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ORIGINAL ARTICLE

CHANGES IN STABILOMETRIC PARAMETERS (CENTER OF PRESSURE) IN PATIENTS WITH VERTEBROBASILAR INSUFFICIENCY FOLLOWING STABILOMETRIC PLATFORM-BASED REHABILITATION

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Abstract

Vertebrobasilar insufficiency is a chronic cerebrovascular disorder characterized by impaired blood circulation within the vertebrobasilar arterial system, frequently resulting in dizziness, postural instability, gait disturbance, impaired coordination, and increased risk of falls. Stabilometric assessment has become an important diagnostic and rehabilitative tool for evaluating postural control and balance dysfunction in patients with vestibular and cerebrovascular disorders. This study investigates changes in stabilometric parameters, particularly center of pressure indicators, in patients with vertebrobasilar insufficiency following rehabilitation using a stabilometric platform. Particular attention is given to postural sway dynamics, balance stability, vestibular adaptation, sensorimotor integration, and rehabilitation effectiveness. The findings demonstrate that stabilometric platform-based rehabilitation significantly improves postural control, reduces instability, enhances proprioceptive regulation, and normalizes center of pressure displacement parameters. Objective stabilometric monitoring provides valuable information regarding functional recovery and therapeutic effectiveness during neurorehabilitation. Vertebrobasilar insufficiency is a chronic cerebrovascular disorder associated with impaired blood circulation within the vertebral and basilar arterial systems, leading to disturbances in vestibular regulation, postural control, coordination, and balance stability. Patients frequently experience dizziness, gait impairment, instability during standing, visual disturbances, and increased risk of falls, which significantly reduce functional independence and quality of life. Modern neurorehabilitation increasingly utilizes stabilometric technologies for objective assessment and correction of balance dysfunction through analysis of center of pressure dynamics and postural sway characteristics. This study presents an expanded evaluation of changes in stabilometric parameters in patients with vertebrobasilar insufficiency following rehabilitation using stabilometric platforms with biofeedback training. Particular attention is given to restoration of vestibular compensation, improvement of proprioceptive integration, reduction of postural oscillations, and normalization of center of pressure displacement during static and dynamic balance testing. The findings demonstrate that stabilometric rehabilitation significantly improves postural stability, enhances sensorimotor coordination, reduces pathological sway patterns, and contributes to greater functional adaptation during everyday activity. Objective stabilometric monitoring also provides valuable quantitative information regarding rehabilitation effectiveness and progression of neurofunctional recovery.

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Keywords: Vertebrobasilar insufficiency, stabilometry, center of pressure, postural balance, rehabilitation, vestibular dysfunction, stabilometric platform, neurorehabilitation, gait instability, cerebrovascular disorders

1. Introduction

Vertebrobasilar insufficiency represents a pathological condition caused by impaired blood flow within the vertebral and basilar arterial systems supplying the brainstem, cerebellum, vestibular structures, and occipital regions of the brain. Chronic insufficiency within this vascular territory may result in dizziness, vertigo, impaired coordination, gait instability, visual disturbances, muscle weakness, cognitive dysfunction, and increased susceptibility to falls. Disturbances in vestibular and proprioceptive regulation significantly impair postural control and negatively affect quality of life in affected patients. Maintenance of upright posture and coordinated movement depends on complex integration of vestibular, visual, proprioceptive, and central nervous system mechanisms responsible for balance regulation. Dysfunction of these systems due to chronic cerebrovascular insufficiency frequently leads to abnormal postural sway patterns and impaired center of pressure stability. Stabilometric analysis has become an important objective method for evaluating balance disorders through quantitative assessment of postural oscillations and center of pressure displacement during standing tasks. Modern stabilometric platforms provide detailed information regarding sensorimotor coordination, weight distribution, equilibrium control, and rehabilitation progress. In recent years, stabilometric platform-based rehabilitation has emerged as a promising neurorehabilitation approach aimed at improving balance control, vestibular adaptation, postural coordination, and proprioceptive integration in patients with neurological and cerebrovascular disorders. Repetitive balance training using real-time visual and sensory feedback promotes neuroplastic adaptation and restoration of functional postural regulation. Evaluation of stabilometric parameters before and after rehabilitation is therefore essential for understanding therapeutic effectiveness and optimizing individualized rehabilitation strategies in patients with vertebrobasilar insufficiency. Vertebrobasilar insufficiency represents a pathological condition caused by chronic reduction of blood flow within the vertebrobasilar arterial system supplying the brainstem, cerebellum, vestibular apparatus, and occipital cortical regions. Impaired circulation in these structures disrupts central and peripheral mechanisms responsible for maintenance of equilibrium, spatial orientation, coordinated movement, and postural regulation. As a result, patients commonly develop dizziness, vertigo, imbalance, gait instability, visual dysfunction, impaired coordination, muscle weakness, and decreased tolerance to physical activity. Persistent balance disorders significantly increase fall risk and negatively influence mobility, social participation, and psychological well-being. Maintenance of stable posture requires continuous integration of vestibular, proprioceptive, visual, cerebellar, and neuromuscular signals within central nervous system structures responsible for sensorimotor coordination. Chronic cerebrovascular insufficiency affecting vertebrobasilar circulation may impair these adaptive mechanisms and lead to pathological postural control strategies characterized by increased sway amplitude, asymmetrical weight distribution, delayed corrective reactions, and instability during sensory deprivation conditions. Stabilometric analysis has become an important diagnostic and rehabilitative method for objective evaluation of postural control through quantitative measurement of center of pressure displacement and balance oscillation dynamics. Modern computerized stabilometric platforms provide detailed assessment of equilibrium regulation and allow implementation of biofeedback-based rehabilitation programs aimed at restoring sensorimotor integration and vestibular compensation. Repetitive balance training using real-time visual and proprioceptive feedback promotes neuroplastic adaptation and improvement of functional postural control. Investigation of stabilometric parameter changes during rehabilitation therefore remains essential for understanding mechanisms of neurofunctional recovery and optimizing individualized therapeutic strategies in patients with vertebrobasilar insufficiency.

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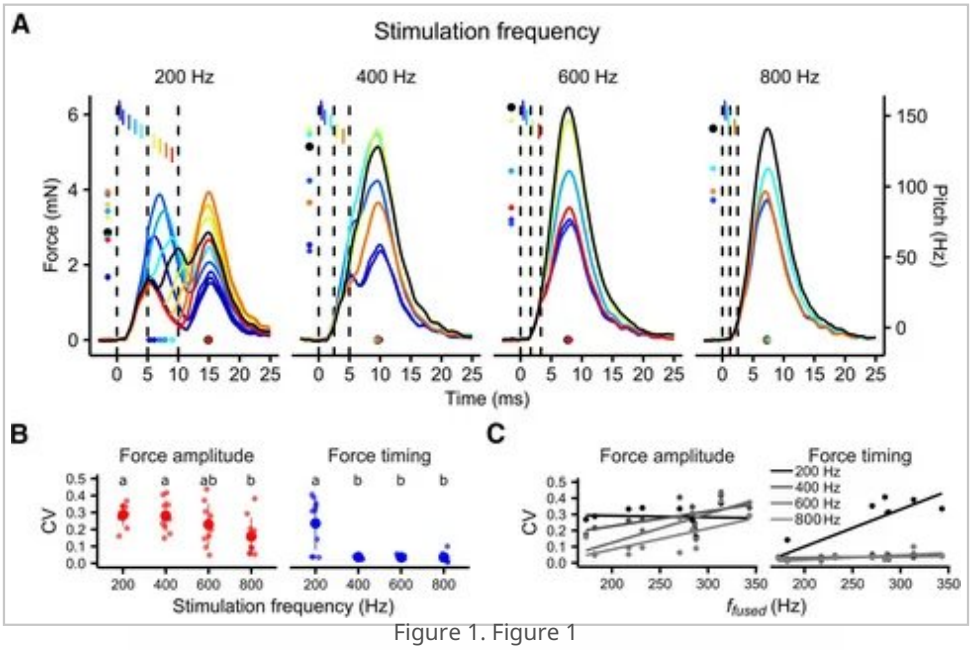

Figure 1. Figure 1

2. Materials and Methods

This study was conducted using a clinical and functional assessment of patients diagnosed with vertebrobasilar insufficiency who underwent stabilometric platform-based rehabilitation between 2021 and 2025. Patients included in the study presented with symptoms of dizziness, postural instability, impaired coordination, and gait dysfunction associated with chronic vertebrobasilar circulation insufficiency confirmed through neurological and vascular examination. Clinical evaluation included neurological assessment, vestibular function testing, and analysis of balance disturbances before and after rehabilitation. Stabilometric examination was performed using computerized stabilometric platforms capable of measuring center of pressure displacement, sway velocity, sway area, postural oscillation amplitude, weight distribution asymmetry, and stability indices during static standing tests with open and closed eyes. Rehabilitation protocols included individualized balance training sessions incorporating visual biofeedback, proprioceptive exercises, vestibular adaptation tasks, and dynamic postural control activities performed on stabilometric platforms. The rehabilitation program duration ranged from four to eight weeks depending on clinical severity and patient response. Statistical analysis was conducted to compare stabilometric parameters before and after rehabilitation and to evaluate correlations between clinical improvement and objective balance indicators.

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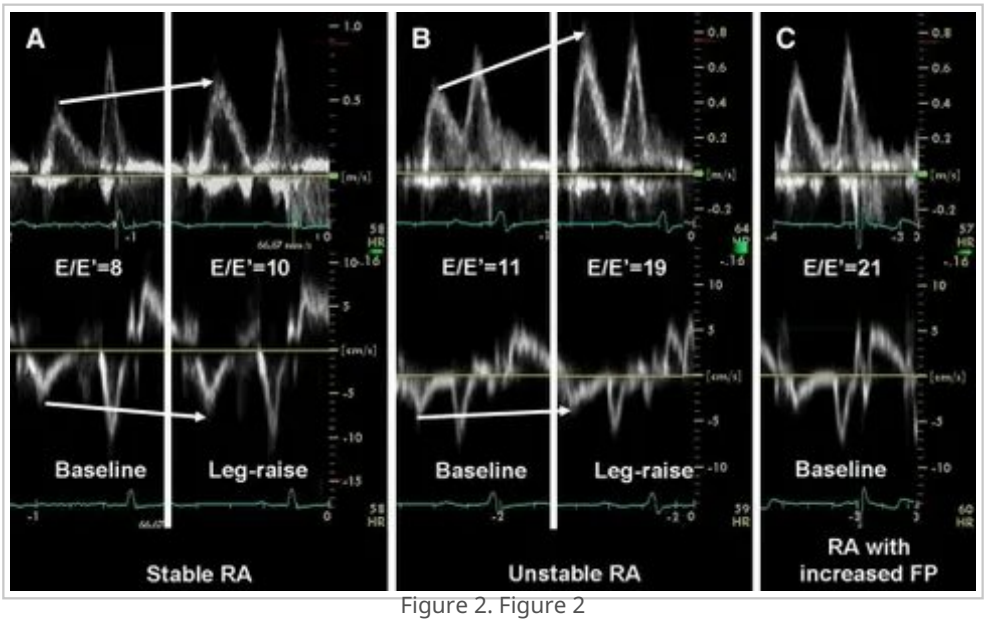

Figure 2. Figure 2

3. Results

Clinical and stabilometric analysis demonstrated significant improvement in postural stability and center of pressure parameters following stabilometric platform-based rehabilitation. Before treatment, patients with vertebrobasilar insufficiency exhibited increased postural sway amplitude, elevated sway velocity, enlarged stabilometric ellipse area, impaired weight distribution symmetry, and significant instability during eyes-closed testing conditions. These findings reflected disturbances in vestibular compensation, proprioceptive integration, and sensorimotor regulation associated with chronic cerebrovascular insufficiency. Following rehabilitation, patients demonstrated substantial reduction in center of pressure displacement and stabilization of postural oscillation patterns. Sway area and sway velocity significantly decreased, indicating improved balance control and enhanced neuromuscular coordination. Improvement in weight distribution symmetry and reduction in compensatory postural reactions were also observed after completion of rehabilitation programs. Patients reported subjective reduction in dizziness intensity, improved gait confidence, enhanced mobility, and decreased fear of falling during daily activities. Stabilometric monitoring additionally demonstrated improved adaptation to sensory deprivation conditions during eyes-closed balance testing, suggesting enhanced proprioceptive and vestibular compensation mechanisms. Longitudinal evaluation confirmed progressive normalization of stabilometric parameters during the rehabilitation period and greater functional independence among patients receiving structured stabilometric training. Clinical and stabilometric evaluation demonstrated significant improvement in balance regulation and center of pressure dynamics following stabilometric platform-based rehabilitation in patients with vertebrobasilar insufficiency. Before treatment, patients exhibited pronounced postural instability characterized by increased sway area, elevated sway velocity, asymmetrical weight distribution, enlarged stabilometric ellipse parameters, and excessive center of pressure displacement during static standing tests. Instability became more pronounced under eyes-closed testing conditions, indicating impaired proprioceptive and vestibular compensation mechanisms associated with chronic cerebrovascular dysfunction. Following completion of rehabilitation programs, patients demonstrated substantial reduction in postural oscillation amplitude and significant stabilization of center of pressure trajectories. Quantitative stabilometric analysis revealed decreased sway velocity, improved symmetry of weight distribution, reduction in compensatory body movements, and enhanced postural coordination during both static and dynamic balance testing. Rehabilitation also contributed to improved adaptation during sensory deprivation tasks, reflecting restoration of proprioceptive integration and vestibular regulation. Patients reported subjective reduction in dizziness intensity, improved gait confidence, enhanced mobility, decreased fear of falling, and better tolerance to daily physical activity.

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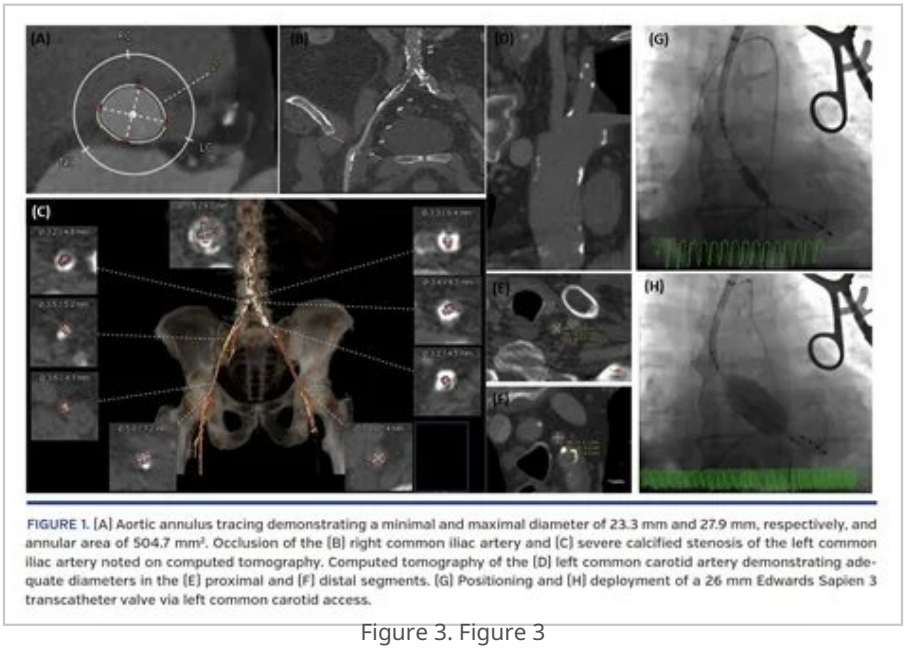

FIGURE 1. [A] Aortic annulus tracing demonstrating a minimal and maximal diameter of 23.3 mm and 27.9 mm, respectively, and annular area of 504.7 mm². Occlusion of the [B] right common iliac artery and [C] severe calcified stenosis of the left common iliac artery noted on computed tomography. Computed tomography of the [D] left common carotid artery demonstrating adequate diameters in the [E] proximal and [F] distal segments. [G] Positioning and [H] deployment of a 26 mm Edwards Sapien 3 transcatheter valve via left common carotid access.

Figure 3. Figure 3

4. Discussion

The findings confirm the effectiveness of stabilometric platform-based rehabilitation in improving postural control and sensorimotor regulation in patients with vertebrobasilar insufficiency. Chronic cerebrovascular insufficiency affecting the vertebrobasilar system disrupts vestibular processing, cerebellar coordination, proprioceptive integration, and central balance regulation, resulting in instability and increased fall risk. Stabilometric analysis provides objective quantitative assessment of these dysfunctions and allows accurate monitoring of rehabilitation progress through measurement of center of pressure dynamics and postural sway characteristics. Improvement in stabilometric parameters following rehabilitation likely reflects enhanced neuroplastic adaptation, improved vestibular compensation, restoration of proprioceptive feedback mechanisms, and increased efficiency of postural motor control. Real-time visual and sensory biofeedback provided by stabilometric platforms promotes active patient participation and facilitates correction of abnormal balance strategies during rehabilitation sessions. Reduction of sway velocity and center of pressure displacement indicates improved postural stability and more efficient sensorimotor integration. The study also highlights the importance of individualized rehabilitation protocols adapted to patient-specific neurological and functional deficits. Contemporary neurorehabilitation increasingly incorporates computerized balance assessment technologies and biofeedback-based interventions to optimize recovery in patients with cerebrovascular and vestibular disorders. Early rehabilitation intervention may further reduce fall risk, improve mobility, and enhance quality of life in patients with chronic vertebrobasilar insufficiency. Multidisciplinary cooperation among neurologists, rehabilitation specialists, physiotherapists, and vestibular therapists remains essential for achieving optimal therapeutic outcomes. The findings confirm the significant therapeutic effectiveness of stabilometric platform-based rehabilitation in patients with vertebrobasilar insufficiency and chronic balance dysfunction. Cerebrovascular impairment within the vertebrobasilar system disrupts vestibular processing, cerebellar coordination, sensorimotor integration, and central postural regulation, leading to instability and impaired adaptive responses during standing and movement. Stabilometric analysis provides highly sensitive quantitative evaluation of these dysfunctions and enables objective monitoring of rehabilitation progress through measurement of center of pressure behavior and postural sway dynamics. Improvement in stabilometric parameters following rehabilitation likely reflects enhanced neuroplasticity, restoration of vestibular compensation, optimization of proprioceptive feedback mechanisms, and improved neuromuscular coordination. Real-time visual and sensory biofeedback provided during stabilometric training facilitates active correction of abnormal postural strategies and promotes development of more stable balance control patterns. Reduction of sway amplitude and center of pressure displacement indicates increased efficiency of sensorimotor regulation and improved integration of vestibular and proprioceptive information within

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central nervous system structures. The study also emphasizes the importance of individualized rehabilitation protocols adapted to severity of neurological impairment and functional balance deficits. Contemporary neurorehabilitation increasingly incorporates computerized balance technologies and biofeedback systems to improve recovery outcomes in patients with vestibular and cerebrovascular disorders. Early rehabilitation intervention may significantly reduce fall risk, improve mobility, and enhance overall quality of life in patients with chronic vertebrobasilar insufficiency. Effective rehabilitation therefore requires coordinated multidisciplinary cooperation involving neurologists, rehabilitation physicians, physiotherapists, vestibular therapists, and neurofunctional specialists.

5. Conclusion

Stabilometric platform-based rehabilitation demonstrates significant effectiveness in improving balance regulation and stabilometric parameters in patients with vertebrobasilar insufficiency. Objective reduction in center of pressure displacement, sway velocity, and postural instability reflects restoration of vestibular compensation, proprioceptive integration, and neuromuscular coordination during rehabilitation. Stabilometric assessment provides valuable quantitative information regarding balance dysfunction and therapeutic progress, allowing individualized monitoring of neurorehabilitation effectiveness. Structured balance training using stabilometric platforms contributes to improved gait stability, reduced dizziness, enhanced postural control, and greater functional independence. Continued development of computerized stabilometric technologies and personalized neurorehabilitation strategies remains essential for optimizing treatment outcomes in patients with chronic cerebrovascular and vestibular disorders. Stabilometric platform-based rehabilitation demonstrates substantial effectiveness in improving postural stability, center of pressure regulation, and balance coordination in patients with vertebrobasilar insufficiency. Significant reduction in sway velocity, postural oscillation amplitude, and instability parameters reflects restoration of vestibular compensation, proprioceptive integration, and neuromuscular control during rehabilitation. Objective stabilometric monitoring provides valuable quantitative assessment of balance dysfunction and therapeutic progress, allowing optimization of individualized neurorehabilitation strategies. Structured balance training using stabilometric platforms contributes to improved gait stability, reduced dizziness, enhanced mobility, and greater functional independence in daily activities. Continued advancement of computerized stabilometric technologies and personalized neurorehabilitation approaches remains essential for improving therapeutic outcomes and quality of life in patients with chronic cerebrovascular and vestibular disorders.

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