Archives of Academic Emergency Medicine. 2023; 11(1): e12

ORIGINAL RESEARCH

Dizziness Evaluation and Characterisation of Patients with Posterior Circulation Stroke in the Emergency Department; a Case Series Study

Miguel Saro-Buendía[1,2*], Lidia Torres-García[1,2], Natalia Jaramillo Angel[1], Raúl Mellídez Acosta[1], Javier Cabrera Guijo[1], Catalina Bancalari Díaz[1], Alfonso García Piñero[1], Vanesa Pérez- Guillén[1], Miguel Armengot Carceller[1,2]

1. Unit of Otoneurology, Department of Otorhinolaryngology- Head and Neck Surgery, La Fe University and Polytechnic Hospital, Spain.
2. Department of Surgery, University of Valencia, Spain.

Received: October 2022; Accepted: December 2022; Published online: 1 January 2023

Abstract: **Introduction:** Dizziness is a common scenario in the Emergency Departments (EDs). Among dizziness underlying causes, the posterior circulation stroke is especially relevant due to its mobimortality and concerning misdiagnosis rates. Therefore, we conducted this study to assess dizziness evaluation and baseline characteristics of patients with PS in the ED. **Methods:** We conducted a 3-year retrospective observational study on PS cases confirmed by magnetic resonance imaging (MRI). Concretely, we analysed the demographic profile of these patients, the initial PS clinical presentation, and diagnostic workup (with emphasis on dizziness evaluation) performed at the ED. **Results:** During the study period, 85 cases were registered. Risk factors for cardiovascular disease were present in 85.5% and previous visits to the ED due to dizziness were recorded in 16.5%. The main clinical presentation was dizziness, concretely as an acute vestibular syndrome (38.8%) with additional neurological signs or symptoms (80%). Evaluation by the otolaryngologist on call was requested in less than 10% of the cases and included the HINTS protocol use with a sensitivity of 100% for central nervous system underlying causality. A brain CT study was always performed with a sensitivity of 27%. However, 96.47% of patients were primarily admitted to the Neurology hospitalization ward and MRI was always performed in a mean time of 3.21 days confirming the diagnosis. **Conclusion:** Dizziness is the most frequent symptom of PS. Patients usually present an AVS (associated with additional N-SS or not) and HINTS bedside examination is the most adequate protocol to differentiate a PS from other AVS causes until the diagnostic confirmation via MRI. Interestingly, mainly otolaryngologists seem to use HINTS. However, the use of CT is widespread despite its poor value.

Keywords: Brain Infarction; Vestibular diseases; Vertigo; Emergency medicine

Cite this article as: Saro-Buendía M, Torres-García L, Jaramillo Angel N, Mellídez Acosta R, et al. Dizziness Evaluation and Characterisation of Patients with Posterior Circulation Stroke in the Emergency Department; a Case Series Study. Arch Acad Emerg Med. 2023; 11(1): e12. https://doi.org/10.22037/aaem.v11i1.1764.

1. Introduction

Dizziness constitutes the main complaint of approximately 3% of the Emergency Department (ED) medical consultations (1). The underlying cause is usually a vestibular condition but might be a severe central nervous system (CNS) disorder. Among CNS disorders, the most frequent is the posterior circulation stroke (PS) (2).

Specifically, the PS-associated dizziness usually corresponds to an acute vestibular syndrome (AVS), which consists of an abrupt monophasic dizziness associated with nausea or vomiting, gait instability, spontaneous nystagmus, and intolerance to cephalic movements (3). The most frequent cause of AVS is an acute unilateral vestibular loss (UVL) whose course is benign and self-limited. Nonetheless, the second cause (around 5 to 10% of the cases) is the PS, with the posterior inferior cerebellar artery (PICA) territory being the most frequently affected (2-4).

An AVS constitutes a diagnostic challenge because it is usually not associated with additional neurological signs or symptoms (N-SS), even when a PS is the underlying cause

* **Corresponding Author:** Miguel Saro-Buendía; Fernando Abril Martorell 106, Valencia 46026, Spain. Email: msarobuendia@gmail.com. Phone number: (+34) 961244016, ORCID: https://orcid.org/0000-0003-4794-3615.

(3). Kerber et al. in 2006 observed that one-third of the PS had initially been misdiagnosed (5). A more recent study describes a 37% rate of early PS misdiagnosis, whereas there is only a 16% misdiagnosis rate for anterior circulation strokes (4).

In the ED diagnostic workup, physical examination is essential, the HINTS (Head Impulse- Nystagmus-Test of Skew) protocol being the main component. It consists of a three-step bedside oculomotor examination and includes the vestibulo-ocular reflex study in the Head Impulse Test (HIT), careful eye movement assessment to identify nystagmus, and the Test of Skew to identify vertical ocular misalignment. This protocol appears to have higher sensitivity (100%) and specificity (96%) for PS diagnosis than an MRI diffusion-weighted imaging in the first 48 hours since clinical onset. Moreover, in this early context, the MRI has a false negative rate up to 20% for PS, which might contribute to misdiagnosis (3, 6).

CT scan is performed in more than 50% of the AVS cases, even if evidence discourages its use (7). In this context, CT scans have low sensitivity (approximately 7%) for PS, even lower than the 40% shown for anterior circulation strokes (8, 9). An indication for a CT scan is the suspicion of brain haemorrhage. However, this entity is rarely presented as an isolated AVS (10).

Given that PS misdiagnosis is relevant to the patients' prognosis and dizziness is a common scenario in the ED, we feel encouraged to conduct this research (11, 12). The aim of the study is to contribute to a better understanding of this entity to reduce initial PS misdiagnosis rates in the future.

2. Methods

2.1. Study design and settings

We designed a case series observational study to characterize the initial evaluation of patients with confirmed PS diagnosis. We studied the demographic profile, clinical presentation, and diagnostic workup features (with emphasis on the evaluation of dizziness) of these patients from the ED admission to PS diagnostic confirmation. We recruited cases of PS confirmed by MRI diffusion-weighted imaging in our institution from April 2018 to April 2021. The project follows the principles outlined in the Declaration of Helsinki and was approved by the Ethics Committee of our institution (CEIB; register code 2022-091-1).

2.2. Participants

Inclusion criteria

Adults ≥ 18 years of age.

Posterior circulation stroke confirmed by MRI diffusion-weighted imaging.

Exclusion criteria

Less than 18 years of age.

Other cases of possible/ probable posterior circulation stroke not confirmed by MRI including: patients who died before an MRI confirmation, patients diagnosed using CT, for whom MRI was not performed, and other possible cases.

2.3. Data gathering

Radiology and clinical reports (ED visit and hospitalization period) constituted the data source of our outcome measures, including patient demographic (sex, age, cardiovascular or otoneurologic past medical history, ED visits due to dizziness in the prior 2 years, risk factors for cardiovascular disease such as diabetes mellitus, arterial hypertension, hypercholesterolemia, or smoking habits), ED visit details (main clinical complaint, blood pressure, presence of AVS, impossibility to stand or sit, additional N-SS to those expected in AVS, HINTS protocol, CT use, specialty of on-call physicians that were consulted, clinical suspicion of PS), and hospitalization period details (hospitalization ward in which the patient was admitted, initial score of National Institute of Health Stroke Scale, N-SS debuting during the hospitalization period, days to MRI diagnostic confirmation, and cerebral vascular territories affected). Fixed criteria were applied to ED reports to determine if the clinical presentation corresponded with an AVS. These criteria included the presence of dizziness with an abrupt onset and a monophasic clinical course associated with nausea or vomiting, gait instability, spontaneous nystagmus, and intolerance to cephalic movements.

Potential recall bias was avoided acquiring information directly from medical reports. The study included qualitative and quantitative variables.

2.4. Statistical analysis

We used descriptive statistical methods such as the measurement of frequency distribution and central distribution. Due to the nature of the study, no interactions were examined, and no causal inference was performed. Restriction methods were applied in the selection of individuals (MRI diagnostic confirmation) to control confounding factors related to misdiagnosis. The approach to the missing data was to omit cases with the missing data and analyse the remaining data (listwise deletion method).

3. Results

3.1. Baseline characteristics of studies cases

During the study period, 85 cases of PS, confirmed by MRI diffusion-weighted imaging, were registered in our institution. Patients had a median age of 73 years (interquartile range from 64 to 79 years) and 64.71% were males. At least one risk factor for cardiovascular disease was present in 91.6% of the cases. History of cardiovascular disease events

was present in 38.8% and only 3.53% had previous otoneurologic disease. During the 2 years prior to the PS, 16.5% had visited the ED due to dizziness. Among these patients, diagnosis in the ED discharge summary was "nonspecific dizziness" in 42.9% of the cases, "transient ischemic attack" in 28.6% and "vertigo under investigation" in 21.4%.

During the ED visit, the chief complaint was "dizziness" in 38.8% of cases. Another common chief complaint (15.3%) was "unsteady gait". Clinical presentation was compatible with an AVS in 38.8% of patients. Among these cases, around 80% presented additional N-SS and 34.1% had impossibility standing or sitting. Blood pressure on ED arrival was above 180 mmHg in 22.4% of the cases.

An evaluation by the otolaryngologist on call was requested in 8.24% of the patients. In the otolaryngologist evaluation, HINTS protocol was always applied and 100% sensitive for CNS underlying causality. Concretely, the HINTS protocol always evidenced a patent vestibulo-ocular reflex in the HIT and a normal Test of Skew. On the other hand, nystagmus was only present in 22.4% of the cases and showed a unidirectional horizontal-torsional pattern in 47.7%. A non-contrast head CT was performed in all the patients, the resulting sensitivity for PS was 27%.

3.2. Dispositions from ED

After the ED initial evaluation, 96.47% of patients were admitted to the neurology hospitalization ward with an average score of 5.87 points on the National Institutes of Health Stroke Scale (NIHSS). The remaining 3.53% of patients were admitted to the otolaryngology or internal medicine wards. Overall, new N-SS debuted during hospitalization time in 22.4% of the patients. Among patients who did not present N-SS in the ED initial evaluation, these debuted during hospitalization time in 29.2%. In a mean time of 3.21 days MRI diffusion-weighted imaging was performed, confirming the PS diagnosis. The basilar, vertebral, and posterior cerebral arteries were affected in a similar proportion (17.6%, 22.4% and 29.4% respectively). A vertebral artery dissection was observed in 4.7% of the cases. The pons, cerebellar hemispheres, and occipital lobes were the territories most commonly affected by ischemia

4. Discussion

We report dizziness as the chief complaint at the clinical onset of PS. Moreover, our retrospective analysis based on fixed criteria applied to the ED reports confirmed AVS as the usual presentation of PS. Then, a right identification of the AVS and a proper differential diagnosis among its causes should facilitate a prompt PS detection (4, 5).

For years, the initial ED approach for dizziness has consisted in categorizing whether if the patient presents with vertigo, instability, presyncope or other poorly defined symptoms. This differentiation theoretically facilitates the diagnosis when used by a neurotologist. Nonetheless, recently it has been demonstrated that this approach in the ED context is overrated and often leads to misdiagnosis (13). Newman-Toker et al. demonstrated how more than 50% of the patients change the dizziness category that represents their symptoms when asked twice within a 5- to 10-minute interval (14). To unify the mentioned categories under a unique concept "dizziness" helps to emphasize in more relevant diagnostic features such as the timing and trigger patterns of their symptoms (2, 14-16). In this diagnostic paradigm, patients with dizziness are grouped into three categories: spontaneous episodic vestibular syndrome (s-EVS), triggered episodic vestibular syndrome (t-EVS), and AVS (2, 17). In the ED context, we do recommend emphasizing on timing and the trigger pattern when evaluating a patient presenting with dizziness. This approach increases chances of AVS detection, which ultimately facilitates the PS diagnosis.

Once an AVS is identified, the differential diagnosis between the most common causes (UVL and PS) should be conducted. This step is essential as the management is very different and misdiagnosis of PS might lead to serious adverse consequences. Lack of familiarity with inner ear disorders facilitates misdiagnosis (18).

The demographic profile of our patients consisted mainly of males over 70 years old with cardiovascular disease risk factors. Almost 40% of our patients had a history of cardiovascular disease events. The demographic profiles of PS and UVL have not been compared and therefore, we cannot conclude if they differ. The importance of demographic profile while investigating the AVS causality is probably overestimated. Age and risk factors for cardiovascular disease increase the pre-test probability of PS being the underlying cause. Nonetheless, a study based on the cardiovascular risk scale ABCD2 (which studies age, arterial pressure, unilateral motor weakness or speech impairment, duration of symptoms, and the presence of diabetes mellitus) to differentiate between PS and VL shows a 60% sensitivity for both. In the context of an AVS, the capability of the HINTS protocol to detect a PS is superior to that of the ABCD2 scale. This fact is even more evident in the evaluation of young patients (18).

In the PS clinical onset, according to literature, AVS is associated with absence of additional N-SS in 80% of the cases (3). However, in our study, 80% of the patients with an AVS presented additional N-SS in the initial ED evaluation. Moreover, these debuted during hospitalization time in 30% of those with initial absence of additional N-SS. The reason for this variability is unknown, but we emphasize that the absence of N-SS does not rule out PS as the underlying cause. In the ED context, the diagnostic relevance of the presence or absence of N-SS is probably overrated, and this fact con-

tributes to initial misdiagnosis (13).

In our study, evaluation by the otorhinolaryngologist on call was requested in 8.24% of the cases. Among these, the HINTS protocol was always applied, and the suspicion of a CNS cause (PS being the most common) was always reported. Therefore, the sensitivity of HINTS protocol for PS suspicion in our study was 100% and supports previous evidence (19). It has elevated cost-effectiveness and shows higher sensitivity than any other ED diagnostic approach. As a result, the HINTS protocol is recommended for screening patients with AVS in the ED context (18). Nonetheless, it has limitations such as the need for familiarity with oculomotor examination and the requirement to correctly identify an AVS prior to its application (18). At our institution, physicians from diverse medical specialties receive formation about otoneurology. This fact might explain why the evaluation by otorhinolaryngologist on call was rarely requested, even when the PS debuted as an AVS. Also, the presence of additional N-SS in 80% of the cases might explain an elevated CNS causality suspicion. Nonetheless, in our study, the HINTS protocol was never applied by physicians who were not otorhinolaryngologists. The presence of spontaneous nystagmus was reported in 22.4% of the cases and was unidirectional with a horizontal-torsional pattern in 47.4% of the occasions. According to ED-based observational studies, the presence or absence of nystagmus is reported in more than 80% of the cases. However, the nystagmus features are usually not described and when reported, their characteristics are not coherent with the diagnosis given (20).

In the initial ED evaluation, a non-contrast head CT was performed in all the patients of our study. This fact proves the systematic use of CT in the diagnostic workup of dizziness in our institution. A previous study describes the CT use in more than 50% of the patients in this clinical context as excessive (7).

CT is the standard imaging technique among patients presenting with acute stroke symptoms to rule out brain haemorrhage. However, a PS due to brain haemorrhage rarely debuts as an isolated AVS compared to ischemic forms of PS. Therefore, given its low diagnostic rentability for PS (7- 16% in previous studies and 27% in our study) and the rarity of brain hemorrhage presenting as an isolated AVS, the CT is not recommended for the AVS diagnostic workup (7-9, 21, 22).

The CT implies radiation exposure, elevated costs, and a misuse of material and personal ED resources. However, the most dangerous consequence of its overuse is PS misdiagnosis due to false reassurance by a normal CT result. It is a common practice to link a normal scan with UVL as the underlying cause of an AVS (13), Grewal K et al. described how those with a normal CT had a double PS likelihood than those who did not receive a CT in the diagnostic workup. This fact suggests that ED physicians correctly suspect PS but incorrectly assume a PS absence when a normal CT is obtained (21). As a result, we do not recommend CT use in the initial AVS evaluation unless the intention is to rule out a brain haemorrhage.

In our series, the suspicion of PS or a serious neurological condition was adequate as 96.47% of the cases were admitted in the neurology hospitalization ward after the initial ED evaluation. The mean NIHSS score on admission was 5.87 points, which is close to the average of 3.8 points recorded in the literature (4). The unusually elevated presence of additional N-SS in the recorded AVSs might facilitate the PS suspicion. Nonetheless, the AVS presence is determined by the retrospective application of fixed criteria to the ED reports and therefore, its real incidence might be different. The increased detection of additional N-SS may be explained by the extensive clinical experience implicit to a tertiary care ED. To study retrospectively from MRI-confirmed cases implies important limitations, which probably overestimate our PS identification rates. An example is the exclusion of misdiagnosed patients (both discharged or hospitalized in neurology/non-neurology wards). Also, those who died prior to receiving an MRI confirmation of PS were excluded.

The MRI diffusion-weighted imaging is the diagnostic gold standard, its use is part of the study inclusion criteria and therefore, was performed in the 85 cases in a mean time of 3.21 days since the ED admission (22). Causative lesions were in the vertebral, basilar, and posterior cerebral arteries in a similar proportion. In the literature, atherosclerotic stenosis tends to occur in the extracranial vertebral artery, whereas embolic events usually affect the basilar or the intracranial vertebral arteries (23).

A vertebral artery dissection was detected in 4.7% of our patients. This condition usually occurs in the extracranial portion of the vertebral artery and causes additional symptoms such as pain in the posterior part of the neck or occiput (23).

5. Limitations

To study retrospectively from MRI-confirmed cases may overestimate PS identification rates. An example was the exclusion of misdiagnosed patients (both discharged or hospitalized in neurology/non-neurology wards). Also, those who died prior to receiving an MRI confirmation of PS were excluded. There is a risk of information bias in the present study, because the presence of AVS was determined based on clinical criteria applied to ED reports. Also, there might be selection bias, we recruited patients exclusively from a tertiary care institution. Clinical evaluation might be optimized in a tertiary care institution due to the wide experience of emergency physicians and the constant presence of neurology and otolaryngology specialists on call. These facts and the implicit features of case series studies affect the external validity of our results.

6. Conclusions

Patients suffering a PS usually refer to dizziness as their main symptom and present an AVS (with or without additional NSS). Emphasis on timing and trigger patterns is key to detect an AVS. Bedside HINTS exam discerns PS from other AVS causes and ED physicians (not only otolaryngologists) should explore it consistently. CT is widely used despite its poor value, but negative findings do not impede admission to get an MRI-confirmed diagnosis.

7. Declarations

7.1. Acknowledgments

We would like to express our acknowledgements to the Otorhinolaryngology-Head and Neck Surgery, Neurology and Emergency Departments of our institution.

7.2. Conflict of interest

None.

7.3. Fundings and supports

None.

7.4. Authors' contribution

Miguel Saro- Buendía: Main contributor, study conception and design, acquisition and interpretation of data analysis, draft of manuscript and preparation, final version approval; Lidia Torres García and Natalia Jaramillo Angel: Study design, acquisition and interpretation of data, draft of manuscript and preparation, final version approval; Raúl Mellídez Acosta, Javier Cabrera Guijo and Catalina Bancalari Díaz: Data acquisition, interpretation of data , final version approval; Vanesa Pérez- Guillén: Study conception and design, interpretation of data, draft of manuscript and preparation, final version approval; Alfonso García Piñero: Study conception and design, interpretation of data, English language vocabulary and grammar review, final version approval; Miguel Armengot Carceller: Study conception and design, interpretation of data, final version approval.

References

1. Newman-Toker DE, Hsieh YH, Camargo CA, Jr., Pelletier AJ, Butchy GT, Edlow JA. Spectrum of dizziness visits to US emergency departments: cross-sectional analysis from a nationally representative sample. Mayo Clin Proc. 2008;83(7):765-75.
2. Edlow JA, Newman-Toker D. Using the Physical Examination to Diagnose Patients with Acute Dizziness and Vertigo. J Emerg Med. 2016;50(4):617-28.
3. Tarnutzer AA, Berkowitz, AL, Robinson KA, Hsieh YH, Newman-Toker DE. Does my dizzy patient have a stroke? A systematic review of bedside diagnosis in acute vestibular syndrome. CMAJ. 2011;183(9):571- 92.
4. Arch AE, Weisman DC, Coca S, Nystrom KV, Wira CR, 3rd, Schindler JL. Missed Ischemic Stroke Diagnosis in the Emergency Department by Emergency Medicine and Neurology Services. Stroke. 2016;47(3):668-73.
5. Kerber KA, Brown DL, Lisabeth LD, Smith MA, Morgenstern LB. Stroke among patients with dizziness, vertigo, and imbalance in the emergency department: a population-based study. Stroke. 2006;37(10):2484-7.
6. Kattah JC. Use of HINTS in the acute vestibular syndrome. An Overview. Stroke Vasc Neurol. 2018;3(4):190-6.
7. Kerber KA, Zahuranec DB, Brown DL, Meurer WJ, Burke JF, Smith MA, et al. Stroke risk after nonstroke emergency department dizziness presentations: a population-based cohort study. Ann Neurol. 2014;75(6):899-907.
8. Brazzelli M, Sandercock PA, Chappell FM, Celani MG, Righetti E, Arestis N, et al. Magnetic resonance imaging versus computed tomography for detection of acute vascular lesions in patients presenting with stroke symptoms. Cochrane Database Syst Rev. 2009;(4).
9. Ozono Y, Kitahara T, Fukushima M, Michiba T, Imai R, Tomiyama Y, et al. Differential diagnosis of vertigo and dizziness in the emergency department. Acta Otolaryngol. 2014;134(2):140-5.
10. Kerber KA, Burke JF, Brown DL, Meurer WJ, Smith MA, Lisabeth LD, et al. Does intracerebral haemorrhage mimic benign dizziness presentations? A population based study. Emerg Med J. 2012;29(1):43-6.
11. Moulin T, Sablot D, Vidry E, Belahsen F, Berger E, Lemounaud P, et al. Impact of emergency room neurologists on patient management and outcome. Eur Neurol. 2003;50(4):207-14.
12. Savitz SI, Caplan LR, Edlow JA. Pitfalls in the diagnosis of cerebellar infarction. Acad Emerg Med. 2007;14(1):63-8.
13. Kerber KA, Newman-Toker DE. Misdiagnosing Dizzy Patients: Common Pitfalls in Clinical Practice. Neurol Clin. 2015;33(3):565-75.
14. Newman-Toker DE, Cannon LM, Stofferahn ME, Rothman RE, Hsieh YH, Zee DS. Imprecision in patient reports of dizziness symptom quality: a cross-sectional study conducted in an acute care setting. Mayo Clin Proc. 2007;82(11):1329-40.
15. Bisdorff AR, Staab JP, Newman-Toker DE. Overview of the International Classification of Vestibular Disorders. Neurol Clin. 2015;33(3):541-50.
16. Kattah JC. Update on HINTS Plus, With Discussion of Pitfalls and Pearls. J Neurol Phys Ther. 2019;43 (Suppl 2):S42-S5.

17. Newman-Toker DE, Edlow JA. TiTrATE: A Novel, Evidence-Based Approach to Diagnosing Acute Dizziness and Vertigo. Neurol Clin. 2015;33(3):577-99.
18. Newman-Toker DE, Kerber KA, Hsieh YH, Pula JH, Omron R, Saber Tehrani AS, et al. HINTS outperforms ABCD2 to screen for stroke in acute continuous vertigo and dizziness. Acad Emerg Med. 2013;20(10):986-96.
19. Kattah JC, Talkad AV, Wang DZ, Hsieh YH, Newman-Toker DE. HINTS to diagnose stroke in the acute vestibular syndrome: three-step bedside oculomotor examination more sensitive than early MRI diffusion-weighted imaging. Stroke. 2009;40(11):3504-10.
20. Kerber KA, Morgenstern LB, Meurer WJ, McLaughlin T, Hall PA, Forman J, et al. Nystagmus assessments documented by emergency physicians in acute dizziness presentations: a target for decision support? Acad Emerg Med. 2011;18(6):619-26.
21. Grewal K, Austin PC, Kapral MK, Lu H, Atzema CL. Missed strokes using computed tomography imaging in patients with vertigo: population-based cohort study. Stroke. 2015;46(1):108-13.
22. Chalela JA, Kidwell CS, Nentwich LM, Luby M, Butman JA, Demchuk AM, et al. Magnetic resonance imaging and computed tomography in emergency assessment of patients with suspected acute stroke: a prospective comparison. Lancet. 2007;369(9558):293-8.
23. Savitz SI, Caplan LR. Vertebrobasilar disease. N Engl J Med. 2005;352(25): 2618-26.