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Case Presentation

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Binocular Vision Therapy in the Management of HAART-Related Accommodation and Convergence Dysfunction: A Case Study

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Abstract

Introduction: Accommodative insufficiency can occur in presbyopic HIV-positive individuals on Highly Active Antiretroviral Therapy (HAART). Contributing factors include direct neuronal damage from HIV, lens or ciliary body changes, and adverse effects of HAART on cranial nerves essential for accommodation and convergence.

Case presentation: A 65-year-old HIV-positive presbyopic male presented with double vision, difficulty focusing on near objects, and a six-month history of HAART. Unaided distance visual acuity (VA) was 6/9 in both eyes (OD and OS), and near visual acuity was N36. Refraction revealed OD: +1.75 DC @ 10 (6/6), OS: Plano/+1.75 DC @ 170 (6/6), and near addition of +2.75 DS improving near VA to N6. Binocular assessment showed 3Δ exophoria at distance, 6Δ intermittent exotropia at near, amplitude of accommodation (AA) of 10 diopters, and near point of convergence (NPC) of 8 cm. A prescription of kryptok bifocal lenses with OD: Plano/+1.75C X 10 and OS: Plano/+1.50DC X 90, along with near addition (+2.75D), was provided. Structured binocular vision therapy (BVT) included Brock string training and vectogram-based adduction exercises.

Outcome: Over 10 therapy sessions, the patient reported resolution of diplopia and improvement in focusing ability. Post-therapy assessments showed ortho alignment at distance, improved NPC of 8 cm, AA of 10 diopters, and stable binocular vision with positive fusional amplitudes of 10/8 (distance and near).

Conclusion: This case emphasizes the need for early detection and management of binocular vision dysfunctions in HIV-positive patients on HAART. Prism correction and BVT significantly alleviated symptoms, highlighting the importance of tailored interventions to enhance visual comfort and quality of life in this population.

Introduction

Convergence and accommodation are fundamental mechanisms of the visual system that work in tandem to provide clear and single binocular vision, especially for near tasks. Convergence involves the inward movement of the eyes to focus on a near object, while accommodation refers to the adjustment of the lens to maintain a clear image on the retina. Failure in either of these mechanisms can result in visual symptoms such as blurred near vision, diplopia, eye strain, and headaches, significantly affecting an individual's quality of life [1]. While convergence and accommodation dysfunctions are frequently observed in presbyopic patients due to the natural aging of the visual system, additional systemic and neurological factors can exacerbate these issues. Human Immunodeficiency Virus (HIV) infection is one such systemic condition that has widespread effects on the body, including the visual system. HIV-positive patients are at risk for various ocular complications, ranging from anterior segment pathologies to posterior segment involvement, as well as neuro-ophthalmic conditions [2].

Highly Active Antiretroviral Therapy (HAART) has revolutionized the management of HIV by significantly improving life expectancy and reducing opportunistic infections. However, prolonged use of HAART is not without side effects, some of which may impact neuromuscular and visual functions [3]. The interaction between HIV pathology, HAART-associated side effects, and the physiological changes of presbyopia creates a complex scenario that may contribute to the failure of convergence and accommodation mechanisms [4-8]. Accommodation and convergence are closely inter dependent, developing in tandem to enable the perception of a single, clear image. The Accommodative Convergence (AC) to Accommodation (A) ratio represents the relationship between the convergence induced by a stimulus for accommodation and the accommodation elicited to support that convergence [9]. Age-related decline in accommodative ability is a well-documented phenomenon, with the amplitude of accommodation reducing to less than 2 diopters by the age of 45–50 years. This decline typically leads to noticeable difficulty in focusing on near objects, necessitating corrective lenses for reading [10]. By approximately 70 years of age, accommodation diminishes further to around 1 diopter. Clinically, the amplitude of accommodation is most often evaluated using subjective techniques such as the Push-Up (PU) or Minus Lens (ML) method [11,12]. However, while the broader spectrum of HIV-related ocular manifestations has been explored extensively, the direct effects of HIV and its treatment on binocular vision and accommodative function remain insufficiently studied. This highlights a critical gap in understanding how systemic and pharmacological factors contribute to disruptions in visual mechanisms in this population. Further research is necessary to elucidate these relationships and improve patient care. This case report discusses a rare presentation of convergence and accommodation mechanism failure in an HIV-positive presbyopic patient undergoing HAART. It provides an in-depth analysis of the clinical presentation, possible

etiological factors, and the challenges in managing such cases. By exploring the interplay between systemic health, pharmacological effects, and visual dysfunction, this report aims to emphasize the importance of early detection and tailored interventions. Additionally, it highlights the need for comprehensive ophthalmic evaluations in HIV-positive individuals to address not only life-threatening conditions but also quality-of-life concerns like visual function, which are often overlooked. Through this report, we hope to contribute to the understanding of how HIV and its treatment can affect convergence and accommodation, encouraging further research and multidisciplinary collaboration in managing such complex cases.

Case Presentation

This case report highlights the evaluation and management of a 65-year-old male patient presenting with convergence and accommodation mechanism failure, compounded by presbyopia and systemic factors related to HIV and Highly Active Antiretroviral Therapy (HAART). The patient initially reported double vision for the past week and difficulty with near tasks, alongside a history of hearing impairment. His systemic history included HIV, managed with HAART, and he was using ocular lubricants for dry eye. The patient initially presented with bilateral cataracts, with a visual acuity of 6/24p in the right eye (OD) and 6/18p in the left eye (OS). Post bilateral cataract surgery, he achieved visual acuity of 6/9 in both eyes with minor cylindrical correction. However, he reported overlapping images at both distance and near, and referred to the Binocular Vision Therapy (BVT) Clinic for further evaluation. At the BVT clinic, his best-corrected visual acuity (BCVA) was 6/9 in both eyes for distance and N36 for near, improving to 6/6 with a pinhole. Anterior and posterior segment evaluations were unremarkable. Binocular vision assessment revealed 3 prism diopters of exophoria at distance and 8 prism diopters of intermittent exophoria with good control at near, as measured by the Prism Bar Cover Test (PBCT). Retinoscopy findings showed a refractive error of OD: +1.75 DC @ 10 (6/6) and OS: Plano/+1.75 DC @ 170 (6/6), with near add correction of +2.75 DS achieving near visual acuity (NVA) of N6. The Near Point of Convergence (NPC) was 8 cm, and the Near Point of Accommodation (NPA) was 10 diopters. Negative Fusional Vergence (NFV) was 8/6 (Base-Out) at both near and distance. Accommodative facility with ±2.00 DS flipper lenses was reduced, with 2 Cycles Per Minute (CPM) in each eye and 3 CPM binocularly, with difficulty in clearing minus lenses. On sensory evaluation he was appreciating diplopia on worth four dot test and 140 sec of arc stereopsis. Based on these findings, the patient was diagnosed with presbyopia with convergence insufficiency and accommodative insufficiency. A prism correction of 2 Base-In was prescribed in both eyes to alleviate diplopia in free space. At follow-up, the patient reported significant symptomatic improvement with the prism glasses. His visual acuity 6/6 in both eyes, with near visual acuity of N6. Binocular vision findings remained stable, with an NPC of 8 cm, NPA of 10 diopters, and Positive Fusional Vergence (PFV) of 10/8 (Base-Out) at both near and distance measured with prism glasses. Accommodative facility with ±2.00 DS flipper lenses was reduced, with 8 Cycles Per Minute (CPM) in each eye and 6 CPM binocularly, with no difficulty in clearing any lenses. Motor Evaluation showed ortho for distance

and 6 prism diopter exophoria noted for near. Sensory examination showed Normal Retinal Correspondence (NRC) with 140 seconds of arc stereopsis. Therapy included Brock string exercises, single aperture rule training, vectogram, and synoptophore-based adduction exercises. After completing 10 clinic-based therapy sessions, the patient showed improved in fusional amplitudes and accommodative facility. He reported no further diplopia or focusing difficulties.

This case underscores the importance of binocular vision assessment and tailored interventions in managing convergence and accommodative dysfunctions, particularly in patients with systemic conditions such as HIV on HAART. Collaborative care and the role of optometrists in identifying and addressing such complex visual dysfunctions are crucial to enhancing the quality of life for these patients **(Table 1)**.

Table 1: Distribution of clinical variables as determined during patient's examination and follow up visit.

Tests	Pre-Therapy	Post-Therapy
Vision Distance with correction	OD-6/6, OS-6/6	OD-6/6, OS-6/6
Vision Near with correction	OD-N6, OS-N6	OD-N6, OS-N6
Refraction Dry	OD: Plano/+1.75 DC @ 10, OS: Plano/+1.75 DC @ 170	OD: Plano/+1.75 DC @ 10, OS: Plano/+1.75 DC @ 170
Prescription	OD: Plano/+1.75 DC @ 10, OS: Plano/+1.75 DC @ 170	OD: Plano/+1.75 DC @ 10, OS: Plano/+1.75 DC @ 170
Fundus	WNL	WNL
Motor Evalution for Distance	3 PD Exophoria	Ortho
Motor Evalution for near	8 PD IXT	6 Exophoria
Sensory Evaluation for Distance	Diplopia	BSV
Sensory Evalution for Near	Diplopia	BSV
Stereopsis	140 sec of arc	140 sec of arc
NPC	8	8
NPA Uniocularly	10	10
NPA Binocularly	10	10
Positive Fusional Amplitudes for Distance	8/6	10/8
Positive Fusional Amplitudes for Near	8/6	10/8
Accommodative facility Binocularly (BAF)	3	8
Accommodative facility Monocularly (MAF)	2	6
Diagnosis	presbyopia with convergence insufficiency and accommodative insufficiency	

Discussion

HAART stands for Highly Active Antiretroviral Therapy. It is a combination therapy (cART) regimen used to treat HIV infections. HAART typically consist of a combination of three or more antiretroviral drugs from different classes, such as: Nucleoside Reverse Transcriptase Inhibitors (NRTIs), Non-Nucleoside Reverse Transcriptase Inhibitors (NNRTIs), Protease inhibitors (PIs), Integrase Strand Transfer Inhibitors (INSTIs). Reduced amplitude of accommodation in HIV patients may result from direct neuronal infection by HIV-1, pathological changes in the ciliary muscle or the lens, or disruptions in the sensory components of the visual system. Accommodation involves an increase in the curvature of the lens, facilitated by the contraction of the ciliary muscle **[13]**, which is innervated by the parasympathetic motor nerves. HIV-1 appears to compromise the blood-ocular barrier, leading to direct or indirect alterations in the ciliary muscle's circulation and parasympathetic function, potentially contributing to parasympathetic neuropathy and accommodation dysfunction **[14-17]**. Receded amplitude of accommodation can result in accommodative insufficiency, a condition frequently observed in both presbyopic and non-presbyopic populations. In the context of HIV-positive individuals, accommodative failure **[18]** has been increasingly documented. Thierfelder et al. identified reduced amplitude of accommodation as an early ophthalmological manifestation in HIV-infected patients. They proposed potential mechanisms, including direct neuronal infection by HIV-1 and pathological changes in the lens or ciliary body, as contributing factors. However, their findings did not establish a correlation between accommodative failure and CD4+ T-cell counts **[19]**, suggesting that the dysfunction may occur independently of immune system status. A study reported a significant incidence of accommodative failure among HIV-positive individuals aged 35 to 45 years undergoing Antiretroviral Therapy (ART). It highlighted that the need for near vision correction in pre-presbyopic patients is frequently overlooked. Additionally, the study found no association between accommodative dysfunction and CD4 count and the specific ART regimen employed **[20]**. The amplitude of accommodation, an essential visual function, was observed to be markedly lower in the HIV-positive group compared to age-matched controls within the 25–29 age range, though this difference was not significant in older age groups. Approximately 30% of patients aged 25 to 34 exhibited reduced amplitude of accommodation below the expected norms for their age. Furthermore, the study concluded that accommodative failure was not correlated with current or nadir CD4 counts, viral load levels, or specific antiretroviral therapies **[21]**.

Espana-Gregori et al. reported that advanced AIDS patients exhibit lower-than-expected horizontal latent ocular deviation values at both near and distance. Additionally, the AC/A ratio were found to be reduced in this population. Their findings suggest that AIDS patients may experience convergence excess, contributing to visual symptoms such as blurred vision, photophobia, nyctalopia, and difficulty with near reading tasks. The study also highlights a potential variation in deviation angles in AIDS patients, characterized by reduced values at near and distance. This alteration may be associated with oculomotor muscle dysfunction related to the severity of HIV infection **[22]**. Aligned with their findings, our current study also identified lateral latent ocular deviation in near and distance vision among the HIV-

positive population on HAART. The patient in this report demonstrated intermittent exophoria at near and exophoria at distance [23], which contrasts with the findings of Sadiqu Hassan et al., who observed esophoric deviations for both near and distance vision. Espana-Gregori et al. similarly reported that HIV-positive individuals on HAART often exhibit convergence excess, which may exacerbate visual symptoms such as blurred vision, photophobia, headaches, diplopia, and difficulty reading small print at near distances. While the findings are not identical, they underscore the diverse impact of HIV and HAART on binocular vision anomalies [22]. These findings confirm that HIV-positive patients on HAART may experience binocular vision issues caused by factors such as reduced near point of convergence, low accommodation ability, higher-than-usual reading additions for presbyopia, and problems with the nerves controlling accommodation and convergence. These issues could result from the effects of the HIV virus itself, changes caused by the duration and impact of HAART, or both. Further studies with larger sample sizes are recommended to better understand these issues and determine how common they are in different populations.

Conclusion

This case report highlights the complex interplay between convergence and accommodation mechanism failure in an HIV-positive presbyopic patient undergoing Highly Active Antiretroviral Therapy (HAART). The patient presented with binocular vision issues, including convergence insufficiency and accommodative insufficiency, compounded by systemic factors associated with HIV and HAART. Comprehensive evaluation and tailored interventions, including prism correction and a structured Binocular Vision Therapy (BVT) program, significantly improved the patient's symptoms and functional outcomes. This case underscores the importance of early detection and management of binocular vision anomalies in this population to enhance their visual comfort and quality of life.

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