Review Article

Brainstem Vertigo: A Brainstorming Clinical Entity for a Clinician

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Abstract

Stroke at the brain stem and cerebellum may cause sudden vestibular syndromem and isolated audiovestibular loss can herald impeding for infarction at the anterior inferior cerebellar artery territory. Patients complaining sudden isolated dizziness or vertigo are higher chance for the stroke than the general population. Proper bedside assessment of the patient is superior to the imaging such as magnetic resonance imaging for detecting the central cause. Misdiagnosis of the stroke in patient of brain stem vertigo leads to significant morbidity and mortality. The overdiagnosis of this clinical entity will cause unnecessary costly workups and medical treatment. It is important for a clinician to differentiate brain stem vertigo with isolated dizziness or vertigo from the benign disorders of the labyrinth as the treatment strategy and prognosis are different in these two situations. Bedside clinical indicators are often helpful to identify the central pathology, and so neuroimaging should be advised accordingly. This review article focuses on the epidemiology, pathophysiology, clinical presentations, and current management of the brain stem vertigo. This article will surely increase awareness among the clinicians for accurate diagnosis and treatment of the brain stem vertigo.

Keywords: Brainstem vertigo, cerebellum, isolated vertigo, vertebrobasilar insufficiency

Introduction

Vertigo or dizziness is a nonspecific symptom where patient feels an altered sensation of the orientation in the space. The labyrinth, vision, and proprioception provide important sources of sensation about the position of the head and the body in the space, and any defect in these systems can cause dizziness or vertigo.[1] Episodic vertigo may be found in patient of ischemia at the vertebrobasilar circulation. The vertigo and dizziness may found in isolation or with associated symptoms of the vertebrobasilar insufficiency or along with symptoms of the ischemia to brain stem and the cerebellum. If the clinical features of the stroke are found with vertigo, then diagnosis of the brain stem vertigo is obvious. However, if the vertigo is alone seen, then it can be surely difficult to differentiate from more benign lesions of the labyrinth. Hence, it is often challenging for clinician to differentiate the two conditions at the initial presentation. Missing the diagnosis of acute stroke in a vertigo patient can lead to the hazardous condition of the patient. The typical attack of vertigo in ischemia of the posterior circulation of the brain or infarction of the brainstem is typically sudden in onset and continues for minutes. As labyrinth is supplied by the vertebrobasilar circulation, so the vestibular symptoms are common with ischemia in this distribution. Inner ear is affected selectively as it is an end artery with very scanty collaterals. Identifying the stroke among vertigo patients is highly needed for clinicians and missing the stroke during assessing the vertigo is also not uncommon.[2] Clinicians usually differentiate the stroke from the peripheral vestibular diseases using the focal neurological signs. However, only approximately 19% of the patients of stroke present with acute vestibular syndrome have focal neurological findings.[3]

Methods of Literature Search

Research articles regarding brainstem vertigo were searched through a multiple systemic approach. First, we conducted an

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online search of the Scopus, PubMed, and Medline database with the word brainstem vertigo, vascular vertigo, isolated vertigo, and vertebrobasilar insufficiency. The abstracts of the published articles were identified by this search method, and other articles were identified manually from citations. This manuscript reviews the details of brain stem vertigo patients along with certain important medical problems. This review article presents a baseline from where further prospective trials for brain stem vertigo could be designed and helps as a spur for further research in the medical issues encountered among brain stem vertigo.

Epidemiology

Vertigo and dizziness account for 3.3% of the visits at the emergency department.[4] The stroke is responsible for 3.2%–4% of the vertigo and dizziness at the emergency department.[5] One study documented that only 0.93% of the patients discharged from the hospital with vertigo at the emergency department presented stroke in the follow-up period of 6 months.[6] Posterior circulation stroke accounts for about 20%–30% of all the strokes and the varied clinical presentations.[7] The mortality of the posterior circulation stroke or brain stem stroke is as low as 3.6% to more than 90%.[8] Acute vestibular symptom accounts for 10%–20% of the dizziness patients at the emergency department, so responsible for 400,000–800,000 United States emergency department visits per year.[9] One study showed that 25% of the acute vascular vertigo is occurring due to the stroke.[10] The majority of the patients with vertigo due to ischemic strokes cause acute vestibular symptoms, but only 20% of the patients have focal neurological deficits, whereas the remaining have only isolated vertigo.[10]

Pathophysiology

It is commonly thought that isolated vertigo is often due to a peripheral vestibular pathology. However, in the present era, doing early imaging has shown that isolated vertigo without neurological signs, many a times, to be originated from the brain stem and cerebellar strokes.[11] The vertebrobasilar arterial circulation supplies the cerebellum, medulla, pons, midbrain, occipital lobes, posterior temporal lobes, and thalamus. This arterial circulation has extracranial and intracranial vertebral arteries of both sides, which unite to form the basilar artery, and it runs midline on the ventral surface of the brain stem, supplying by its small and deep perforators. After that, it merges with the circles of Wills to provide the superior cerebellar arteries and posterior cerebral arteries. Intracranial vertebral arteries give posteroinferior cerebellar arteries (PICAs) and basilar artery, which give rise to anteroinferior cerebellar artery (AICA). The location of the lesion in case of patients with vascular vertigo can be varied. Some common causes for posterior circulation stroke include embolism of intracranial arteries such as AICA and PICA which cause cerebellar ischemia, embolism at the distal part of the basilar artery which can lead to infarcts at the upper cerebellum, midbrain, thalamus, and territories of the posterior cerebral artery so known as top-of-the-basilar infarcts.[12] Ischemia at the territory of the intracranial vertebral arteries causes lateral medullary syndrome and affecting the basilar artery, leading to the bilateral and crossed symptoms and signs. Vertebrobasilar ischemia or posterior circulation stroke comprises approximately 20% of all the strokes.[13] One study documented that isolated vertigo was found in approximately 62% of the vertebrobasilar ischemia patients, and in approximately, 19% of these cases present isolated vertigo as the initial symptom.[14] Inferior cerebellar and small brain stem infarctions are responsible for the recognized cause of the isolated vertigo after development in neuroimaging and neurotology.[15] It is clinically vital to differentiate the isolated vertigo of the vascular origin from beginning of the vestibular pathology, where the prognosis and management are also different.

Clinical Presentations

Ischemia in vertebrobasilar circulation presents with neurologic localizing signs, but small infarcts in brain stem or cerebellum can present with sudden onset vestibular symptoms without any other localizing features. These abrupt onsets of vestibular symptoms indicate central origin and may mimic to the acute symptoms of peripheral vestibulopathy where patients present with acute onset of the dizziness, nausea, vomiting, and imbalance, which last for days to weeks. Vertigo or dizziness often accompanies with other neurological features in cerebrovascular disorders [Table 1]. However, isolated vertigo is mostly seen in peripheral vestibulopathy. Patients of stroke may present with sudden onset vertigo or dizziness. The vascular vertigo may be acute or episodic and rarely positional vestibular syndrome (recurrent positional vertigo). Many clinicians underestimate the importance of the isolated vertigo in case of the ischemia of the brain stem. The diagnosis of the isolated vertigo in brain stem and cerebellar strokes is increasing markedly in present clinical practice with the use of the expertise of the neurotology and neuroimaging.[16] The isolated vertigo in case brain stem ischemia is usually transient and occurs abruptly and often lasts for minutes. In patient of the vertebrobasilar insufficiency presenting with vertigo, approximately 62% have a history of at least

Table 1: Differentiating features between the peripheral vestibular and central vertigo

Clinical parameters	Peripheral	Central
Isolated vertigo	Always present	Sometimes present
Hearing loss	Common	Uncommon
Disequilibrium	Mild	Severe
Autonomic symptoms	Severe	Mild to moderate
Neurologic features	Absent	Present
Compensation	Rapid	Slow
Bed side head impulse test	Abnormal	Normal or abnormal in some cases

one episode of the isolated vertigo and approximately 19% present vertigo as the initial symptom.[14] In one study, out of the 42 patients with stroke in the vertebrobasilar circulation, 12 cases showed isolated episodes of the vertigo before infarction [Table 2].[14] Patients of the infarction at the region of the AICA may present with episodic isolated vertigo, fluctuating hearing loss, and/or tinnitus mimicking to the Meniere's disease as the initial symptoms 1–10 days before infarction.[17] The patient visiting the emergency department with a complaint of the vertigo or dizziness has two folds of higher risk to the stroke than those with the absence of the vertigo or dizziness during 3-year follow-up.[18]

Isolated vertigo with or without cochlear features may be only presentation of the transient ischemia in the vertebrobasilar circulation. ABCD score is a very useful tool used for assessing the chance of stroke and the imaging of the brain should advise accordingly. The ABCD score uses age, blood pressure, clinical features, duration of the transient ischemic attack, and presence of the diabetes mellitus. Approximately 1% of the vertigo patients with score 3 or less have cerebrovascular events in comparison to the 8.1% of the patients of vertigo with a score of 4 or more.[19] ABCD score should be used to evaluate the risk of the stroke, and neuroimaging is advised accordingly. A serial imaging may be needed for small infarct as it may be missed in early imaging. In stroke, immediately computed tomography (CT) scan of the brain is useful to confirm the presence of bleeding or not. Study showing false-negative magnetic resonance imaging (MRI) may be seen with acute vertebrobasilar strokes.[20] Hence, the bedside clinical findings are often needed to identify the patient with central pathology. Patient often present with isolated vertigo typically occurs abruptly and lasts for minutes. The patient of brain stem vertigo has usually no history of decreased hearing, tinnitus, otorrhea, otalgia, and fullness of the ear. The otoscopic examination reveals normal tympanic membrane and the fistula test is negative. Hearing assessment done by pure tone audiometry show normal hearing. Bedside clinical findings are important for identifying the central etiology for isolated vertigo. An elderly patient with the symptom of acute vestibular syndrome with no other localizing neurological signs indicates this brain stem vertigo.

Table 2: Episodes of isolated vertigo before infarction in the vertebrobasilar circulation (Grad and Baloh[14])

Site of infarction	Patients with isolated vertigo prior to infarction	Total
AICA territory	2	6
PICA territory	0	6
Cerebellar	4	12
Labyrinthine	1	2
Multifocal	5	16
Total patients	12	42

AICA: Antero-inferior cerebellar artery, PICA: Posteroinferior cerebellar artery

Diagnosis

There is evidence of data which indicates that a three part bedside ocular motor evaluation test (HINTS-Head Impulse, Nystagmus, and Test of Skew) along with hearing loss by finger rub (HINTS plus) rules out the stroke more accurately in comparison with early MRI.[21] It is not often easy for differentiating the brain stem vertigo from the peripheral vestibulopathy. There is a study showing that a 3-step examination of the ocular movement which include normal horizontal head impulse test (HIT), changing direction of nystagmus, and skew deviation. This test is highly sensitive in comparison to the early MRI while maintain the high specificity.[22] However, early diffusion-weighted MRI may show false-negative result in 12%–20% cases of the stroke cases in the first 48 h.[22] One study confirmed the diagnostic usefulness of the signs which include normal horizontal HIT, abnormal vertical smooth pursuit, skew deviation, and central type of the nystagmus during the bedside examination which showed a 100% sensitivity and 90% specificity for stroke if one of these signs was associated with acute vestibulopathy.[23] Mild degree of the skew deviation is often unnoticed at the time of the bedside examination and gaze-evoked nystagmus are absent in case of cerebellar stroke, so bedside HIT may be considered the best tool to differentiate isolated vertigo in the brain stem or cerebellar stroke from acute peripheral vestibular disorders. However, this bedside HIT has few limitations and positive in brain stem or cerebellar strokes.[24] Another predictor for central cause of the acute vertigo is changing direction of the nystagmus on eccentric gaze.[25] Acute peripheral vertigo is usually associated with horizontal nystagmus, which beats only in one direction and increases its intensity when the patient looks at the direction of the fast phase of the nystagmus. Torsional or vertical nystagmus points to the central pathology, whereas the majority of the stroke patients presenting with acute vertigo have a nystagmus with predominantly horizontal vector which mimics to the peripheral vestibulopathy.[26] A change in direction on eccentric gaze differentiates nystagmus of central pathology from a peripheral vestibulopathy. Another clinical predictor for a central pathology in acute vertigo is skew deviation. Skew deviation is vertical ocular misalignment result from an imbalance of vestibular neural firing from the two sides to the oculomotor system.[27] It usually occurs a part of the pathological ocular tilt reaction. The ocular tilt reaction is usually explained by the interruption of the ocular-otolithic pathways at the level of vestibular nucleus. The skew is seen by alternate cover test and can be easily done at the bedside examination. Although the skew has been found in patients of peripheral vestibulopathy, it has been also identified as a predictor of posterior fossa lesion. Skew has been commonly found in the brain stem strokes and has been documented as an early manifestation of basilar artery occlusion.[28] One study compared oculomotor features in patients with vestibular neuritis with those of patients with vestibular pseudoneuritis (usually due to stroke); it has been suggested that the skew deviation could be a very specific predictor of central pathology among patient presenting with

acute vestibular syndrome.[25] Vestibular-evoked myogenic potential (VEMP) is also useful for diagnosis in cerebellar stroke. In AICA infarction, around 50% of the patients show abnormal cervical VEMP (cVEMP) response to the clicking sound in the affected side.[29] Patients with abnormal response in cVEMP often have sensorineural hearing loss, canal paresis in the affected side in comparison to the normal side. This cVEMP finding represents that the peripheral vestibular component plays a crucial role for causing abnormal response in cVEMP in infarction of the AICA.[29] Abnormal ocular VEMP may suggest adjacent brain stem involvement in case of cerebellar stroke.[30]

Radiological Test

If there is cerebellar infarction or cerebellar hemorrhage or any other central lesions, patient needs urgent CT scan or MRI of the brain. Immediate CT scan will help to confirm the presence of hemorrhage or not in the stroke. If the MRI is available, it will be the diagnostic option of the choice. There is a rule for imaging in acute vertigo is need of the neuroimaging and it should be by MRI [Figure 1], rather than CT scan. However, there certain specific exception including the requirement of the CT scans in hemorrhage before the thrombolysis or confirming the suspected vertebral artery dissection with CT angiography. Study strongly supports to the use of imaging in case patient with brain stem vertigo, particularly in elderly age or at risk of the cerebrovascular disease.[31] CT scan is helpful to find out the hemorrhage but insensitive to acute stroke particularly for infarction at the posterior circulation. However, the MRI with MR angiography is immediately done in patients with progressing neurologic symptoms and signs which suggest impeding occlusion of the posterior circulation.

Treatment

The brain stem vertigo is usually due to the posterior circulation ischemia. These patients should be hospitalized preferable under the stroke specialist or neurophyscian. Before treatment, the cause must be identified, and the risk factor should be informed. Aspirin and other antiplatelet drugs are useful for treating such clinical entity.[32] Patients with cerebellar infarction should urgent need evaluation for embolism from heart or great blood vessels for preventing recurrence. If any source of embolism from the heart is suspected, immediately cardiologist should intervene this situation. Large infarction in the cerebellum may lead to compression of the brain stem, which further causes hydrocephalus, cardiorespiratory complications, coma, and death.[33] Hence, neurosurgical intervention may be required for brain stem decompression.

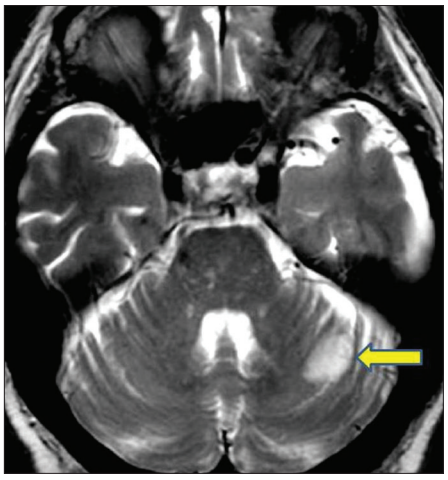

Figure 1: T2-weighted magnetic resonance imaging showing infarction (yellow arrow mark) at the left lobe of the cerebellum

Conclusion

Vertigo or dizzy patients often give a challenge to the clinician for the diagnosis. Differentiation between the central and peripheral vertigo is very vital and helps to get diagnostic evaluation and treatment of the brain stem stroke patient with isolated vertigo. Isolated sudden onset vertigo may be the only early symptom seen in brain stem stroke or stroke due to posterior circulation ischemia. The sensation of the instability or imbalance, especially raises this possibility of this diagnosis. Clinician plays a vital role for differentiating the brain stem vertigo from more benign diseases affecting the labyrinth as the treatment strategy and prognosis differs in these two clinical situations. Treatment of vertigo may lead to significant morbidity and mortality, whereas the overdiagnosis of this brainstem vertigo or vascular vertigo may cause unnecessary financial burden for workups and treatment.

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Conflicts of interest

There are no conflicts of interest.

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