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Vibratory Platform Effect of Kinetic-Functional Performance on Elderly Balance

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Abstract: The objective of the present study was to analyze the effect of exercises in active elderly performed on the vibratory platform, in relation to the balance indirectly, through the stimulation of the mechanoreceptors in order to prevent falls. A prospective experimental study was carried out with nine elderly individuals between 60 and 75 years of age, of both genders. It was initially assessed: Quality of Life, through the SF-36 Questionnaire; The equilibrium by means of the functional tests Timed UP and Go (TUG) and Berg Balance Scale (BERG); for the function of the mechanoreceptors the Joint Positional In Sence (JPS) and Proprioceptive Sensitivity Topognosia (PST) tests were used. They were submitted to ten exercises for lower limbs (LL), upper limbs (UL) and stretching over the Vibratory Platform (FIT4 VP-200), totaling ten sessions, performed twice a week. The results were described by average, standard deviation and percentages, using the Wilcoxon test to compare the BERG, JPS and SF-36 domains (VIT, AE and SM); for the TGSIA and the other domains of the SF-36, the t-Students test was used. Thus, it has been concluded that the exercises on the Vibratory Platform benefit the elderly by improving the muscular condition, through the performance in the mechanoreceptors, indirectly improving the balance and as a consequence the quality of life.

Keywords: *Vibratory platform, elderly, balance, proprioception, falls.*

I. INTRODUCTION

In Brazil the number of elderly (from 60 years of age) increased from 3 million in 1960 to 7 million in 1975 and 14 million in 2002 (an increase of 500% in 40 years) and is estimated to reach 32 million by 2025 , According to IBGE, making the country the sixth largest number of elderly in the world [1]. The process of senescence generates structural and functional changes throughout the organism. The suppression of several stages of postural control and the reduction of the compensatory capacity of the balance system predisposes the elderly to falls. It is a fact of epidemiological, economic and social relevance, since the consequence of falls is the main cause of the loss of independence and deaths in the elderly. Thus, it is important to understand the mechanisms of balance, making it possible to act effectively in the prevention of falls [2].

According to the International Classification of Functioning, Disability and Health (CIF), the balance depends on the interaction of three sensory systems: the vestibular system, responsible for the information about the position and movements of the head; the visual system, which informs the spatial position of objects in relation to our body; and the proprioceptive system, which controls posture and body movement. These three systems should always work in tune, otherwise the individual will present equilibrium problems [3].

The effects of vibratory training on muscular performance are obtained by stimulating a sensory system: stretching reflex or myotatic, activating the mechanoreceptors, facilitating the activation of muscle fibers of higher threshold, improving strength, power and performance in functional tests, modifying the gait pattern of the elderly and improving the balance [4]. When combined with muscle contractions, such as squatting exercises, the effects of the stimuli are even more intense [5].

Considering the presence of somatosensory alterations in elderly individuals and the importance of proprioceptive stimulation in favor of the maintenance of the balance, the objective of this study is to evaluate the effects of functional kinetic performance in the elderly undergoing the vibratory platform and its influence on balance and Quality of Life (QOL) of this population.

II. METHODS AND MATERIALS

This is an experimental, prospective and quantitative study, carried out at the Physiotherapy Clinic of the Positivo University (UP-PR), following the ethical principles for research, with favorable opinion No. 53933/12 of CEP-UP.

The included volunteers were those who met the following criteria: active elderly patients who received medical release for exercise on the vibratory platform. Exclusion criteria were: patients with pacemakers, patients suffering from severe cardiac or vascular diseases, patients with severe herniated disc, people in the post-operative or infectious recovery phase, wearers of hip or knee prostheses, bearers of pins, screws or metal plates, epilepsy, acute migraine, those bearing tumor and pathologies that may cause physical limitations. The participants were informed of the possible risks, discomforts and benefits of the study and all signed the Informed Consent Form.

The study population consisted of 9 patients of both genders, aged between 60 and 75 years. The SF-36 (Medical Outcomes Study questionnaire Short Form 36 translated) [6] was applied, which presents eight domains directly related to the individual's health: Functional Capacity (FC), Physical Appearance (PA), DOR, General Status (GE), Vitality (VIT), Social Aspect (SA), Emotional Aspect (EA), Mental Health (MH). The questionnaire was applied before and after the intervention. Each domain presents its score and the higher the score the better the quality of life. Functional tests were also applied (recorded on video):

1. Timed Up and Go (TUG): evaluates functional mobility, balance, gait, motor coordination and risk of falls [7,8];

2. Berg Balance Scale: determines the risk factors for the loss of independence and falls with a maximum score of 56 points [9].

The physical tests performed were:

1. Proprioceptive Sensitivity Topognosia (PST): evaluates the tactile sensitivity. This is applied in the dominant upper limb (MS) with the objective of evaluating the effect of the platform on the receptors of the whole body, since the effects of vibration are more effective in the regions near the base of vibration [10].

2. Joint Positional in Sense (JPS): evaluates knee proprioception, clinically defined as the ability to reproduce joint angles, since muscle receptors contribute to proprioceptive information.

After the initial evaluation, the experimental protocol developed by the researchers was applied, consisting of ten exercises, including six isometric and four dynamic, on the vibratory platform model FIT4 VP200. Oscillation amplitude selected was the low, approximately 1 ~ 2 mm. The variations of resting time and vibration frequency were determined [11], and divided into steps as shown in Table 1.

TABLE I. DESCRIPTION OF THE TRAINING PROTOCOL USED.

Vib . Freq→ Rep. time↓	30 Hz	40 Hz	45 Hz
60s rep.	1º session	4º session	7º session
30s rep.	2º session	5º session	8º session
15s rep.	3º session	6º session	9º e 10º session

In the first three sessions, only isometric and stretching exercises were performed for adaptation. In the other sessions, isometric, dynamic and stretching exercises.

Descriptive statistics were used for the analysis of the data by means of average and standard deviation. The normality of the data was verified through the Shapiro-Wilk test, which indicated that the data can be considered as having normal distribution.

The Wilcoxon test was used to compare the paired scores on the BERG Balance Scale, JPS, and the AF, VIT and AE domains of the SF-36. For the other tests and domains the t-Student test was used. The level of significance used for all tests was 5% ($p < 0.05$). For the statistical calculations of all analyzes the Statistica® 7.1 program for Windows® was used.

III. RESULTS

The sample consisted of 9 (nine) active individuals (67% female and 33% male), average 67.33 years of age. Among the participants, 77.77% reported muscle weakness; Pain in the knees, back, in the muscles in general, difficulty getting down, getting up from the chair and sleeping.

The participants reported to begin noticing the beneficial effects of the vibratory platform from the 4th session onwards, among them: relief of pain, body lightness, ease of walking, improvement of sleep (more relaxing), discontinuation of sleeping medication, possibility to wear shoes - what was not possible before due to the pain - cramp relief, paresthesia, better humor and corporal posture. It was also observed that frequencies of 35Hz and 40Hz with resting times of 30s and 15s, produced sweating and increased respiratory rate, which at the end of the exercises quickly returned to normal. This has been observed within the SF-36 domains that presented statistical significance (FC and MH). Nevertheless, the percentiles obtained in the other domains, associated with the clinical references reported by the subjects, are also relevant as described in Table 2.

TABLE II. DOMAINS OF THE SF-36 QUALITY OF LIFE QUESTIONNAIRE (AVERAGE Ø, STANDARD DEVIATION Σ, PERCENTAGE % & SIGNIFICANCE P).

SF-36 Domains	Before Ø (σ)	After Ø (σ)	Percentage	Sig (p)
Functional Capability (FC)	61,11 (±26,3)	78,33 (±18,2)	28%	< 0,02
Physical Aspect (PA)	80,56 (±34,9)	86,11 (±22,0)	7%	> 0,86
Dor (DOR)	51,44 (±30,8)	70,78 (±22,6)	38%	> 0,069
General State (GS)	79,00 (±15,5)	77,56 (±17,9)	-2%	> 0,73
Vitality (VITAL)	68,33 (±17,0)	76,67 (±16,4)	12%	> 0,097
Social Aspect (SA)	72,33 (±24,0)	79,33 (±10,8)	10%	> 0,30
Emotional Aspect (EA)	74,11 (±36,5)	92,67 (±14,6)	25%	> 0,11
Mental Health (MH)	68, 44 (±11,0)	82,67 (±13,3)	21%	< 0,012

Functional tests showed important percentage results, since the individuals in the sample were active, as shown in Table 3.

TABLE III. FUNCTIONAL TESTS (AVERAGE Ø, STANDARD DEVIATION Σ, PERCENTAGE % AND SIGNIFICANCE P).

Functional Tests	Before Ø (σ)	After Ø (σ)	Percentage	Sig (p)
BERG Scale	53,9 (±2,4)	55,4 (±1,0)	3%	> 0,06
TUG 1	8,38 (±2,2)	7,5 (±1,9)	-11%	> 0,21
TUG 2	9,04 (±2,4)	8,54 (±2,4)	-5%	> 0,5

The PST physical test presented statistical significance (p = 0.014), the JPS test was not significant; however, there was a tendency for improvement in the percentage of -21%, as shown in Table 4.

TABLE IV. PHYSICAL TESTS (AVERAGE Ø, STANDARD DEVIATION Σ, PERCENTAGE % AND SIGNIFICANCE P).

Physical Tests	Before Ø (σ)	After Ø (σ)	Percentage	Sig (p)
JPS	9,6 (±5,2)	7,55 (±6,8)	-21%	> 0,37
PST	3,7 (±1,6)	1,8 (±0,8)	-51%	< 0,014

IV. DISCUSSION

In the elderly, coordination, balance and neuromotor reflexes gradually decrease, making it difficult to perform simple tasks, thus compromising their autonomy and independence. Physical activity minimizes declines in aging, prevents falls, increases functional capacity, increases muscle strength, endurance, and balance [12].

Several studies that contemplate vibratory platform exercises associate squatting exercises. This association seems to intensify the neuromuscular responses through the activation of the vibratory tonic reflex, increasing the synchrony of the motor units and providing greater neuromuscular efficiency [13].

Results demonstrated in Table 2, referring to the SF-36 Questionnaire:

- The FC Domain: with statistical significance (p = 0.02), it was verified that the vibratory platform acts on the increase of muscular blood circulation;
- decreases arterial resistivity due to reduced blood pressure;
- increases the peak of isokinetic torque, heart rate, flexibility and muscle power, observed by the of the pain relief and improvement of physical condition referred by the participants as clinical evidence: lightness, decrease of fatigue, ease of climbing stairs, cramps relief and paresthesias.

These results come from the intervention of the vibration on the muscles, by facilitating the activation of the stretching reflex, increasing the neural support to the alpha motoneurons of homonymous and synergistic muscles, besides inhibiting the action of the alpha motoneurons of the antagonists [14].

Increases in the AE (25%) and SM (p = 0.012) domains demonstrate the relationship of physical effects associated with improved (more relaxed) sleep and mood, as reported by participants. This finding is due to the hormonal release that the vibration could provide, mainly by the increase of testosterone and growth hormone (GH) and decrease of the cortisol, responsible for stress, which alone would already bring benefits to anxieties and tensions [15].

No statistical significance was observed in the other SF-36 domains, such as PA, DOR, EG, VIT, SA, EA, and may be related to the short intervention period (10 sessions) and to the sample number [16]. However, with the exception of EG, all domains showed a percentage increase, which indicates improvement in the quality of life related to the same.

Muscle proprioceptive stimuli may alter the pattern of intramuscular coordination, facilitating movement around the vibration-stimulated joint. This is due to the fact that muscle spindles are sensitive to changes in the length of muscle fibers [17]. The results obtained in the physical test PST (p = 0.014) show that vibration acts on the mechanoreceptors of the whole body, since it was performed in the UL, providing the effects reported by the participants and observed in the results, favoring the greater agility reported, thus improving the balance and consequently the quality of life.

In this study, it was verified that the TUG and BERG functional tests for active individuals tend to the highest score, since all individuals scored on the maximum cut line. This demonstrates the need for more sensitive and specific tests, such as QuickScreen, Strength and Balance Platform to assess gait, balance, independence and risk of falls.

Corroborating the parameters used in the present study, clinical trials confirm that in order to obtain benefit, the vibration protocols evaluated in the elderly should have a frequency between 12.6Hz and 60Hz with amplitudes ranging from 55 μm to 8.31mm, with the duration of the intervention being Range from 30 seconds to 10 minutes, intervention period from 4 to 48 weeks [18]. Thus, studies with low frequencies and amplitudes of vibration show positive effects in the training and rehabilitation of the physical capability of individuals.

V. CONCLUSION

According to the results obtained, it has been concluded that exercises on the vibratory platform can be an important stimulus for the neuromuscular system, benefiting the elderly for the short duration of the session, with improvement of the muscular condition indirectly favoring the balance and consequently the quality of life. A promising intervention in the prevention of falls.

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