Influence on Balance After Walking with Whole-Body-Vibration and Gluteus Medius and Anterior Tibialis EMG: a Pilot Study

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Influence on balance after walking with whole-body-vibration and gluteus medius and anterior tibialis EMG: A pilot study

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Abstract— **Studies indicate that whole body vibration (WBV) has an influence on muscle, causing a tonic stretch reflex. Studies evaluated the effects of WBV on the balance of healthy adults, but none of them used an intervention with a walk on the vibration platform. The aim of this study was to compare the balance, measured by means of a freeman disc with accelerometer, and the electromyographic activity (EMG) of the muscles gluteus medius and anterior tibialis before and after WBV. The pilot test was applied in only 1 volunteer, where 3 days of collection were performed within 1 week. The results suggest an increase in disc oscillation after WBV and EMG of muscles decreased after the intervention on the first day and an increase on the second and third day of collection. The result shows that whole-body vibration can influence the balance and electromyographic activity of the gluteus medius and anterior tibialis of a healthy adult, however, a longer-lasting protocol and more volunteers are needed to clarify its real effect.**

Keywords— **Whole body vibration, balance, vibration platform**

I. INTRODUCTION

Whole body vibration (WBV) can be seen negatively, as suggested by the review of Seidel and Heide (1986) [1], where a higher risk to the health of workers exposed to vibrations above 40Hz daily was found, and pathologies are more common in the central nervous system, musculoskeletal system, circulatory system and the female reproductive system.

However, before that, in 1966 they had already done the first study with humans in which a controlled vibration was applied to the muscular tendons and wombs, and generated a tonic stretch reflex response [2]. More than 40 years later, a study verified this reflex in knee extensor muscles during WBV, through electromyographic activity (EMG) [3].

In a study [4], which analyzed the acute effect of WBV on the balance and performance of healthy individuals and found no significant difference, but the EMG of the muscles analyzed decreased, the authors then interpreted it as a fatigue effect. The protocol was applied with the volunteers in different positions being standing, in a squat position, making small jumps, alternating the body weight from one leg to the other and standing under the heels [4]. The same group of researchers [5] did an 8-month training with the WBV, with the same positions and with the progressive increase in the frequency of vibration and exposure time, even so there was no difference in balance and performance, but there was improvement in vertical jump.

On the other hand, a study [6] that applied a 4-week training with 3 sessions per week of WBV verified improvement in balance and muscle endurance and there was a significative difference between the intervention and control groups, where the same protocol was used except for the WBV. The volunteers were instructed to stand in forefoot, with their heels off the ground and with their knees at 10° of flexion [6].

The platform used in the aforementioned studies [4,5,6] doesn't allow walking while receiving vibration. According to a review [7], the studies found indicate that WBV combined with exercise can promote muscle strength, power and flexibility. Important muscles are activated during gait, such as dorsiflexors, quadriceps femoris, hip flexors, hamstrings, plantar flexors and erector spinae[8], leading to the hypothesis that walking under a vibration platform can potentiate the stimulus for these muscles, even in a light intensity activity.

The gluteus medius (Gmed) and the anterior tibialis (AT) are muscles requested in the stabilization of the hip and ankle [9,10] and thus the present study sought to compare the EMG of the Gmed and AT before and after walking on the vibration platform uniaxial with parallel bar and whether this intervention improves the balance of a healthy adult.

II. MATERIALS AND METHODS

A. Sample

To adjust the methodology, a pilot test was applied with the author of the present study. The participant is female, 23 years old, 1.70m tall, with 60kg of mass, physically active and without any diagnosed musculoskeletal pathology.

B. Balance test

The balance was evaluated through a Freeman disk instrumented with accelerometer and Bluetooth communication, which sends the oscillation data to a dashboard on a computer. The test was applied with duration of 30s and interval, sitting in a chair, 2 min before and 2 min after each intervention. A support bar was used to prevent falls.

C. Electromyography: Gluteus medius and anterior tibialis

The electromyographic activity of Gmed and AT are collected during equilibrium tests before and after WBV. In The Gmed, the electrodes were placed in 50% of the line that goes from the iliac crest to the trochanter, with a distance between electrodes of 20mm following the direction of the muscle fibers. In AT, the electrodes were placed in 1/3 of the line between the tip of the fibula and the tip of the medial maleolo [11]. The device used to collect the electromyographic signals was the EMG System, SAS2000V12-wf, with 6 channels of capture of EMG signals, collecting the electrical signals generatedby the muscles, allowing the analysis of muscle activity during a task. Four devices of analog output communication of the electromyography apparatus was used, connected on pins 7, 8, 9 and 10. The electromyograph data is rectified and passes through a high pass filter with a cutoff frequency of 20Hz and a filter passes low with a cutoff frequency of 500Hz, at a sampling frequency of 1 kHz. The data were collected by the device's own software.

D. Vibration protocol

The intervention was made by means of a uniaxial vibration platform with parallel support bar (Fig 1), as in previous articles a standard for the intervention was not established and the platform was created for walking, which is a differential in relation to previous studies. The frequency of 20Hz and the amplitude of 5mm were used, with 4 series of 30s with 10s of interval, without going beyond the upper and lower limits of the volume established in other studies [7]. The volunteer was instructed to walk during vibration and be standing during breaks. The protocol was applied for 3 days, the first two days in a row and the last with an interval of 1 day.

Fig1. Vibrating platform with parallel bar

E. Data analysis

The data collected by the freeman disc and the electromyograph were analyzed using Microsoft Excel. First, the outliers were identified and removed, by means of the quartile function, calculating the 1st ($1Q$) and 3rd ($3Q$) quartile and the interquartile (IQ) value, qualified by the difference between the 1st and 3rd quartile. Equations were used to determine the upper and the lower limite of all EMG data collections.
The equation to the lower limite is (Eq. 1):

$$1Q-1{,}5\times IQ=min$$

The equation to the upper limite is (Eq. 2):

$$3Q+1{,}5\times IQ=max$$

Next, the means of the variables of velocity, distance, vertical amplitude X axis and horizontal amplitude Y axis of the oscillation of the disc of each collection, and the EMG of each muscle before and after each intervention, were arranged in graphs. It was also verified the relative frequency of the differences between the data before and after the intervention and calculate the averages of the percentages. Finally, the results of the equilibrium tests were compared before the intervention, between the 1st and 2nd day and then the 2nd and 3rd day. No statistical test was used by the limited number ofthe sample.

III. Results

A. Equilibrium

The balance was evaluated before and after each intervention with the WBV through the freeman disc with accelerometer. The means of these variables were compared using the graph (Fig2).

The percentages of difference between the variables before and after the intervention were calculated. On the first day, an increase of 15.17% in speed, 16.82% of distance, 29.10% of amplitude on the X axis and a decrease in Y axis amplitude of 19.87% were identified. On the second day of collection it was verified that there was an increase of 2.84% in speed, 14.70% of distance, 16.68% of amplitude on the X axis and 7.64% in y-axis amplitude. The average of the percentages of oscillation difference of each variable was determined and an increase of 11.86% speed, 7.08% distance, 26.55% amplitude in X axis and decrease of 0.19% in Y axis were found.

The relative frequency between the pre-intervention tests of the 1st and 2nd day showed an increase of 14.76% in speed, 13.08% in distance, 12.21% in X-axis amplitude and 7.66% decrease in Y-axis amplitude. From the 2nd to the 3rd day there was an increase of 20.68% in distance, 6.04% amplitude on the X axis and a decrease of 11.19% in speed and 16.38% in y-axis amplitude. from the 1st to the 3rd day showed an increase of 5.22% speed, 31.05% distance and a decrease of 2.17% of amplitude on the X axis and 1.15% of the amplitude in the Y-axis.

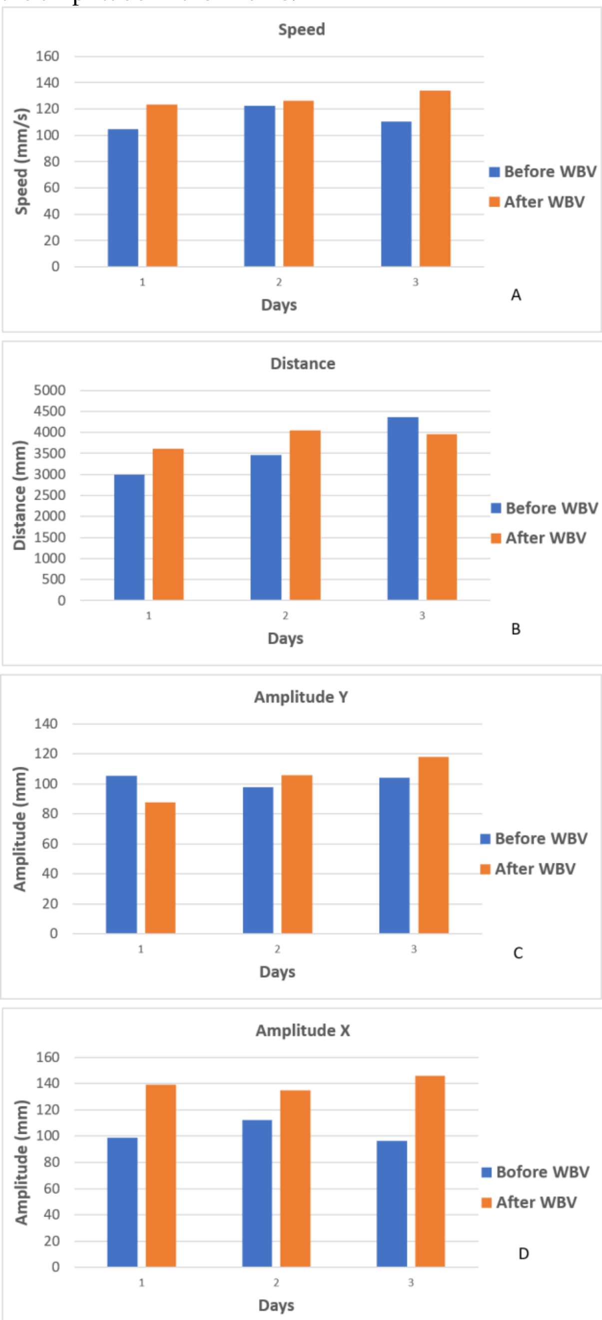

Fig2. Comparison charts of freeman disk oscillation before and after WBV in their respective days. A: oscillation speed; B: Oscillation distance; C: Amplitude of the oscillation on the Y-axis; D: Amplitude of the oscillation on x-axis.

B. Electromyography: Gluteus mediuus and anterior tibialis

EMG data of Gmed and AT muscles were collected by the electromyograph and sent to their software and were later analyzed by Excel. The outliers were checked and eliminated from the collection and then the mean of each collection of each intervention was verified, the average were compared through the graphs (Fig3 and Fig4).

The percentage difference before and after each intervention was calculated. On the first day there was a decrease of 85.31% of the EMG of the right Gmed, 14.58% in the right AT, 80.51% in the left Gmed and an increase of 4.21% left AT. On the second day there was an increase of 25.30% in the right Gmed, 49.90% in the right AT and a decrease of 34.46% in the left Gmed and 43.19% in the left AT. On the third day the data showed an increase of 75.38% in the right Gmed, 63.52% in the right AT, 9.98% in the left Gmed and 27.74% in the left AT.

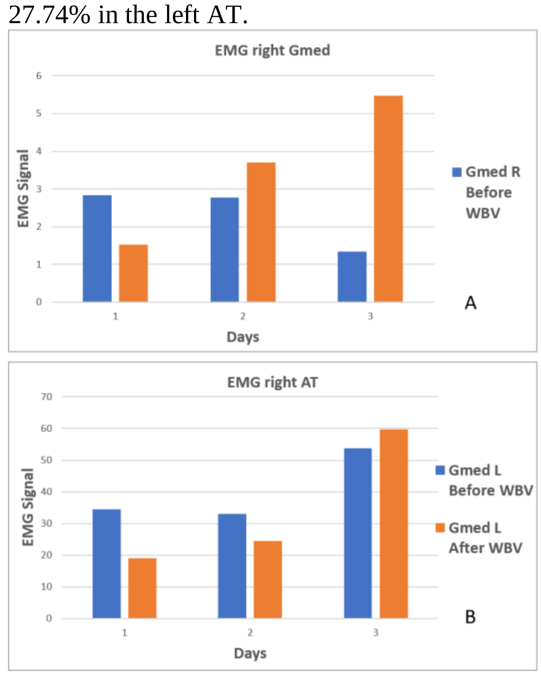

Fig3. Emg comparison charts between before and after the intervention of each day of collection. A: Gmed right; B: AT right.

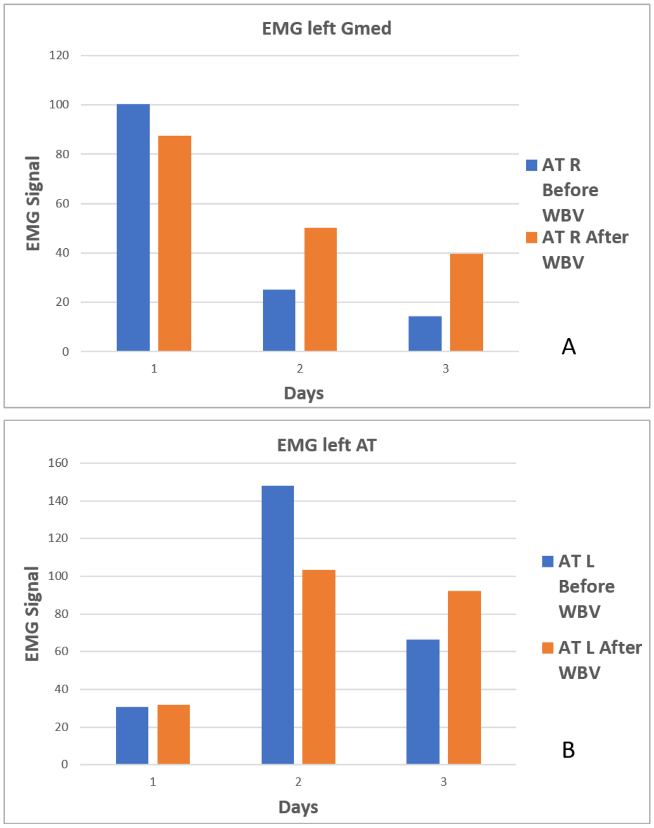

Fig4. EMG comparison charts between before and after the intervention of each collection day. A: Left Gmed; B: At left.

IV. Discussion

The present study was carried out in order to verify and improve the methodology to evaluate the effects of WBV in healthy adults, which brings us to the N of only 1 volunteer.

The results in relation to balance show an increase in the oscillation of the freeman disc after intervention, which leads us to believe that the balance worsens, especially if we look at the amplitude in the X axis, which presents us with the mid-lateral oscillation and had the highest percentage of difference between the pre and post intervention tests.

In the Review of Alam, Khan and Farooq[7], some articles found indicate neuromuscular fatigue after the intervention with WBV, which may have led to greater instability and consequently a greater oscillation of the volunteer in the disc. In this study, we can perceive more fatigue factors, such as the averages of EMG, which shows us on the first day that muscle activation decreased, especially in the glutes that are the hip stabilizers and are required during walking. However, this effect on EMG doesn't recur every day, on days 2 and 3, it is noted that after the intervention, most muscles presented a higher activation after WBV.

There is a study [6] that suggests the improvement in the balance of physically active adults with WBV, within a 4-week protocol, but more studies have been done [12,13] with the elderly and people with Parkinson's disease, who indicate an improvement in balance after WBV, however the results are not conclusive about the intervention being better than traditional treatments.

It is necessary that the protocol be applied for longer and in a larger N so that more consistent results can be analyzed.

V. CONCLUSION

The result of the pilot test shows that whole body vibration can influence balance and electromyographic activity of the muscles gluteus medius and anterior tibialis of a healthy adult, however, a longer-lasting protocol and more volunteers are needed to clarify its real effect.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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