>6 sec L | 8 sec R<br>14 sec L | 15 sec R<br>22 sec L | 25 sec R<br>33 sec L | 40 sec R<br>38 sec L | 40 sec R<br>46 sec L |

At the completion of her 12 week rehabilitation protocol, the patient was able to perform Romberg's test with an acceptable level of sway and her one legged balance had improved from six seconds to 72 seconds on the right. Performance of functional activity improved in the neck flexion test, breathing patterns improved and forward lean improved with the squat. Postural analysis showed a marked decrease in the upper crossed syndrome. She complied with her home exercise protocol, as well as the sparing strategies for her work. At that point, she was discharged.

## CASE STUDY #2

A female 42-year-old related family member (to the first patient) presents with a similar complaint of suboccipital neck pain, dizziness and headaches of a 14 year duration. Her complaint has no vector of injury or known causative factor. She suffers from her pain and unsteadiness intermittently and it persists for weeks at a time. She admits to an average of one attack per month and relates her problem to work and emotional stress. Her work is a sedentary office position as an entrepreneur. She describes her dizziness as an unsteady feeling, as a sensation of movement from side to side. This is exacerbated with rapid head movements and from laying to sitting. It is an intense sensation which severely affects and limits her daily life. She denied any hearing difficulties or ringing in the ears. Outcome assessment in the form of neck disability index (54%, moderate), pain disability questionnaire (60/180), the Henry Ford Headache Disability Inventory (14 on the emotional subscale and 20 on the functional subscale), Activities-specific Balance Confidence Scale[23] (rated at 36%) and PAR-Q (answered no to all questions) were performed during an episode. Family history was relevant, due to the obvious similarities to her mother's complaint. All other familial and social factors were denied. She had not seen any other provider for this problem. The clinical impression was postural overuse, psychosomatic pain, dysmetria and disequilibrium.

Her evaluation was as follows: Vitals; 5'11", 147 pounds, BP 146/72 on the right, BP 140/78 on the left, pulse – 72 beats per minute, temperature 97.0°F and respiration – 15 breaths per minute. No change in blood pressure found in sit to stand or lying down to stand. Auscultation of the carotids and inferior vena cava was normal. Observation revealed a well formed, but distressed 42-year-old female. Percussion to the spine reveals tender musculature at the occiput, cervicothoracic junction and the lumbosacral junction. Palpation showed active myofascial trigger points at the occiput, levator scapulae, SCM's, rhomboids, lumbar erector spinae, psoas and plantar muscles. All finding were bilateral, with the exception of the left lateral head tilt. Cervical spine x-ray examination confirmed a "military spine" and mild spondylosis at C5-C7. Cervical range of motion was found to be minimally limited in right lateral flexion, extension and right rotation. Lumbar range of motion was minimally limited in extension and mildly in flexion. Postural examination revealed forward head carriage with a left head tilt and rounded shoulders. Chiropractic examination showed shortened SCM's, levator scapulae, upper trapezius, pectorals, anterior deltoids, psoas and hamstrings. Segmental dysfunction was noted as follows: occiput (inferior) C2 (right rotation restriction), C6 and C7 (right lateral flexion restriction), L5 (left rotation restriction) and an anterior sacrum.

During a neurological examination, she showed no pathologic reflexes, all deep tendon reflexes were +2/5 bilaterally, cranial nerve examination was within normal limits and sensory dermatomes were intact. Orthopedically, she tested positive to Dix-Hallpike maneuver and Romberg's. Previously mentioned testing was performed and found to be negative. Functional testing revealed chin pointing on curl up, disequilibrium with the sit to stand test worsening towards the 2$^{nd}$ repetition, a medium fall risk (35/56) on the Berg standing[24], clinical testing of sensory interaction for balance[25] failing the 5$^{th}$ and 6$^{th}$ condition (eyes closed on unstable surface and under the dome) within five seconds and gait analysis showed toeing out.

Functional analysis of respiration revealed paroxysmal breathing patterns. Scapular winging and altered scapular abduction were noted in the push up and shoulder abduction, respectively.

The patient's primary diagnosis was upper crossed syndrome, her secondary diagnosis was cervical disequilibrium and her tertiary diagnosis was cervicalgia. Her complication factors included psychosomatic stress, myofascial pain syndrome, subluxation complex, muscle imbalance, muscle weakness, diminished proprioception and altered gait.

Acute care included management of myofascial pain through electrotherapy, trigger point compression, spray and stretch techniques, PIR stretching, diversified CMT, as well as contrast treatment. Transitional care focused on patient reactivation and included gait training, PNF stretching, pelvic stabilization, scapular stabilization, postural retraining and sparing strategies at home and work. Active care included isometric to isotonic strengthening and closed chain kinematics (from supine to prone to quadruped, then seated to standing). We also provided ergonomic analysis, coping strategies (to address the bio-psycho-social aspect and to limit chronicity) and a home stretching and strengthening routine.

Treatment was initiated at a three times a week frequency and passive care lasted three weeks. Transitional care was rendered at two times per week for two weeks and active rehabilitation was rendered at two times per week for six weeks. Outcome measures were given every two weeks and were compared to clinical benchmarks to progress the patient through the phases of care. Her pain and disability showed improvement subjectively and, on the neck disability index at the 4$^{th}$ week assessment (35%), they improved. Her disequilibrium and headaches did not respond until the 4$^{th}$ week of active rehabilitation. At the end of her treatment protocol, her outcome assessments were as follows: neck disability index – 20%, moderate; pain disability questionnaire – 30/180; the Henry Ford Headache Disability Inventory – 4 on the emotional subscale and 10 on the functional subscale; and the Activities-specific Balance Confidence scale[26] – rated at 65% (administered during an episode). Repeated functional testing confirmed her improvement with a low fall risk (45/56) on the Berg standing,[27] clinical testing of sensory interaction for balance[28] failing the 5$^{th}$ and 6$^{th}$ condition (eyes closed on unstable surface and under the dome) after 35 seconds and improved posture and gait (improved head and shoulder carriage and no toeing out on gait). She was released to prn care and was instructed to return if her symptoms reappear.

| | Initial | 2 weeks | 4 weeks | 6 weeks | 8 weeks | 12 weeks |
|---|---|---|---|---|---|---|
| NDI | 52% | 44% | 35% | 26% | 24% | 20% |
| HDI (emotional/functional) | 14/20 | 10/18 | 10/16 | 10/16 | 8/10 | 4/10 |
| DHI (physical/ emotional/functional) | 22/12/18 | 18/12/14 | 16/10/14 | 12/8/10 | 8/8/10 | 8/6/10 |
| ABCI | 36% | 41% | 53% | 55% | 59% | 65% |
| Berg | 22/56 | 26/56 | 43/56 | 46/56 | 50/56 | 50/56 |
| One leg balance | 6 sec R<br>4 sec L | 8 sec R<br>7 sec L | 33 sec R<br>22 sec L | 59 sec R<br>55 sec L | 40 sec R<br>56 sec L | 72 sec R<br>66 sec L |

## TREATMENT PROTOCOLS AND BENCHMARKS

The short-term goals of both of the patients included stretching shortened facilitated muscles and activating inhibited muscles (PIR), decreasing myofascial trigger points, improving subluxation complex, instructing to maintain positions of comfort and decreasing pain. The intermediate goals centered around early reactivation and included postural re-education, stretching shortened facilitated muscles, activating inhibited muscles (PNF, flex building), improving proprioception (non-weight bearing), improving core stabilization via breathing techniques, monitoring and tracking progress via outcome assessment and ruling out vestibular dysfunction. Considering the patient's complicating factors, we initiated sparing strategies according to the patient's ADL's.

Long-term goals would include home/self care activities and active rehabilitation. **Stage 1 active rehabilitation – core and postural stabilization –** enhances equilibrium by improving faulty mechanics/postural imbalances, propriosensory retraining, a system of exercises that utilize balance boards, balance beams, rocker boards, wobble boards and balance shoes,[29] increased proprioceptive input (weight bearing) and improved coordination/integration of the vestibular, ocular and tactile sources of balance (via closed chain kinematics and unstable sources). **Stage 2 active rehabilitation – endurance training –** improves aerobic potential (brisk walk, HIIT[30]). **Stage 3 active rehabilitation – strength training –** includes isometric protocols to improve functional reserve of strength in the postural muscles. Hettinger-Muller protocols are instituted to create static strength at 2/3 maximum contraction, then they are graduated to multiple angles. Isotonic strength is the next progression[31] and D.A.P.R.E. protocol is used. The adaptation in the D.A.P.R.E. protocol makes it ideal for the rehabilitation setting.[32] **Stage 4 active rehabilitation – home protocol –** includes self care, which is administered in the form of a home exercise routine and includes stabilization exercise, postural training and applicable muscle lengthening procedures.

## DISCUSSION

The similarities in these cases are by no means a quantitative measure of the effects of functional disturbances on the balance and stabilization systems of the body. They do, however, provide a basis for further testing and a qualitative example of structure as it relates to function. These two cases, while not genetic, still share many of the postural and altered movement patterns. The shared link in these cases is the upper cervical dysfunction. Hulse has shown the relationship between upper cervical joint dysfunction and disequilibrium and recommends an integrated approach.[33] The aforementioned etiologies can prompt disturbances in the cerebellar integration of sensory afferents of cervical proprioception, as nociception can contribute to dysafferentation from the zygapophyseal joints.[34]

Chiropractic care and the rehabilitation mindset in treating cervicogenic disequilibrium is custom tailored to identify and address the root causes of this issue and equally suited to alleviate the contributing factors. The advantage over other types of providers would be in the ability to treat,

diagnose and monitor simultaneously, the last of which is pivotal. This is because the complaint can constantly change when the treatment is implemented. The practitioner must be ready for an immediate and unexpected reaction. Therefore, it is imperative that the practitioner rule out more sinister etiologies before instituting a conservative care program. In addition, one must be equipped with the diagnostic triage required in a working diagnosis. The distinction between central and peripheral lesions causing vertigo/dizziness must be accurately deduced and is a major differential in case management that would determine conservative care versus further investigation and outside referral.

## CONCLUSION

Dizziness, and more specifically cervicogenic disequilibrium, is a complex and multi-faceted issue with a very high prevalence. It is concluded that 23-30% of adults have experienced at least one episode of dizziness and 3.5% of adults experience a chronic, recurrent episode greater than a one year duration by age 65.[35] Familial similarities (body type, psychosomatic stress and postural stress) can sometimes predispose a patient to functional disturbances. Disequilibrium can commonly be related to cervical dysfunction[36] and manipulation is a safe[37] and effective[38,39] way of restoring proper cervical function. The correct diagnosis, along with a diversified approach that concentrates on addressing joint dysfunction, soft tissue changes and functional disturbances, can correct such issues. The rehabilitation mindset, along with outcome assessment tools, is essential in monitoring progress, establishing benchmarks and justifying changes in the clinical protocols. Self care and stress management are other valuable tools in maintaining positive results.

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