

Improvement of Balance, Coordination Related to Gait by Different Circuit Training Program in Patient with Wallenberg Syndrome: A Case Report

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ABSTRACT

Objective: To determine the effect of different balance training protocol to improve the Wallenberg syndrome and its symptoms.

Design: Case study pre and post intervention design.

Patient: A 38-year-old women presenting the symptoms of the nausea and vomiting at the initial days of diagnosis after few days she complaint towards the improper balance and coordination. Gait speed was reduced gradually and she was taking the maximum support while walking.

Intervention, we assessed the inclusion criteria based on the assessment and the rehabilitation was started. The main focus was towards the balance and coordination improvement along with the gait speed. The total 8-week protocol was given. At the initial days the strengthening for upper and lower limb was focused. Later, the balance training, star excursion exercises, circuit gait training, treadmill training were given. After the 8 weeks the re-assessment was performed for the gait, balance and coordination.

Results: After the intervention for balance, coordination and gait the patient shown the improvement. She was walking without support and managing the all ADLs by herself. Follow up was done after the 1 month, improvement was present accordingly.

Conclusions: The circuit training, balance training and the treadmill training were effective in the Wallenberg syndrome to improve the gait, coordination and balance. Activities of daily living were shown the much improvement in the patients.

Key words: Wallenberg syndrome, lateral medullary syndrome, balance, coordination, gait, physiotherapy, rehabilitation, stroke.

INTRODUCTION

Lateral Medullary Syndrome (LMS), also known as Wallenberg Syndrome, is a neurological condition caused by a stroke or other damage to the lateral part of the medulla oblongata in the brainstem. This syndrome is characterized by a variety of symptoms, including vertigo, nystagmus, dysphagia, hoarseness, ipsilateral ataxia, facial pain and numbness, and contralateral loss of pain and temperature sensation in the trunk and limbs. The severity and combination of symptoms can vary

depending on the location and extent of the damage.¹

Clinicians estimate that there are over 60,000 new cases of Lateral Medullary Syndrome (LMS), the most prevalent posterior ischemic stroke syndrome, annually in the United States. Risk factors for LMS vary with age but commonly include atherosclerosis, coronary artery disease, hypertension, and diabetes.¹⁰

The symptoms of LMS can vary depending on the location and severity of the injury, but some common symptoms include: Dysphagia (Difficulty Swallowing): This

can range from mild to severe and may require feeding assistance, Hoarseness or Dysphonia: Difficulty speaking or changes in voice quality, Vertigo: A sensation of spinning or dizziness, often accompanied by nausea and vomiting, Nystagmus: Involuntary eye movements, often horizontal, Ataxia: Difficulty with coordination and balance, leading to unsteady walking and a tendency to fall, Horner's Syndrome: A combination of symptoms including ptosis (drooping of the eyelid), miosis (constricted pupil), and anhidrosis (lack of sweating), Facial Sensory Loss: Numbness or reduced sensation on one side of the face, Decreased Pain and Temperature Sensation on the Contralateral Side of the Body: This means that the person may have difficulty feeling pain or temperature changes on one side of the body, Hiccups: In some cases, persistent hiccups may occur, Dysphonia: Difficulty speaking or changes in voice quality, Dysphagia: Difficulty swallowing, Facial Sensory Loss: Loss of sensation on one side of the face, Vertigo: A sensation of spinning or dizziness, Nystagmus: Involuntary eye movements, often horizontal, Ataxia: Difficulty with coordination and balance, Horner's Syndrome: A combination of symptoms including ptosis (drooping of the eyelid), miosis (constricted pupil), and anhidrosis (lack of sweating) on one side of the face, Decreased Pain and Temperature Sensation on the Contralateral Side of the Body. This means that the person may have difficulty feeling pain or temperature changes on one side of the body, Hiccups: In some cases, persistent hiccups may occur.²

The lateral medullary syndrome is a rare condition, but it's important to note that it can be life-threatening if not treated promptly. Therefore, early recognition and intervention are crucial for improving patient outcomes.¹

Physiotherapy management is more important to the Wallenberg syndrome according to the symptoms. Most common intervention focused on the balance and

coordination and gait training. As the patients' activities of daily living was affected by the condition the intervention focused on the same.

The physiotherapy intervention available on the Wallenberg syndrome is inferior than the other syndrome the main reason for the diagnosis of the syndrome and the prevalence of the Wallenberg syndrome.²

METHODS

Instruments

Star excursion balance test³

The star excursion balance test (SEBT) is indeed a valuable tool for assessing dynamic balance, strength, flexibility, and proprioception. It's particularly useful in identifying deficits in dynamic postural control due to musculoskeletal injuries like chronic ankle instability. Additionally, it can help identify athletes at greater risk for lower extremity injuries and can be used during rehabilitation to monitor progress and guide treatment. The BOSU Balance Trainer, commonly known as the BOSU ball, is a fitness tool designed by David Weck in 1999. It comprises an inflated rubber hemisphere affixed to a firm platform and is frequently employed for balance exercises. When the dome side is positioned upward, the BOSU ball offers an unsteady surface while maintaining stability.⁵ Six studies were conducted to evaluate inter-rater reliability, while seven studies focused on intra-rater reliability. The median QAREL scores for the included studies were 66.89% (range: 55.56% to 75.00%) for inter-rater reliability and 59.03% (range: 33.33% to 66.67%) for intra-rater reliability. The median ICC values for inter-rater reliability were 0.88 (range: 0.83 to 0.96), 0.87 (range: 0.80 to 1.00), and 0.88 (range: 0.73 to 1.00) for the anterior, posteromedial, and posterolateral directions, respectively.⁵

Before starting the test same length tape will required. Total eight tape was paste on the floor which were 45 perpendicular to each other. The central point will be the standing point where patient can stand. The total

distance was measured with the help of the inch tape. Pre and post measurement was noted after giving the physiotherapy treatment. The main goal of the Star excursion balance test was the dynamic activities in standing position which improve the coordination balance strength and flexibility.

BOSU Ball⁴

The BOSU Balance Trainer, commonly known as the BOSU ball, is a fitness tool designed by David Weck in 1999. It comprises an inflated rubber hemisphere affixed to a firm platform and is frequently employed for balance exercises. When the dome side is positioned upward, the BOSU ball offers an unsteady surface while maintaining stability.

This study aimed to examine the effects of incorporating a Both Sides Up (BOSU) ball into a balance and strength training program on functional outcome, proprioception, and muscle strength in patients with Wallenberg syndrome.

Circuit Training⁶

A study was conducted to assess the effects of a four-week progressive training program on static balance and muscle electromyography (EMG) activity in 16 middle-aged females (mean age: 46.9 ± 8.7 years; height: 161.1 ± 6.0 cm; weight: 65.4 ± 11.2 kg). Participants underwent training three times a week for 50 minutes per session, with each session focusing on six basic exercises. The exercises were designed to progressively challenge participants' base of support, stability, vision, resistance, and torque. Pre- and post-training measures of balance included feet-together standing, tandem stance, and one-leg stand (unsupported leg in the sagittal plane) with eyes closed, as well as a Stork Stand (unsupported leg in the frontal plane) with both eyes open and closed. Postural deviations were recorded for each individual in each position, and muscle recruitment was assessed using root mean squared (RMS) EMG activity for the

soleus, biceps femoris, erector spinae, rectus abdominis, and internal oblique muscles of the dominant foot side. The study found that balance scores significantly improved post-training in both the Balance Error Score System ($p < 0.05$) and Stork Stand positions ($p < 0.01$). Additionally, muscle activity was reduced post-training in all muscles in each condition except the soleus in the tandem position, although not all reductions were statistically significant.

CASE DESCRIPTION

A 38 year old lady came to the neurodepartment as the complain of the balance and the coordination issues. as her history was more relevant towards the neurological complain as is went to the n hospital with the nausea and vomiting symptoms where she was admitted for the next 5 days they were done the various reports. They have done the anti-neutrophil cytoplasmic antibody (ANCA), this was showing the G-ANCA Negative Patents with a number of other diseases, such as ulcerative colitis and ankylosing spondylitis, will come only have ANCA as well However in these cases there is no associated vasculitis and the ANCA are thought to be incidental or epiphenomena rather than part of the disease itself. After the 2 days she was complaining the bilateral pain and generalised weakness in upper limb and lower limb. The 2D echo Doppler was showing the normal reports. Medication was given according to the symptoms. Same day left upper limb angiogram was done as she was complaining the weakness and numbness over the palmar area. The report was showing the complete occlusion of the left ulnar artery with first part of subclavian artery mild stenosis and the MRI scan of brain and angiography was shown the Acute infarct in left PICA territory involving left posterior inferior cerebellar hemisphere and left half of vermis with no e/o haemorrhagic transformation. Acute infarct in left half of medulla and left half of inferior cerebellar peduncle with no e/o haemorrhagic transformation se lateral medullary

/Wallenberg syndrome. The MR angiography of brain vessels reveals the thrombosis of left vertebral artery and left posterior inferior cerebellar artery and hypoplastic right posterior communication artery. And the discharged patient came to the physiotherapy department for the further treatment the neuro assessment was done on same day. It included the demographic data and observation. Posture was deviated to the right as she was using the right side more. The back colour spot was present on the fifth figure in the left side. And she was complaining the sensation loss for same. Sitting and the standing balance was impaired. She was using the support for sitting to standing. Memory was intact according to the mini mental status examination. the sensory and motor assessment. The sensory assessment was showing the impairment in the superficial and deep sensation were lost in the left side of the 5 figure. Pain touch sensation was absent in the left side fifth figure. Deep and cortical sensation were intact compared to both sides. The motor assessment was included and the muscle testing were showing the 4/5 in upper limb and 3/5 in the lower limb. The more weakness was present in the right side. Spasticity was normal according to the modified Ashworth scale. Passive range and active range of motion were normal, range was full. Deep tendon reflexes were normal 5/5. Coordination was absent. According to the berg balance test patient was showing the score <45 indicates the individuals may be at greater risk of falling. Time up and go test was performed it showed the mean was the 13.6 sec. gait step and stride length reduce and the cadence was more. The left side step length was less than the right side. After four weeks of inpatient rehabilitation, which included physical therapy (PT), occupational therapy (OT), and medication management, she was discharged to return home. Upon discharge, she required assistance with most activities of daily living (ADLs), including grooming, feeding, dressing, navigating stairs, toileting,

showering, and transferring to and from the bed and wheelchair. While her comprehension, problem-solving skills, and memory were normal, it was observed that she was not making significant efforts to use her lower limb for ADLs.

Testing and Intervention Procedures

After the patient underwent screening for inclusion and signed an approved informed consent form. The treatment was started according to the need and the requirement. The rehabilitation was started with the walking with included the front walking, lateral walking, backward walking and obstacle walking as the circuit training. One study was showing the improvement in the balance with the neuromuscular control as study was showing the using the BOSU ball the core muscles were able to control body position with less activity post training suggesting improved muscle coordination and efficiency. There results suggest that short term progressive floor BOSU balance training can improve standing balance in middle aged women.⁶

The BOSU Ball was used to trained the lower limbs as the support was given to the patient with the help of the parallel bar. The hip movements flexion extension abduction and adduction were performed 5 days a week for next one month.

Star excursion exercises were performed after gaining the patient confidence, were lateral lunges, front lunges were introduced and the repetition were performed and therapist was standing behind the patient. The 2 set of each side were performed twice in a day for the 5 days per week for the next 6 weeks. Study conducted in the 2018 showing the training of Hop-to-stabilization exercises have been shown to significantly enhance strength, balance, and functional performance. It is recommended that clinicians include these exercises in their rehabilitation protocols to address the deficits associated with Chronic Ankle Instability (CAI) by using the balance error scoring system (BESS) and star excursion balance test (SEBT).⁷

Treadmill training was started after the 4 week of physiotherapy treatment. The total 20 mins session of training on treadmill was started. The basic needed support was given. The unsupported training slowly after the 2 weeks of intervention. The finding from the Sharon et.al study suggested that, following a stroke, the effectiveness of treadmill training (TT) in improving walking endurance may be influenced by level of difficulty during the training

sessions. This supports the idea of incorporating TT at more challenging levels into stroke rehabilitation programs.⁸ Other than the balance training the patient was receiving the stretching, strengthening, resisted range of motion for upper limb and lower limb with the help of weight cuff for ten repetition 5days for week for next 6 weeks. The coordination exercise was started for the lower limb.



Fig 1: stair case climbing.



Fig 2: star excursion exercises.(anterior)



Fig 3: star excursion exercises (lateral view)



Fig 4 : Treadmill training



Fig 5: Gait training (forward walking)

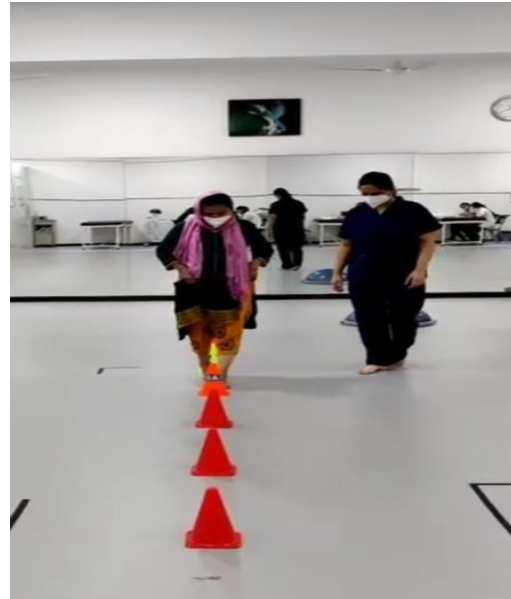


Fig 6: Obstacle walking

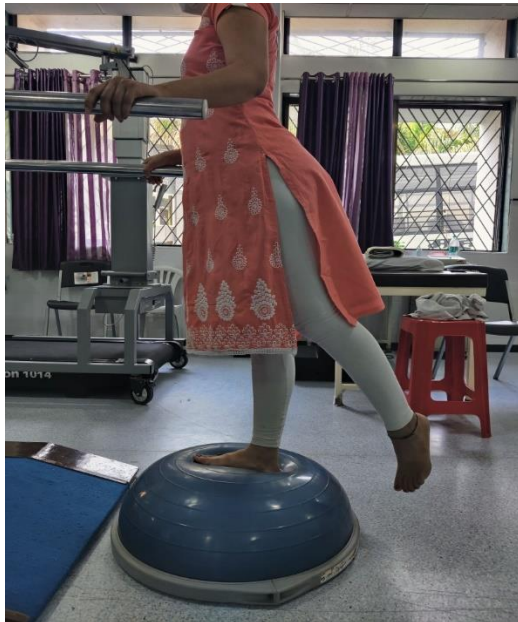


Fig 7 : BOSU ball training (hip extension)



Fig 8 : BOSU ball training (hip abduction)



Fig 9 : BOSU ball training (hip adduction)

RESULTS

The balance, coordination and the gait were performed before the treatment. In the initial days the more focus was present on the strength training and the neurological assessment. The rehabilitation was focus on the balance and gait which will further important to improve the activities of daily living. After the rehabilitation treatment, the balance, coordination and gait showed the significant improvements. Star excursion exercises were shown the more results as she were using the bilateral side for the static lunges. The distance between the star excursion before intervention compare to after intervention was showing the better results.

Treadmill training initially was given for 10 mins after the completion of the rehabilitation the training was given for 20 mins and without support. Muscle strength was improved from 3/5 to 5/5 in the lower limb. The activities of daily living much improved after the physiotherapy rehabilitation.

BOSU ball was shown the better result when the patient was standing on it. Initially the maximum support was given but after one month support was reduce to minimum.

DISCUSSION

Posterior ischemic stroke syndrome, also known as Wallenberg's syndrome, affects about 60,000 new cases in the United States annually.⁹ It is estimated that 800,000 Americans suffer from acute stroke each year, with 83% of strokes being ischemic in nature. A significant portion, around 20%, of ischemic strokes occur in the posterior circulation. Infarcts in this region are more common among individuals who consume alcohol. The primary causes are large artery atherothrombosis (75%), cardio-embolism (17%), and vertebral dissection (8%). Other contributing factors include hypoplastic vertebral artery, Moya-Moya disease, and vertebrobasilar dolichoectasia. Less frequently, conditions like subclavian steal syndrome, Fabry disease, and mitochondrial encephalopathy

can lead to Wallenberg's syndrome. The posterior inferior cerebellar artery (PICA) and the vertebral artery are the most commonly affected vessels.⁹

The vertebral artery is divided into four segments, with the fourth segment being the largest. The Posterior Inferior Cerebellar Artery (PICA) originates from the fourth segment of the vertebral artery, which comes from the subclavian artery. The PICA has five segments: anterior medullary, lateral medullary, tonsillomedullary, telovelotonsillar, and cortical. The lateral medullary segment extends near the origin of the glossopharyngeal, vagus, and accessory nerve roots. The PICA supplies the medulla, the choroid plexus, the tela choroidea of the fourth ventricle, the cerebellar tonsils, the inferior vermis, and the lower aspect of the cerebellar hemisphere. It provides a major contribution to the blood supply of the choroid plexus and the majority of branches of the choroid plexus.¹⁰

Starting with a thorough physical assessment of lower extremity sensation, balance control, gait, and endurance, rehabilitation for balance impairment tailors a specific program to address the patient's primary complaints and functional deficits. This program incorporates dynamic balance and gait training, visual feedback training, and behaviour modification techniques to reduce fear and instil safety recommendations for movement and gait.¹¹

In our study main focused was on the balance gait and coordination. The circuit training which was more effective compared to other. Circuit training included the front back lateral obstacle walking. Which improve the coordination as well as balance. The step and stride length were improved day by day. The treadmill training was initiated after the circuit training. The total 20 mins was given to the gait training but along with the circuit training.

Patients with Wallenberg syndrome often experience truncal lateropulsion, tilting towards the side of the brain lesion, and mobility issues due to gait ataxia.

Rehabilitation aims to address these symptoms, although there is limited research on effective treatment. Treadmill ambulation with partial body-weight support has shown promise in managing balance and "pusher's syndrome". Dysphagia and dysphonia are common, and early assessment of swallowing with diet modification can prevent aspiration pneumonia. Vertigo is challenging to treat and often does not respond well to medication. Therapeutic options include postural control and visual-vestibular interaction exercises.¹²

The effectiveness of a balance control measurement procedure using posturography was assessed in patients with Wallenberg syndrome, who experienced difficulties in maintaining balance while standing still. Posturography revealed notable improvements in standing balance following rehabilitation. Particularly, improvements were more pronounced in anteroposterior sway than in mediolateral sway when visual compensation was not utilized. In summary, an initial posturography assessment is advised for patients with Wallenberg syndrome, followed by a tailored balance rehabilitation program based on their posturography results, which can significantly enhance their quality of life through balance training.¹³

This study involved the patient in the early period as previous study stated the early intervention may effective in the Wallenberg syndrome. The patient was admitted in the hospital and after the discharge the physiotherapy rehabilitation was started. The rehabilitation was given in the OPD basis to get the maximum results. The treatment protocol was finalised and the treatment was given with in the one week. Which included the circuit training for balance coordination and gait. The maximum results were found after the treatment which gone help her while doing the activities of daily living.

CONCLUSION

This study highlights the positive effects of balance training on patients with Wallenberg syndrome, particularly in terms of improving quiet standing balance and gait. The findings suggest that incorporating balance training into rehabilitation programs is crucial for managing Wallenberg syndrome. Additionally, circuit training and early rehabilitation can serve as valuable tools for objectively assessing and managing standing balance and gait in these patients.

Declaration by Authors

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