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Whole body vibration versus balance training in patients with chronic ankle instability: A randomized controlled trial

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Abstract---Background: The ankle is the most often injured joint in athletics. The most frequent kind of ankle injury is a lateral ankle sprain. Whole Body Vibration (WBV) is a unique biophysical technique that generates whole-body vibration impulses for mechanical stimulation. It has been demonstrated in recent years to improve the neurological, muscular, and skeletal systems. Objective: The goal of this study is to assess the effect of systemic vibration and balance training on pain intensity and balance, in CAI patients. Methods: 45 female patients will be enrolled in the research after being recommended by an orthopedic expert for recurrent ankle instability. They will be divided into three equal-sized groups. Group (A) comprises of fifteen patients who will get a six-week exercise program designed specifically for CAI and Whole-Body-Vibration Training (three sessions per week). Group (B) comprises of fifteen patients who will get a six-week, three-session-per-week, conventional exercise

program for CAI and balance training. Group (C) consists of fifteen patients who will get a standard exercise plan for CAI. pain; balance and function status of the patients were examined before and after the treatment. Results: there was a statistically significant difference in pain, function and balance after Whole-Body-Vibration WBV and biodex balance system BBS training application, with BSS training being superior to WBV training in balance. Conclusion: whole body vibration and Biodex balance training are effective modalities for improving pain, balance and function control in patients with chronic ankle instability with superior effect of Biodex balance training.

Keywords---chronic ankle instability, Whole-Body-Vibration, biodex balance system.

Introduction

Ankle joint is the alternate most common injured body part in sports. lateral ankle sprains (LAS) are the most common type of ankle injury ¹. It's more common in women than in males, and in children, compared with adolescents and grown-ups. Ankle recurring injury accounts for 25% of all recurring injuries ². Re-injury of ankle sprain generates chronic ankle instability (CAI), which acts as a cause for recurring sprains in 55% – 72% of the cases. Sports conditioning was established to be the topmost threat for CAI ³. Ligament laxity, muscle weakness, proprioception deficiencies, and postural control deficiencies perform in CAI.

Two primary types of CAI are mechanical ankle instability (MAI) and functional ankle instability (FAI). varied deficiencies that perform in each type of instability have been honored in those with CAI. Functional deficiencies include bloodied proprioception, altered neuromuscular control (NMC), strength deficiencies, and lowered postural control. Impairments in the proprioceptive system and NMC lead to postural control deficiencies. During single leg balance, the bottom pronates and supinates trying to maintain the body's center of gravity (COG) above the base of support (BOS). This is called the ankle strategy of postural control ⁴. Whole- body – vibration (WBV) training is a form of neuromuscular training that has been gradually used as a preventative and rehabilitative tool ⁵. The oscillating vibration platform produces fast and short- term changes in the length of the muscle-tendon complex, triggering the primary consummations of the muscle spindles that could evoke the tonic vibration reflex ⁶. Enhanced excitability of the a and c motoneurons and increased synchronization of the motor units. These physiological changes could lead to further effective proprioceptive feedback, thereby perfecting balance capability and the active protection medium of the ankle joint ⁷.

Whole body vibration (WBV) is a new biophysical modality to give systemic vibration signals for mechanical stimulation and has lately surfaced as an exercise intervention that can have positive effects on the neural, muscular and skeletal systems. WBV exercise involves standing on a platform that oscillates at a particular frequency and amplitude, which turns on muscle contractions via

stimulation of sensory receptors ⁸. The purpose of this study is to compare between Whole-Body-Vibration and balance training on, pain severity, balance and function in patients with CAI.

Materials and Methods

Study design

Randomized controlled trial

From December 2021 to March 2022, this randomized controlled clinical trial was carried out at the Faculty of Physical Therapy's Out-Patient Clinic at the national institute for neuromotor system. Before each patient participated in the study, the study's aims and protocol were explained to him. For participation in this study, all patients signed an informed consent form that had been approved by the institution.

Participants

The study will be conducted on forty-five female patients referred by an orthopedic surgeon with the diagnosis of chronic ankle instability. They will be divided into 3 equal groups the study aim and procedure will be explained to the patients and they will be asked to sign a consent form. A. Participants will be included in the study if there are ^{9,10}:

- A history of at least one significant ankle sprain.
- The initial sprain must have occurred at least 12 months prior to study enrollment.
- The most recent injury must have occurred more than three months prior to study enrollment. (Unassisted walking without limping for at least three months after injury).
- A history of the previously injured ankle joint giving way, recurrent sprain and/or feelings of instability.
- The injured/unstable ankle is functionally weaker, more painful, looser, and less functional than the uninvolved ankle.
- Age between 18 – 35
- BMI 18.5 - 24.9

Exclusion Criteria

- A history of previous surgeries or fractures in either limb of the lower extremity.
- Acute injury to musculoskeletal structures of other joints of the lower extremity in the previous three months, which impacted joint integrity and function (ie, sprains, fractures) resulting in at least one interrupted day of desired physical activity.
- Any positive findings on an anterior drawer or talar tilt test ⁹.
- Balance deficits due to vestibular disorders, such as vertebrobasilar insufficiency and visual disorders.

Randomization

After the screening process, four patients have been ruled out because they didn't meet the inclusion criteria and two patients were excluded as they refused to participate in the study. A randomization process was performed for forty-five patients; a computer-generated randomized table was used for allocation. A random numerical sequence was used to hide patient allocation in sealed opaque envelopes. The researcher opened the subsequent envelope in the sequence in front of every patient as they officially entered the trial, they will be divided into 3 equal groups the study aim and procedure will be explained to the patients and they will be asked to sign a consent form.

- Group (A)
- Consists of 15 patients who will receive a traditional exercise program for CAI and Whole-Body-Vibration Training for 6 weeks (3 sessions /week).
- Group (B)
- Consisting of 15 patients who will receive a traditional exercise program for CAI and Balance Training for 6 weeks (3 sessions/ week).
- Group (C)
- Consisting of 15 patients who will receive a traditional exercise program for CAI

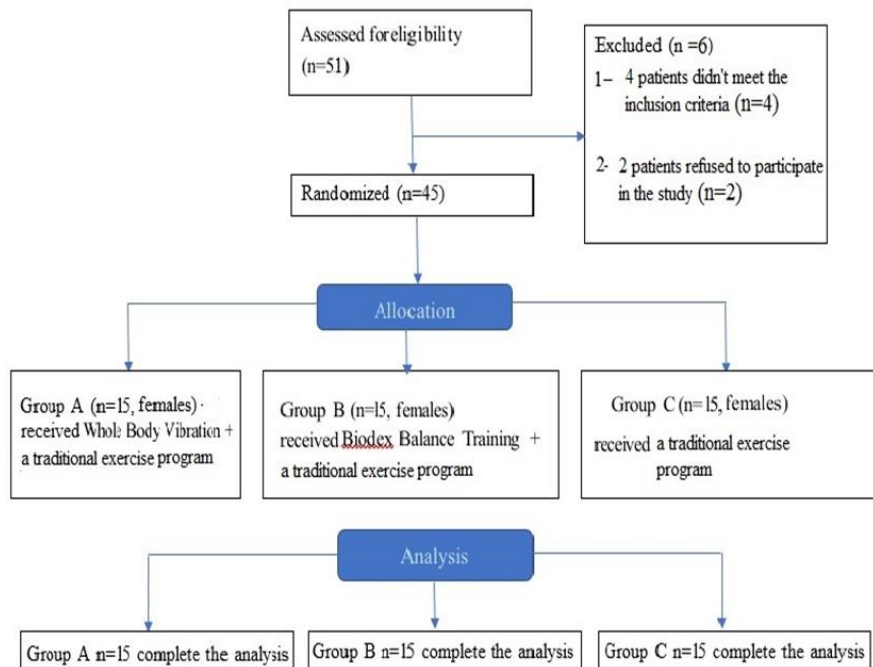


Figure 1. Flow chart of study participants

Outcome measures

A visual analog scale was used to evaluate pain levels

All cases will be assessed before and after the treatment program for their pain using a 100 – mm visual analogue scale (VAS) to estimate the case's pain, with 0 representing no pain and 10 representing the worst pain imaginable this approach of evaluation is both reliable and valid for measuring pain ¹¹.

The Biodex Balance System™ SD (BBS) (Biodex Medical Systems Inc., New York, USA) is a reliable and valid tool for assessment²⁴. Balance apportions will be conveyed utilizing the Biodex Balance System (BBS) (Biodex clinical frameworks, Inc. Shirley (NY). BBS gives substantial, solid and repeatable objective proportions of a patient's capacity to adjust on steady and shaky surfaces. It is utilized as a unique postural control evaluation and furthermore a preparation framework. Medio-Lateral Stability Index (MLSI), Antero-Posterior Stability Index (APSI), and Overall Stability Index (OASI). A high score shows significant development away from the member's COG, which demonstrates helpless equilibrium. The BBS assists with surveying the member's NMC in a shut chain by estimating the capacity of the member to control dynamic one-sided postural dependability on a mobile surface.,¹³. All of the evaluations have been done before therapy and at the finish of the six-week treatment program.

Treatment Plan

Whole Body Vibration Training

All members in Entire Body Vibration Training gather will take after an organized 6 weeks dynamic vibration program comprising of program as a follow Therapists inquired the patients sometime recently starting the WBV work out to warm up by strolling for 3 min on a treadmill. Vibration stacking was carried out in a standing position on a WBV stage (Control Plate Worldwide, Irvine, California, USA) with the knees bowed, kept up at a 45° point, and the back and head straight. The shaking stage with a sagittal pivot then again pushes the proper and cleared out legs upward and downward, in this manner advancing protracting of the extensor muscles of the lower limits. The reaction of the neuromuscular framework could be a chain of fast muscle contractions. This sort of preparation gives reflex muscle incitement with no genuine unfavorable occasions. The WBV was connected at a recurrence of 25–30Hz and sufficiency of 3–5mm with an add up to a length of 30min/session, three sessions/week for add up to 6 weeks ¹⁴.

Whole Body Vibration

The vertical sinusoidal WBV plate (Crazy Fit Massage, WBV- X1150) was utilized in this ponder. The crest to peak amplitude was extending from 5 to 8 mm with 50 Hz frequency ³⁴, which came about in gravitational powers about 3–7g. ³⁵ The patients stood in on the vibration platform with their feet shoulder-width separated, hands by their sides, and wore institutionalized thick cotton socks to anticipate any dampening that might result from footwear This session was performed twice a week for six weeks. The vibration protocol was 1-minute vibration taken after by 1-minute rest for five min ¹⁵.

Traditional exercise program

The 6-weeks rehabilitation program consist of 18 visits to the physiotherapy department. Stretching and Strengthening Exercise: For all treated groups, each patient performed the strengthening and stretching exercises twice a week for 6 weeks. In each session, each patient performed two sets of calf muscle extending. Each set is comprised of three repetitions. The patient stood on a movable incline board, which gently stretched the calf musculotendinous unit. Subsequently, the exercises were performed with a slightly flexed knee to target the soleus muscle.³⁶ At long last, the patient kept up the position for 30-second, ten seconds rest in between, and one-minute rest between sets ¹⁶. Ankle pronation strengthening exercises were also performed against the red thera-band during the first two weeks since the peroneal muscles are the most muscles affected in CAI patients.³⁷ Four sets were performed with 10 repetitions per each set. The same works out were performed with the green thera-band at the taking after two weeks. At long last, in the final two weeks, these exercises were performed with the blue band. They held each exercise for 8-10 sec ¹⁷. During the supervised research facility rehabilitation sessions, subjects will participate in flexibility, strength, and balance exercises for around 30 minutes. The program will be dynamic and subjects progressed through the different stages. Except for the few bipedal errands (bipedal calf raise, carioca, and figure of eight), all therapeutic exercises will total on the included limb as it were. Supervised sessions will to be utilized to survey and progress the home exercise program as required to guarantee appropriate procedure and to preserve an appropriate level of trouble ¹⁸.

Statistical analysis

Data were screened for normality assumption, homogeneity of variance, and presence of extreme scores. Shapiro-Wilk test for normality showed that all measured variables were normally distributed, so repeated measure MANOVA was used to analyze these data. Statistical analysis was conducted using SPSS for Windows, version 20 (SPSS, Inc., Chicago, IL). The p-value was set at < 0.05.

Results

Effect of treatment on pain Comparison between groups

There was no significant difference in the mean values of pain pre treatment between the three groups ($p = 0.801$), while there was a significant difference post treatment between the three groups ($p = 0.001$) (Table 1).

Table 1
Mean value of pain pre and post treatment of the three groups

Pain	Pre	Post	MD	% of change	P-value	Sig
	$\bar{X} \pm SD$	$\bar{X} \pm SD$				
Group A	5.9 ± 1.35	1.2 ± 0.77	4.7	79.7%	0.001	S

Group B	6.1 ± 1.3	0.9 ± 0.7	5.2	85%	0.001	S
Group C	6 ± 1.25	3.7 ± 0.9	2.3	38.3%	0.001	S
f-value	0.223	30.8				
P-value	0.801	0.001				
Sig	NS	S				

\bar{X} : Mean

SD: Standard deviation

MD: Mean difference

p value: Probability value

S: Significant

NS: Non significant

Effect of treatment on balance

Comparison between groups

There was no significant difference in the mean values of overall pre treatment between the three groups ($p = 0.919$), while there was a significant difference post treatment between the three groups ($p = 0.001$) (table 2).

Table 2

Comparison between pre- and post-study mean values of balance among groups

Balance	Pre-study $\bar{X} \pm SD$	Post-study $\bar{X} \pm SD$	MD	% of change	P value	Sig.
Overall						
Group A	1.8 ± 0.9	5 ± 1.7	3.2	177.7%	0.001*	S
Group B	2 ± 1	10.6 ± 2.7	8.6	430%	0.001*	S
Group C	2.1 ± 0.99	2.2 ± 1.3	0.1	4.8%	0.889	NS
(F-value)	0.084	113.15				
(P-value)	0.919	0.001*				
Antero-posterior						
Group A	1.7 ± 0.8	4.9 ± 1.4	3.2	188.2%	0.001*	S
Group B	2 ± 0.8	5.5 ± 1.8	3.5	175%	0.001*	S
Group C	1.9 ± 0.7	1.91 ± 0.68	0.01	0.5%	0.987*	NS
(F-value)	0.378	45.6				
(P-value)	0.686	0.001*				
Medio-lateral						
Group A	1.36 ± 0.66	2.2 ± 1.2	0.82	60.3%	0.040*	S
Group B	1.4 ± 0.78	6.6 ± 1.9	5.2	371%	0.001*	S
Group C	1.68 ± 0.66	1.73 ± 0.67	0.05	3%	0.906	NS
(F-value)	0.394	95.03				
(P-value)	0.676	0.001*				

\bar{X} : Mean

SD: Standard deviation

MD: Mean difference

S: Significant

p value: Probability value

NS: Non significant *: significant

Discussion

This study was conducted to compare the effectiveness of WBV with BBS training in the treatment of CAI patients. According to the results, there was a

statistically significant difference in pain, function and balance after WBV and BBS training application, with BSS training being superior to WBV training in balance. To the author's knowledge, that is the first study comparing the effect of WBV and BBS training on postural sway control and dynamic postural stability in patients with CAI. As the results of this study came in agreement with ¹⁹, who revealed that using WBV training enhances dynamic postural control and increases the neuromuscular activity of sensory-motor system response among dancers with CAI. Our results were consistent with the results of (Sierra- Guzman et al.,2017), who said that a six-week unilateral balancing training program on uneven surfaces and a vibration platform has contributed to improving balance, joint position sense, and postural sway control in athletes with unilateral CAI ²⁰. Previously, it was also tested the effect of WBV training on elite female adolescent basketball population they found improving in functional strength, static, and dynamic balance skills ²¹.

Similarly, (Yeon et al., 2018) found that WBV stimulation with 10, 20, and 25 HZ frequencies is effective for ankle range of motion and balance abilities in adults with CAI ²², but the authors did not reveal a 50 HZ frequency effect as our study. Moreover, the activation of neuromuscular spindles and alpha motor neurons by the tonic vibration reflex leads to improving function, balance, and postural control ²³. The results of our study showed that was a significant improvement in postural sway control using WBV with opened and closed eyes in CAI patients. Such findings have been approved by (Baumbach et al.,2013) ²⁴. They tested the effect of a six-week WBV and functional treatment on unilateral unstable ankle sprains and they found enhancement of postural sway control in all directions, but they noticed also temporary hyposensitivity of the foot soles after the interventions. This finding is consistent with (Ritzmann et al., 2014) ²⁵.

Who stated WBV has an acute effect on postural sway control in the anterior-posterior direction in comparison to conventional balance training. WBV can be used to acutely enhance spinal hyperexcitability and muscle contraction, and modulate neuromuscular control during balance postural demanding tasks, especially with populations suffering from postural instability ^{26,27}. These results were in line with, (Akhbariet al., 2007) who concluded that the BBS exercise program decreased ankle musculature onset and peak latency, and improved dynamic postural stability in functionally unstable ankles ²⁸.

Limitations

Lack of blinding is seen as a limitation worthy of mention

Conclusion

WBV and Biodex balance training are effective modalities for treating CAI with superior effect of Biodex balance training.

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