ARTICLE

Neurological Impact of Wallenberg Syndrome on the Visual-Vestibular Systems

Megan Hueske, OD[1]
Chung To, OD, FAAO[1]
Chrystyna Rakoczy, OD, FAAO[1]
[1]*James A. Haley VA Polytrauma and Traumatic Brain Injury Tampa, Florida 33612*

ABSTRACT

Purpose

This case discusses the neurological impact of Wallenberg syndrome on the visual-vestibular system and provides a clinical pathologic correlation between neuro-anatomic involvements with the manifesting symptoms.

Case Report

A 50-year-old male presented for consultation following a left lateral medullary infarct occlusion of the left vertebral artery (Wallenberg syndrome) with complaints of intermittent binocular diplopia, vertigo, and oscillopsia. Assessment revealed an intermittent central nystagmus, a right skew deviation, and a left Horner's syndrome. Video recordings of the nystagmus and ocular motor responses were documented.

Conclusion

Wallenberg syndrome has very defined characteristics which can be used clinically to make a definitive diagnosis.It is important for eye care professionals to understand the neuro-anatomic involvements associated with this condition and make the clinical correlation to aid in the treatment and management of these patients.

Correspondence regarding this article should be emailed to Megan Hueske, OD, at Megan.Hueske@va.gov. *https://doi.org/10.31707/VDR2020.6.1.p8.*

Hueske M, To C, Rakoczy C. Neurological impact of Wallenberg Syndrome on the visual-vestibular systems. Vision Dev & Rehab 2020;6(1):8-14.

Keywords: Horner's Syndrome, Hypertropia, Lateral Medullary Syndrome, Skew Deviation, Nystagmus, Wallenberg Syndrome

INTRODUCTION

Wallenberg syndrome, also known as lateral medullary syndrome, is one of the most recognized brain-stem strokes.[1] It was first described by Adolf Wallenberg in 1895 by clinical observations of the symptoms on a living patient and was later confirmed by pathology via autopsy.[2] This condition is typically a result of atherosclerotic stenosis, occlusion, or dissection of the arteries supplying the lateral medullary region of the brain stem, including the vertebral artery (most common) and/or the posterior inferior cerebral artery (PICA).[1,3] Wallenberg syndrome more commonly affects men during the 6th or 7th decade of life; however, the syndrome can also be associated with a younger age of onset as a result of vertebral artery dissection secondary to trauma.[1] Other causes of Wallenberg syndrome include: vertebral arteritis, metastatic cancer, herpetic brainstem encephalitis, multiple sclerosis, varicella infection, and brainstem tuberculoma, which is a rare form of tuberculosis.[4] The syndrome is characterized by distinct neurological symptoms correlating to the neuro-anatomic areas of involvement but will almost always present with a classical triad of Horner's

syndrome, ipsilateral ataxia, and contralateral hypalgesia. Wallenberg syndrome can be diagnosed purely on this triad alone in a clinical setting in the absence of imaging studies.[1,5]

Case History

A 50-year-old male presented for an ophthalmic consultation following left lateral medullary infarct secondary to occlusion of the left vertebral artery. The patient's chief complaints included: blurred vision at distance and near, intermittent binocular vertical diplopia that was alleviated when closing one eye, reading difficulties, sensitivity to light, vertigo and oscillopsia that has improved since the initial infarct. The patient also reported having to turn or tilt his head to see better, asymmetrical sweating on one side of his face, and nystagmus which was initially uncontrollable but has subsided. The patient was unsteady on his feet and presented in a wheelchair. The review of the patient's medical history included: sleep apnea, hypertriglyceridemia, hyperlipidemia, and hypertension. His active medications as an inpatient were: acetaminophen, amlodipine, aspirin, atorvastatin, baclofen, gabapentin, Lisinopril, meclizine and omeprazole. Family ocular history was unremarkable. No allergies were reported by the patient.

Clinical Examination and Diagnostic Data

The patient presented without correction. His best corrected visual acuity was 20/20 OD, OS, OU with -0.75-0.75x160 OD, and -1.00-1.00x180 OS. Vertical diplopia was confirmed when the patient was binocular. Confrontation visual fields were full to finger counting OD and OS. Pupils were round and reactive with a mild anisocoria OD>OS by 1mm which was greater under dim illumination. No afferent pupillary defect was present. The patient demonstrated mild sensitivity and discomfort to light. Color vision tested with simplified Ishihara color plates was normal OD and OS. No defects were found on red Amsler grid. Extraocular motility testing was full in all nine positions of gaze but an intermittent central nystagmus was noted in primary gaze. Smooth pursuits and saccades were normal. A consistent left head tilt was observed throughout the clinical examination. The distance cover test through the manifest prescription revealed a 3-4 prism diopter exophoria and 6-7 prism diopter right hypertropia. Parks- Bielchowsky 3 Step test showed a right hyper in primary gaze that was worse on left gaze and right head tilt. Torsional testing using the double Maddox rod revealed 5 degrees of excyclotortion in the left (hypo) eye. Near testing with the manifest prescription also showed an exophoria and a right hypertropia of the same degree and magnitude. Slit lamp examination was unremarkable with the exception of mild dry eyes OU and ptosis of the left upper eyelid. Intraocular pressure was normal at 14 mmHg OU at 2:35 pm. Dilated fundus examination was also unremarkable revealing healthy nerves, clear maculae and, flat and intact periphery OU.

Diagnosis

The patient was diagnosed with: left Horner's syndrome (left anisocoria, left upper lid ptosis, and unilateral anhidrosis), right skew deviation (right hypertropia with excyclotortion of the contralateral eye), and improving central nystagmus. The visual and vestibular findings (skew deviation, vertigo and nystagmus) were consistent with the diagnosis of Wallenberg syndrome.

Treatment and Follow Up

A total of 6 prism diopters base down in front of the right eye corrected the right hypertropia and alleviated the constant diplopia at distance and near. Binocular vergence testing through the trial frame with the manifest refraction and 6 BD OD showed balanced vertical fusional amplitudes of 2 break and 1 recovery BD OD and OS.Horizontal distance step vergence was Base In: 4 break/2 recovery

and Base Out: 8 break/6 recovery. Near point of convergence with an accommodative target over a +2.00 ADD was 3 inches break and 4 inches recovery with positive diplopia, and no signs of regression after five complete trials. A final prescription was given using the manifest refraction with 6 BD OD total vertical prisms split between the two lenses. Fresnel prisms would have been a better option, but the patient presented without glasses. Separate single vision distance and near spectacles along with an anti-reflective coating for glare reduction was recommended. Additionally, a light #1 grey tint was added to the single vision distance lens only to address the light sensitivity complaints while indoors under fluorescent lighting.

Final Prescription: single vision distance

OD: -0.75-0.75X160 3BD
OS: -1.00-1.00X180 3BU
Type: single vision distance
Tint: 15% Grey
Anti-Reflective coating

The findings were discussed with the patient along with the visual prognosis. The patient was to continue care with neurology and cardiology and follow up with optometry in 6-8 weeks for recheck of the binocular visual system.

The patient did not come back until 3 months later. At the first follow-up visit, the patient still complained of diplopia with and without the glasses he received at the previous visit, but preferred to go without his glasses. The best corrected visual acuity was stable at 20/20 OD, OS, and OU with no changes in the manifest refraction. No nystagmus or opsillopsia was noted, but complaints of vertigo were still present. The right vertical deviation was now reduced from the initial 6 right hypertropia to 2 right hypertropia without other prism correction. Repeated Parks-Bielchowsky 3 step testing without prism confirmed a reduced right hyper in primary gaze that was worse on right gaze (initially presented worse on left gaze) and worse on right head tilt. Torsional testing using the double Maddox rod consistently revealed 5 degrees of excyclotortion in the left eye which was stable to the initial presentation. An exophoric deviation was still present, but horizontal compensatory ranges were within normal limits with base-in break of 4 and recovery of 2 and base-out break of 8 break and recovery of 6. The vertical prism correction was adjusted from 6 BD OD to 2 BD OD in order to correct for the improving right hypertropia.

The patient was lost to follow-up but showed up in the general ophthalmology eye clinic almost a year later. The diplopia had resolved completely, and no prisms were needed. The vertigo and nystagmus were also resolved.

DISCUSSION

Wallenberg syndrome is an infarct to the lateral medullary region of the brainstem caused by stenosis, occlusion or dissection of the vertebral artery (accounting for 73%) or one of its tributaries (less commonly affecting the PICA or its distal branches).[1] The vertebral artery is the second branch of the subclavian. It travels up the spinal cord through the transverse foramen, giving off the anterior spinal arteries. It enters the skull through the foramen magnum and joins its counterpart to form the basilar artery after supplying the brainstem via its distal branches the superior medullary artery and PICA. The cerebellar blood flow is spared in vertebral artery occlusion due to retrograde flow from the contralateral vertebral or ipsilateral superior cerebellar artery.[1]

Neurologic symptoms associated with Wallenberg syndrome are correlated to structures affected by infarct within the lateral medullary region of the brainstem (see Figure 1). They include but are not limited to: the inferior cerebral peduncle, the solitary nucleus, the vestibular nucleus, nucleus ambiguous,

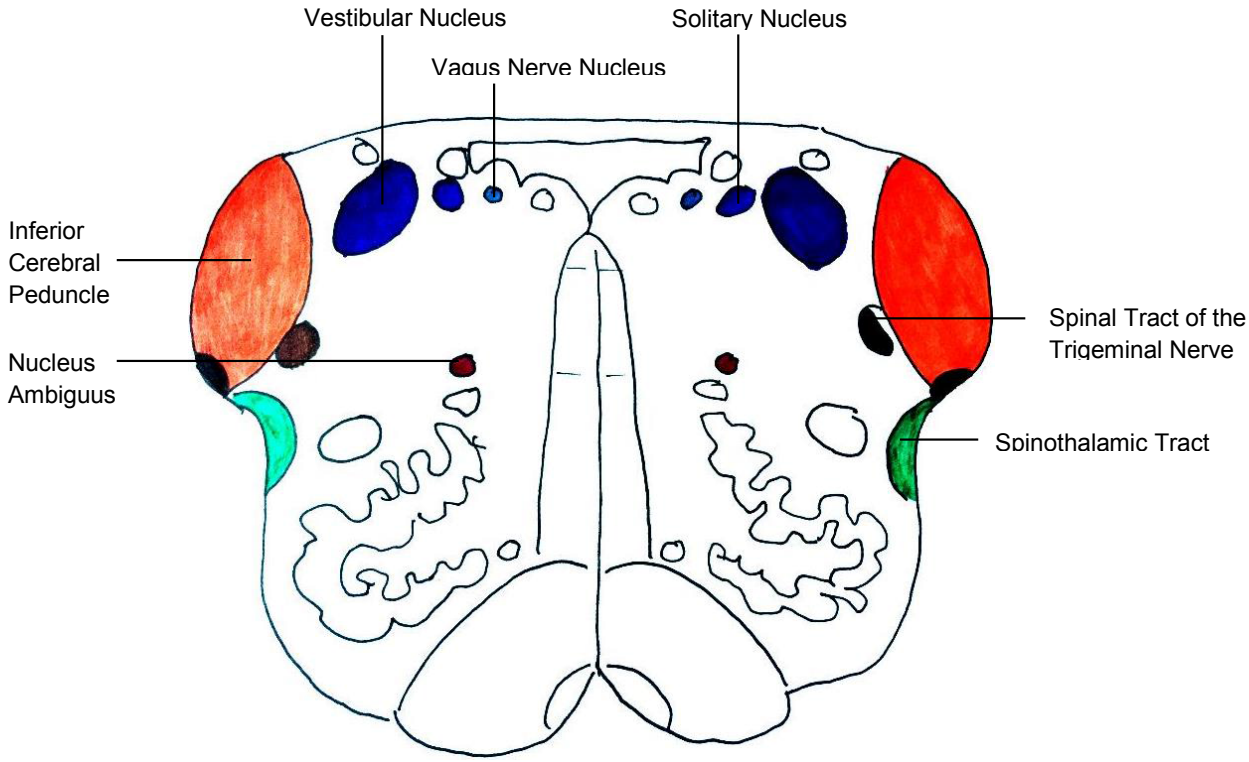

Figure 1: Cross-section of the brainstem at the level of the medulla.

the vagus nerve, and the spinal tract of the trigeminal nerve. Descending sympathetics (which run alongside the spinothalamic tract) can also be affected as they travel alongside the spinothalamic tract. The spinal tract of the trigeminal nerve located on the lateral aspect of the midbrain, controls sensory to the face, pain, and numbness. The spinothalamic tract runs slightly anterior to the spinal tract of the trigeminal nerve and controls pain and temperature. The nucleus ambiguus is medial to the spinal tract of the trigeminal nerve and the spinothalamic tract. Injury to this structure results in hoarseness and dysphagia. Posterior to the spinal tract of the trigeminal nerve is the inferior cerebellar peduncle, which when affected, is responsible for ataxia of the limbs and gait. The vestibular nucleus sits at the medial posterior aspect of the midbrain. A lesion to this area causes nystagmus that can result in nausea, vomiting, and vertigo. Slightly anterior to the vestibular nucleus is the solitary nucleus. When the solitary nucleus is damaged, it causes hoarseness, dysphagia, paralysis of the vocal cord, and diminished gag reflex.[1,6]

Wallenberg syndrome has many impacts on the visual and vestibular systems due to the anatomic structures involved. One of those structures includes descending sympathetic fibers. Starting from the posterolateral hypothalamus, the first order central neurons of the sympathetics run uncrossed through the lateral pons and medulla before synapsing at the ciliospinal center of Budge at the intermediolateral cell column of C8 to T2. The fibers emerge, forming the second order preganglionic axons and ascend into the sympathetic chain before traveling over the lung apex to synapse at the superior cervical ganglion at the carotid bifurcation. Some of the third order post ganglionic fibers course along the external carotid to innervate the sweat glands of the face. Other post ganglionic fibers travel with the internal carotid artery and jump over to the ophthalmic division of the trigeminal nerve in the cavernous sinus to enter the ciliary ganglion without synapsing. These fibers go on to innervate the dilator muscle of the iris via the long ciliary nerves as well as the Müller's muscle in the upper and lower lids. Any damage within the

descending sympathetic fibers can cause a Horner's syndrome which has a classical triad of unilateral ptosis, miosis and anhidrosis.

Binocular diplopia and blurred vision complaints in Wallenberg syndrome are most likely due to vertical angle strabismus as a result of a skew deviation. There are different types of skew deviations which may be comitant or non-comitant and can mimic a CN 4 palsy during the Parks- Bielchowsky 3 step test.[7] A skew deviation in Wallenberg is a vertical misalignment of the eyes in which the hypo eye is excyclotorted. Incyclotorsion of the hyper eye is usually absent or very small in lesions to the lateral medullary region. Incyclotorsion of the hyper eye is more commonly seen in rostral pons and midbrain lesions.[7] The skew deviation in Wallenberg syndrome results from asymmetric disruption of the supranuclear input from the vestibular nuclei responsible for linear motion, static tilt of the head, and transmitting information to the ocular motor neurons as well as the interstitial nucleus of Cajal, all of which are located in the midbrain.[7] The patient will commonly adapt a compensatory head tilt contralateral to the hyper eye in an effort to lessen the diplopia.

Nystagmus associated with Wallenberg syndrome is also caused by a midbrain infarct due to direct damage to the vestibular nuclei or their cerebellar, semicircular canal, or otolithic connections.[8] This results in intermittent central nystagmus, unsteady fixation and oscillopsia. Other oculomotor disruptions, including smooth pursuits and saccades, are dependent on the neuro-anatomic structures affected by the infarct. The cerebellar flocculus, paraflocculus, and vermis climbing fibers pass through the inferior cerebellar peduncle of the midbrain. These fibers are involved with smooth pursuits and gaze-holding.[8] Smooth pursuit eye movements that track targets moving away from the side of the lesion are impaired, but pursuits toward the side of the lesion are normal. The patient may also exhibit lateropulsion or pulling of the eyes toward the side of the infarct.[8,9] Abnormal saccades may also be observed as hypometric (undershoot) saccades occur opposite the infarct while hypermetric (overshoot) saccades occur toward the infarct. Interruption of the cerebellar central connections that traverse the lateral medulla is thought to account for some observed ocular motor deficits.[8] The specific type of abnormality relates to the pattern of neural activity delivered to the ocular motor neurons.

The preferred method for diagnosis of Wallenberg syndrome is an MRI due to its sharp contrast and high spatial resolution, but cerebral angiography and noninvasive duplex Doppler can also be used if an MRI is unavailable.[1] CT scan is not useful due to the bony artifacts obscuring anatomic details. A clinical test called the Head-Impulse-Nystagmus-Test of Skew (HINTS) can also be used to diagnose patients with Wallenberg syndrome. This test can be done bedside and has been shown to be 100% sensitive and 96% specific, which is more sensitive than early MRI in acute vestibular syndrome (described collectively as vertigo, nystagmus, nausea/vomiting, head motion intolerance and unsteady gait).[10] HINTS is a three step oculomotor exam used to diagnose acute vestibular syndrome. In the first step, the examiner looks for presence of nystagmus that changes in direction on eccentric gaze. This can be observed during extraocular muscle testing. The second step involves identification of a skew deviation which can be observed during the alternate cover test and double Maddox rod testing positive for cyclotorsion. In patients with a positive skew test a vertical misalignment is present with excyclotortion of the hypo eye and frequently, incyclotorsion of the hyper eye. The third step involves the horizontal head impulse test of vestibular-ocular reflex (VOR) function. To test the VOR response, the examiner moves the patient's head from side to side while having the patient fixate on a central point or object in front of them such as the examiners nose. The normal VOR response to a rapid, passive and horizontal

head movement is an equal and opposite compensatory eye movement to maintain a stationary eye position in space (negative h-HIT).[10] An abnormal VOR response occurs when there is a loss of vestibular afferent input resulting in the inability to maintain fixation during the horizontal head rotation which requires a corrective gaze shift once the head is stationary (positive h-HIT). This response is typically seen when the head is rapidly rotated toward the side of the vestibular lesion. A patient with Wallenberg syndrome will demonstrate a normal (negative) horizontal head impulse test, direction changing nystagmus and presence of a skew deviation.[7,10] We did not perform VOR on our patient due to nausea and vertigo. In contrast, a positive h-HIT in association with direction changing nystagmus and a skew deviation is indicative of an acute peripheral vestibulopathy which occurs during a lateral pontine stroke.

Risk factors for Wallenberg syndrome are similar to that of stroke, which include: hypertension, diabetes, atrial fibrillation or other heart disease, previous histories of stroke, high cholesterol, sickle cell disease, obesity, unhealthy diet, high alcohol intake, tobacco use, a positive family history, increased age, male gender, and race (African American has the highest prevalence, followed by Hispanics, American Indians, and Alaskan natives, respectively.)[1,11] The prognosis of Wallenberg syndrome is usually excellent with expected recovery over time, typically within three to six months. The recovery of the visual and vestibular systems occurs within the same time frame.[1]

Wallenberg syndrome is rarely fatal and the treatment is symptom dependent. An interdisciplinary medical approach is recommended in the management of these patients. Collaboration with physical therapy can aide in vestibular control. Consultation with speech therapy should be considered when paralysis of the vocal cords is evident.[1] In more severe cases, a feeding tube for dysphasia may be required. Internal medicine and cardiology should be consulted for stroke prevention protocols.[1] Optometric management should include full optical correction of any ametropia. The use of relieving prism should be considered in the presence of strabismic angle deviation, specifically diplopia from a skew deviation. Fresnel prism should be used initially for temporary relief of diplopia. Prism magnitude can be modified accordingly dependent on the patient's rate of recovery. Follow up with frequent intervals is recommended as symptoms are expected to improve with time.

Serious ophthalmic conditions that may present with similar clinical characteristics of Wallenberg syndrome due to shared neuro-anatomic pathways include: Horner's syndrome, cranial nerve IV palsy, traumatic skew deviation, cranial nerve III palsy, Weber syndrome, Benedikt syndrome, and cavernous sinus involvement.

CONCLUSION

Wallenberg syndrome is caused by decreased blood supply to the lateral medullary region of the brainstem. This results in a distinctive clinical triad of Horner's syndrome, ipsilateral ataxia, and contralateral hypalgesia. The visual and vestibular symptoms correlate to the neuro-anatomic structures involved in the infarct to include: nystagmus, vertigo, blurred vision and diplopia. The preferred method of diagnosis is an MRI of the brain with and without contrast, but clinical examination with the Head-impulse-nystagmus-test of skew (HINTS) has been shown to be more sensitive in acute vestibular syndrome.The prognosis is usually excellent in most cases and treatment and management is dependent on the patient's symptoms. Because of significant visual involvement, eye care professionals play a pivotal role in the interdisciplinary medical management of these patients. Full functional recovery is expected within three to six months of the initial onset.

Acknowledgements

The authors would like to thank Nancy Kirk, M.D., Chief of Ophthalmology, James A. Haley Veterans' Hospital and Pennsylvania College of Optometry for support of this paper.

REFERENCES

1. Sacco RL, Freddo L, Bello JA et al. Wallenberg's Lateral Medullary Syndrome clinical-magnetic resonance imaging correlations. Arch Neuro 1993;50:609-14.
2. Kato S, Takikawa M. Ishihara S, et al. Pathologic reappraisal of Wallenberg syndrome: a pathologic distribution study and analysis of literature. Yonago Acta Medica 2014;57:1-14.
3. Kaiser PK, Friedman NJ, Pineda R. The Massachusetts eye and ear infirmary illustrated manual of ophthalmology, 4th ed. Philadelphia: Saunders; 2014.
4. National Center for Advancing Translational Sciences. Genetic and Rare Diseases Information Center (GARD). Wallenberg syndrome; 2016. Available at: http://bit.ly/2Ic6IQb Accessed January 11, 2016.
5. Walker L, French S. Horner's Syndrome: A case report and review of the pathophysiology and clinical features. West Indian Med J 2014;63:278.
6. National Institute of Neurological Disorders and Stroke (NINDS). Stroke syndromes; 2016. Available at: http://bit.ly/2wiGYPf. Accessed Jan 11, 2016.
7. Wong AMF. Understanding skew deviation and a new clinical test to differentiate it from trochlear nerve palsy. J AAPOS 2010;14:61-7.
8. Brazis PW. Ocular motor abnormalities in Wallenberg's Lateral Medullary Syndrome. Mayo Clin Proc 1992; 67:365-8.
9. Hornsten G. Wallenberg syndrome. Acta Neurol Scandinav 1974;50:434-46.
10. Kattah JC, Talkad AV, Wang DZ, et al. HINTS to diagnose stroke in the acute vestibular syndrome. Stroke 2009;11:3504-10.
11. Centers for Disease Control and Prevention (CDC). Conditions that increase risk for stroke; 2016. Available at: http://bit.ly/2ThKd2q. Accessed Jan 11, 2016.

AUTHOR BIOGRAPHY:
Megan Hueske, OD
Tampa, Florida

After Graduating from the Illinois College of Optometry in 2015, Dr. Megan Hueske completed a Residency in Primary Eye Care and Traumatic Brain Injury (TBI) followed by an additional year of advanced clinical optometric fellowship in interprofessional Polytrauma/-TBI Rehabilitation at the James A Haley Veterans' Hospital in Tampa, Florida. She is currently a staff optometrist and a preceptor for students, residents and fellows who rotate through her general and TBI clinics.