CASE REPORT

Dynamic and static postural alterations in HIV-related progressive multifocal leukoencephalopathy in a Latino-Hispanic male: a case study

Martin G. Rosario, Leah Jamison

Texas Woman's University, School of Physical Therapy, Dallas, Texas, United States

Abstract

Introduction: Human immunodeficiency virus (HIV) affects millions of people worldwide. Because of an impaired immune system, HIV-positive people are at a higher risk of contracting HIV-related complications, including progressive multifocal leukoencephalopathy (PML). PML is a progressive disease involving degeneration of the white matter in the central nervous system, causing profound adverse effects on gait and posture. This case report presents gait and posture deficiencies in a physically active 52-year-old Latino-Hispanic male with HIV-related PML.

Case description: System examinations were conducted to evaluate confidence in balance, balance deficits, and fall risk, given the clinical presentation of HIV-related PML. The patient presented a profound balance and gait motor control impairments, with alterations in posture stability, particularly in mediolateral sway, and velocity were increased when adding vestibular input challenge and dual-tasks (counting backward) components. During gait assessment, the patient compensated by reducing speed during the turn and walk back to the sitting position.

Conclusions: This case study strives to provide specific evidence for static and dynamic motor control in PML HIV-related case. Strengthening exercises focusing on posture musculature are highly recommended. Additionally, we encourage to focus on dynamic balance interventions to improve PML-related alterations such the ones presented in this case report.

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Key words: HIV, balance, gait, motor control, PML.

Introduction

Human immunodeficiency virus (HIV) affects 36.9 million people worldwide, with 1.1 million living in the United States (US) only. Within the US, Texas and Puerto Rico are among the places with the highest incidence rate, which have increased in the last few years [1]. HIV reproduces within the brain's immune cells, leading to significant cognitive and motor disturbances. These disturbances interfere with everyday activities and are associated with lower quality of life, thus increasing demand for caregivers and healthcare system. Despite advances in antiretroviral therapy (ART), HIV still adversely affects gait and balance, leading to an increased risk for falls, injury, and premature mortality [2-4].

Address for correspondence: Martin G. Rosario, Texas Woman's University, School of Physical Therapy, 5500 Southwestern Medical Avenue, Dallas, TX 75235, United States, e-mail: mrosario1@twu.edu

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Due to the impaired immune system, those with HIV and other diagnoses affecting the immune system are at a greater risk of contracting HIV-related complications such as progressive multifocal leukoencephalopathy (PML) [5, 6]. PML is a progressive disease involving degeneration of the myelin sheaths in the central nervous system and association of oligodendrocytes through JC papovavirus [5, 6] with profound adverse effects on gait and posture. Those with HIV and PML present a higher mortality rate of 30-50% in the first few months following diagnosis; however, with ART, patients can live longer but suffer neurologic deficits [5, 6]. Among others, some of the PML-related complications are alterations in gait, balance, coordination, speech, and language difficulties [7].

A previous research described the effect of therapeutic training in patients with PML, which focused on helping patients to return to living at home and ambulating independently with an assistive device, after completing an extensive (7-8 months) rehabilitation program [8]. Studies involving postural motor control assessment, especially in Hispanic-Latino population are limited. Therefore, the purpose of this case study was to evaluate dynamic and static postural alterations as well as functional status of a Latino-Hispanic individual with HIV-related PML.

Table 1. Patient's characteristics

Characteristics	Values
Sex	Male
Age	52 year-old
CD4 count	1.357
BMI	27.4
Five-time-sit-to-stand test	11.07 sec
Diagnosed HIV	2002
ABC	12. average score

Case description

The purpose of this case report was to present gait and posture deficiencies in a Latino-Hispanic PML HIV-related subject. PML affects areas of the central nervous system, which are essential for balance and coordination, such as the cerebellum. Many of PML-related cases are presented with a general view of impairment with a poor prognosis. In case of our patient, the doctors sent him back home to live the rest of his "few days" comfortably at home with "no chance of recovering". Several studies explained the negative profound effect on balance, coordination, speech, and in turn, quality of life. The current report shows a more detailed approach to perceive balance and to measure dynamic (gait) and static (standing) balance.

History and interview

A 52-year-old Latino-Hispanic male was referred to physical therapy following a diagnosis of HIV-related PML. Table 1 shows several characteristics of the patient. He was

Table 2. The International Classification of Functioning, Disability and Health (ICF) classification of the patient

Medical diagnosis: HIV-related progressive multifocal leukoencephalopathy (PML) **Physical therapy diagnosis:** impaired motor function and sensory integrity associated with progressive disorders of central nervous system [13]		
Body functions and structures	**Activity limitations**	**Participation restrictions**
Impaired gait characteristic of cerebellar ataxia Impaired vision and depth perception Impaired muscle coordination Impaired sensory integration with balance Impaired balance Progressive loss of function secondary to nature of disease Aphasia	Inability to ambulate at home and commune independently Inability to perform all activities of daily living	Inability to perform home management Inability to work as a manager and bartender at a restaurant Inability to participate in social activities
Contextual factors		
Environmental factors Lack of transportation Active duties as a manager and bartender Health center within home close proximity SSH apartment on first level Wheelchair/walker accessible home	Personal factors Motivated Good understanding of diagnosis and prognosis Good family and community support system No comorbidities Accompanying diagnosis of HIV Integrase inhibitor drug therapy Age: 52 Gender: male	

living independently in San Juan, Puerto Rico, working as a manager of restaurant and a bartender. The patient reported on being HIV-diagnosed in 2002. Before being diagnosed with PML in 2010, he reported "feeling different" and that he had troubles doing everything within his daily routine, particularly involving coordination. Following hospitalization, he was a wheelchair user. The patient was referred to physical therapy in 2011, where he was modified and capable of independent ambulation with a quad cane. In 2017, his abilities to ambulate digressed and he was using a rollator.

The examination strategy formulated the patient's goals, and functional impairments was gathered through a systematic review. The patient reported that he experienced a loss of coordination and balance as well as ataxic gait, leading to his inability to ambulate. Additionally, he expressed that one of his primary goals was to ambulate without assistive devices, which was taken into consideration. The treatment focused on leading causes of his impairments and what could be successfully achieved with a suitable physical therapy.

Table 2 shows a summary of the patient's history and an interview using the International Classification of Functioning, Disability and Health (ICF) classification. The ICF provides insight into the function and abilities in daily life as well as analysis of impairments affecting activity limitation and participation restrictions, thus guiding appropriate and goal-oriented interventions for an individualized plan of care [9].

Systems review

A system review was conducted to assess confidence in balance, balance deficits, and fall risk, given the clinical presentation of HIV-related PML. Upon examination, it was confirmed that the patient has no underlying comorbidities, except for immunocompromise from HIV. He reported that he is presently taking a combination of tivicay and desovy, an integrase inhibitor regimen, for HIV management [10]. Diagnostic techniques used to diagnose PML through MRI and CT scan of the brain demonstrated localized lesions in the affected areas, with insignificant cerebrospinal fluid (CSF) findings [6]. Updated MRI images obtained from 2018 showed demyelination in the corpus callosum (green arrows) and cerebellum (red arrows) as well as atrophy of the cerebellum and cerebral hemispheres (blue arrows) (Figure 1).

Lesions of the corpus callosum can involve an integration and transfer of information from both cerebral hemispheres, thus affecting sensory, motor, and high-level cognitive signals processing [11]. During the development, the corpus callosum seems to represent a crucial role in refining motor movements and cognitive function. A research showed that the corpus callosum has an inhibitory effect that usually prevents uncoordinated hand motor behavior [11]. Lesions of the cerebellum can result in impairments in the coordination of movements, control of posture and gait, and regulation of muscle tone [6]. Given those mentioned above, the clinician determined to assess balance, risk of falls, functional mobility, and gait analysis.

Evaluation

From the ICF assessment (Table 2), it was evident that the independence in ambulation and daily activities were especially important to the patient. Upon further inspection through the examination and interview process, great difficulty associated with postural stability and dynamic bal-

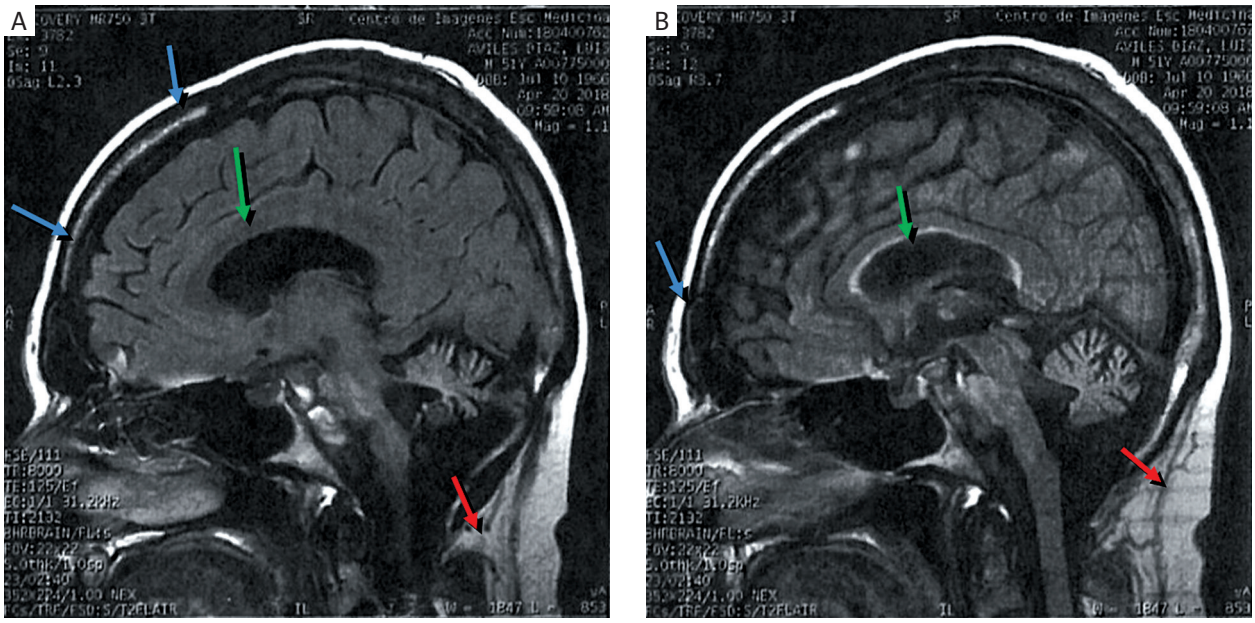

Figure 1. Magnetic resonance imaging from 2018 demonstrating involvement of corpus callosum and cerebellum with cerebellar and cerebellum atrophy. Areas of atrophy are indicated with red arrows

ance were noted. It is well known that stability and dynamic balance are vital components of locomotor control in maintaining forward propulsion [12]. In a study, Morton *et al.* evaluated relative contributions of balance versus leg-coordination deficits to cerebellar gait ataxia and demonstrated that those with cerebellar damage with minimal to no balance deficits typically have fewer walking abnormalities than those with significant balance deficits [12, 13].

Deterioration in upper and lower extremity coordination was demonstrated during an examination of balance and ambulation, which is characteristic for an individual with cerebellar involvement. A study conducted by Ilg *et al.* [14] assessed the benefits of an intensive coordinate training program on motor performance in people with degenerative cerebellar disease. Each participant underwent 1 hour of training for 4 weeks and then, 1-hour home exercise program was provided to continue the training until 8 weeks. Those who participated in their home program, regularly demonstrated greater improvements than those who did not [14]. Consequently, the plan of care should be focused on improving the patient's balance, postural stability, and coordination to improve independence with functional daily activities and ambulation for improved quality of life.

Perceived balance

The ABC scale is patient-specific, and is transferable through all levels of care as the time/cost is minimal and the test is easy to administer [15]. The 16-item ABC scale was administered to the patient (Table 3), assessing his confidence in balance for a variety of daily functional activities without using an assistive device from 0% confidence (no confidence) to 100% confidence (complete confidence). The score was calculated by taking the average of the 16 item scores, resulting in a final score of 12.5%. Scores of less than 67% indicate a high-risk for falling, with 84% of accurately classifying people who fall [15]. The patient rated 0% of confidence, with most items involving ambulating on uneven surfaces and in distracting environments as well as ambulating on stairs. He rated 50% on four items, including walking around the house, retrieving objects from shelves at eye level, getting into and out of a car, and stepping on and off an escalator using the rails for support (Table 3). The balance system requires the interplay of the visual, vestibular, and somatosensory systems. We were expecting balance difficulties in the patient due to his cerebellar atrophy (Figure 1). The cerebellum and the vestibular system (C/V) are involved in coordination, motor control, and balance. Due to damage to the cerebellar structure by PML, the C/V interplay are altered affecting gait and posture. Table 3 shows the reduced balance confidence in several daily activities of the patient. The C/V alterations were presented in the ABC scale of the patient. All the activities that required dynamic balance and coordination had a score of zero. In this ABC scale, zero indicates no confidence of performing these tasks safely without falling. It is important to point out that our patient reported having difficulties performing all the

Table 3. ABC scale characteristics

Item number	Activity	Score %
1	Walk around the house	50
2	Walk up or down stairs	0
3	Bend over and pick up an object	0
4	Bend over and pick up a slipper from the front of a closet floor	0
5	Reach for a small can off a shelf at eye level	50
6	Stand on your tiptoes and reach for something above your head	0
7	Stand on a chair and reach for something	0
8	Sweep the floor	0
9	Walk outside the house to a car parked in the driveway	0
10	Get into or out of a car	50
11	Walk across a parking lot to the mall	0
12	Walk up or down a ramp	0
13	Walk in a crowded mall where people rapidly walk past you	0
14	Bumped into people as you walk through the mall	0
15	Step onto or step off an escalator while you are holding onto a railing	50
16	Step onto or step off an escalator while holding onto parcels such that you cannot hold onto the railing	0
Total average score		12.5%
Each item ranges from 0 to 100%; the score was calculated by taking the average of 16 item scores, resulting in a final score of 12.5%		

16 activities in this questionnaire, giving the item in this tool a 50% as a high value and 0% to various of them.

Five times sit to stand test

The five-times-sit-to-stand test (FTSTS) was selected to assess mobility and function as it measures functional lower extremity strength and movement strategies used for transfers and transitional movements. The FTSTS has excellent test-retest reliability (ICC = 0.994) [16]. The FTSTS was completed to assess transitional and functional movements, while evaluating the risk of falls, with a cut-off score of 12 seconds [17]. The patient completed the task in 11.07 seconds, demonstrating a low-risk for falls and functional lower extremity strength with transitional movement without using an assistive device. Another unexpected, yet important factor, is the normal score of the FTSTS test, presenting the patient's muscle weakness as a factor affecting the balance [18]. In the case of the patient, muscle weakness is unrelated to his balance alteration as proven by his normal FTSTS score. LPGP is a fitness center, which focuses on the wellness and rehabilitation of patients such as our patient. A 3-4 days exercise program was prescribed to the patient for 8 years. The protocol consisted of strengthening, flexibility, and cardiovascular exercises programs designed to halt or slow the balance alteration and in turn, reduce the risk of falls.

Measure balance

Postural sway under varying conditions uses gyroscopes and body-worn accelerometers sensors (APDM Mobility Lab System). The balance tasks were designed to challenge or cancel the visual, proprioceptive, and vestibular input (Table 4). For each task, including the baseline measurement, the participant was instructed to fixate their gaze on an orange square on the wall 10 feet away. Jackson *et al*. assessed quiet-standing balance under four testing conditions: standard (single task), dual cognitive task, manual dual-task, and a combined cognitive/manual dual-task in fallers and non-fallers subjects. In their study, participants considered as "fallers" demonstrated significant differences in their ML sway range than those considered "non-fallers," demonstrating that dual tasking affects postural sway in those considered at a higher risk for falls. Considering this mentioned above, a balance protocol was as follows: four non-COG tasks were performed on the foam pad. 1. Eyes open (EO FOAM); 2. Eyes closed (EC FOAM); 3. Eyes open while moving head up and down to the cadence of a 60 bpm metronome (EO HUD); 4. Eyes closed while moving head up and down to the cadence of a 60 bpm metronome (EC HUD).

The dual cognitive tasks component was added to the balance protocol by counting backward from 100 by 3. The four COG tasks were the same as above, but adding the cognitive components (counting backwards) to a total of 9 tasks. Balance tests protocols are designed to challenge the previously mentioned systems related to standing motor control. PML affects higher cognitive centers and everyday activities required for dual tasks, such as talking and reaching. In an uncompromised cognitive system, this dual-task component has no impact on standing balance. Table 4 showed the higher scores of variables (sway, velocity, and distance of movement) of the patient compared to normative. The measured balance results showed the compromised motor control system of the patient, and how these alterations become more obvious as the tasks become more challenging (single tasks versus dual tasks). The balance data shows the evident alteration in motor control, especially during anterior/posterior jerk and mediolateral velocity. ML jerk and direction are related to a compromised central nervous system [18] such as the cerebellum.

Gait assessment

As expected with cerebellar involvement, a cerebellar ataxic gait pattern was observed during gait analysis via vid-

Table 4. Standing parameters during balance tasks (post-urography results)

Tasks	Sway (m^2/s^4)	AP jerk (m^2/s^5)	ML jerk (m^2/s^5)	AP velocity (m/s)	ML velocity (m/s)	AP distance (m/s^2)	ML distance (m/s^2)
EO firm	0.5372	20.591	102.685	0.0732	0.1257	21.74	50.97
EO foam	3.1913	1092.47	362.148	0.2692	0.3324	181.47	105.19
EC foam	4.9707	1629.73	382.893	0.1981	0.4185	22.9	110.04
EO HUD	1.5106	235.794	323.318	0.08	0.165	78.27	95.11
EC HUD	9.5203	616.122	145.626	0.204	1.3652	142.35	82.11
EO COG	2.4501	1066.42	215.213	0.1464	0.217	177.64	77.34
EC COG	3.8598	918.947	1144.89	0.1045	0.6821	169.72	189.06
EO HUD COG	1.7946	416.013	366.165	0.0688	0.1671	114.48	103.82
EC HUD COG	6.4559	462.231	291.91	0.052	0.3663	136.18	115.75
Normative values	0.0235 ± 0.0.01	0.525 ± 0.4	1.9 ± 1.2	0.13 ± 0.1	0.03 ± 0.02	5.43 ± 1.7	2.9 ± 0.9

EO – eyes open, EC – eyes closed, HUD – head up and down, COG – cognitive task counting backwards from 100.
Significant values from normative are highlighted

Table 5. Dynamic parameters during two-meter walk test (4 trials)

Parameter	Normative mean	Standard deviation	Mean	Standard deviation
Duration (s)	8.76	2.3	29.01	1.06
Sit-to-stand – duration (s)	0.98	0.3	1.18	0.37
Sit-to-stand – lean angle (degrees)	32.62	12.35	31.5	6.08
Sit-to-stand – *n* (#)	1	0	1	0
Stand-to-sit – duration (s)	0.77	0.18	0.7	0.17
Stand-to-sit – lean angle (degrees)	34.62	16.01	31.12	8.81
Stand-to-sit – *n* (#)	1	0	1	0
Turns – angle (degrees)	182.17	6.67	89.3	9.4
Turns – duration (s)	1.94	0.38	1.8	0.27
Turns – *n* (#)			2	0
Turns – turn velocity (degrees/s)	230.56	49.29	126.3	9.20

Significant values from normative are highlighted

eo taken during a therapy session. A slow gait with short and unequal step lengths that were irregular and inconsistent in timing were observed, along with a noticeable over exaggeration of hip and knee flexion during the swing phase, all of which are characteristics of a person with cerebellar ataxia [19]. The patient also demonstrated a wide BOS with difficulty in controlling lowering of bilateral lower extremities in transition from mid-swing and term-swing to initial contact. Additionally, he demonstrated greater step length of the right leg than the left leg, with decreased weight shift to the left lower extremity during mid-stance and terminal stance as well as minimal to no reciprocal arm swing and coordination with alternate lower extremity, when ambulating without an assistive device. During the dynamic test while walking a two-meter walkway (Table 5), the patient showed an increased time and angulation (instability) during turning. A reduction in speed and angle suggest that the patient compensated his balance difficulties by slowing down and getting the truck more perpendicular to the floor, less angle for a safer turn-walk back to the starting point. However, this strategy that the patient has adapted increased the risk of falls due to extra and shorter steps while turning [18]. This report recommends focusing on more dynamic parts of gait such as turning and transition of heel strike to toe, to increase the single limb support time and reduce the double limb support time for a better balance control and fall risk reduction.

Conclusions

The purpose of this paper was to present gait and posture deficiencies in a Latino-Hispanic PML HIV-related subject. PML deteriorates regions of the central nervous system, which are crucial to balance and coordination, such as the cerebellum. Many of PML-related cases concentrate on a general view of impairment with a poor prognosis. Collecting and analyzing measurable values during long-term treatments provides evidence that patients with HIV-related PML have the potential to become functionally independent across continued therapeutic exercises and interventions. This case study strives to provide such data to further contribute to evidence-based practice, with a value-based approach using outcome measures and therapeutic interventions.

Conflict of interest

The authors declare no conflict of interest with respect to the research, authorship, and/or publication of this article.

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