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ORIGINAL RESEARCH

ANALYSIS AFTER STABILOMETRIC PROPRIOCEPTIVE EXERCISES: A RANDOMIZED CONTROLLED CLINICAL STUDY

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ABSTRACT

Objective: identify stabilometric changes before and after a program of proprioceptive training. **Methods**: a randomized controlled clinical trial was conducted with 18 subjects, mean age 20.6 ± 2.1 years of age, of both sexes, with a mean body mass index 23.3 ± 5.4 kg/m² that were evaluated in stabilometric platform before and after a program of proprioceptive training using the equipment and proprioceptive hard rocker, and divided into proprioception (n = 10) and control group (n = 8) group. The proprioceptive training consisted of 10 measures with one foot, knee in semiflexion for 30 seconds twice a week for five weeks using the rocker apparatus and proprioceptive disc. **Results**: D'Agostinotests were performed to test the normality, to which it was noted that the study sample was obtained normal behavior for both groups: proprioception and control, was used the Student t-test for observation the significance of p value (<0.05). At the end of the intervention subjects were reassessed at stabilometric platform on which it was observed that the proprioception group there was a significant reduction in body sway in relation to the control group (p = 0.002). **Conclusion**: the short time, with oneleg proprioceptive training has been shown to be effective for improving balance by reducing body sway.

Key words: postural balance. exercise therapy. evaluation of results therapeutic interventions.

INTRODUCTION

Body balance is essential to human's spatial relationship with the environment. This relationship becomes possible through the integration of three main systems: proprioceptive sensitivities, the vestibular system and vision. Together, these systems interact to stabilize body posture through the sensory information of the musculoskeletal system structures.[1,2] To maintain body balance the sum of the acting forces must equal to zero. However, this situation is hardly ever obtained, because they are influenced by physiological factors, such as breathing, heart rate, venous return, age, physical condition, clinical status, and so forth.[3]

Thus, the neural information from the joints, muscles, tendons, ligaments and capsules are recognized through afferent pathways of the central nervous system (CNS), either consciously or unconsciously influencing muscle tone, motor programs, coordination, muscle reflexes, joint stability and postural balance. This system is called proprioception, and it can benefit from specific exercises for improving the effectiveness of contraction, strength, and muscle reaction time that in turn affect motor coordination, balance and prevent injury[4-6].

Stabilometry is among the resources used to assess postural balance, which enables the discrimination of different behaviours in different diseases, and analyses body sway in healthy subjects to correlate it with possible clinical changes[7]. The evaluation is made by quantifying postural sway in a standing position on a force platform; this is accomplished by monitoring pressure centre shifts in lateral and anterior-posterior directions. It can be assessed bipedal or unipedal. However, this analysis is a recent technology, and few studies have reported its use[2,8].

Given the high number of injuries arising from proprioceptive deficits and considering the rising incidence of injuries by delayed motor response, there is a need for observation techniques to speed up the mechanoreceptor response, which helps proprioceptive control and prevents injury. Thus, the goal is to propose a static proprioception exercise program, considering the oscillatory behaviour and displacement of the body's centre of mass, during pre- and post-training.

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METHODS

This research was approved by the Research Ethics Committee of the State University of Midwest, Opinion No. 223,638/2013. This is a controlled clinical randomized study, whose sample was selected for convenience in Integrated Clinical Guairacá in Guarapuava, Paraná - Brazil. We included individuals of both sexes aged 18-25 years. Pregnant women and individuals with histories of musculoskeletal or neurological injuries, vestibular or cerebellar changes, or adverse conditions of equilibrium were excluded. Thus, 18 subjects were randomly assigned into 2 groups (Table 1): (1) a proprioception group, composed of 10 subjects; and (2) a control group with 8 individuals. All volunteers signed a consent form, according to the rules of the National Board of Health, and met the demands of Resolution No. 466/2012.

Initially, all subjects underwent stabilometric assessments to obtain the values of body sway. For stabilometric assessment we used a *FootWork 1st Informatic* platform. The volunteers were told to begin from a neutral position with bipedal support and to remain motionless, fixating their eyes and mouth half-open for 30 seconds (Figure 1A).

After stabilometric evaluation, proprioception group was subjected to a program of 10 proprioceptive training sessions in the rocker and proprioceptive disc (Figures 1B and 1C) twice a week for 5 weeks totalling 10 interventions. In each session, subjects performed the workout with five repetitions of 1 minute and 30 seconds. The control group performed the same procedures as the proprioception group but without the proprioceptive interventions. The day after the end of intervention the 2 groups were reassessed using the stabilometric platform.

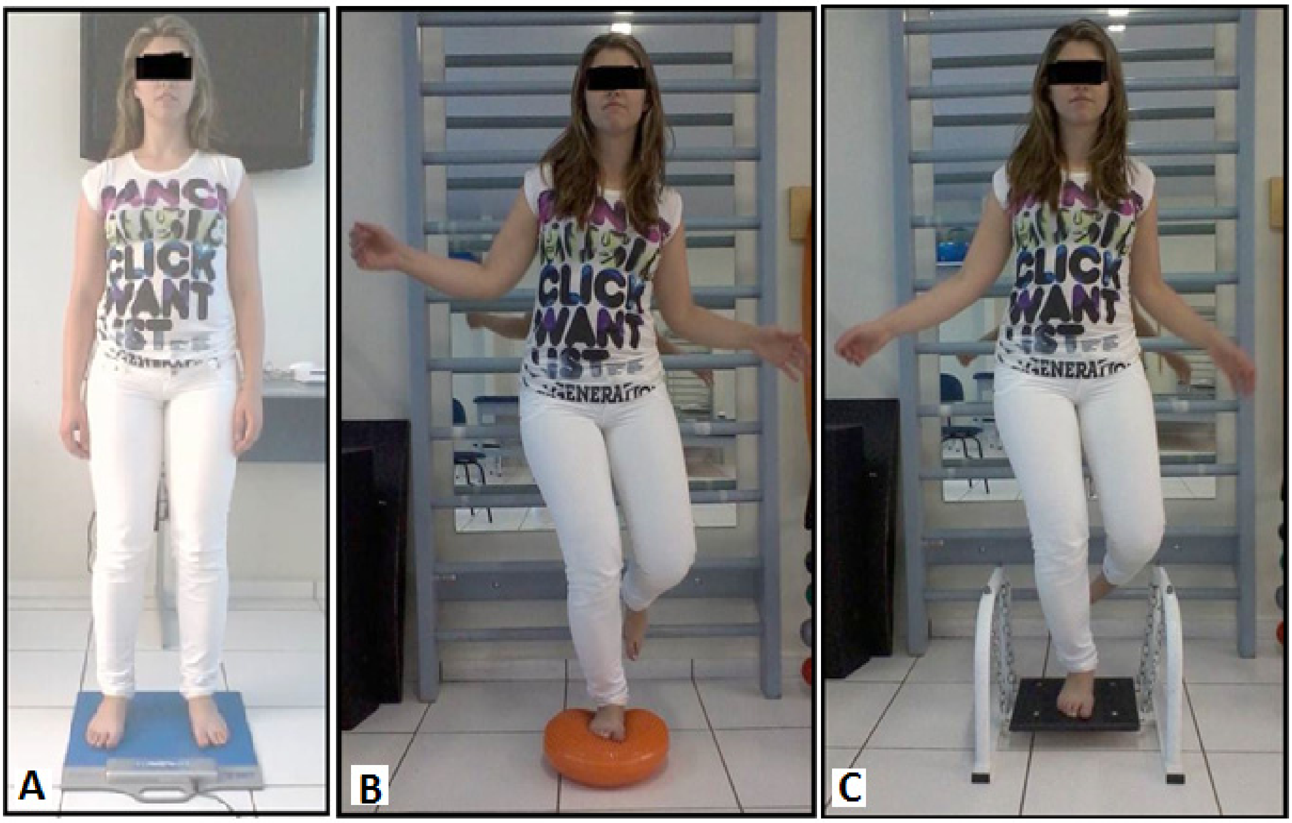

Figure 1. Positioning for stabilometric assessment (A). Proprioceptive training (B, C).

RESULTS

To present the results, we have used descriptive statistics, considering the means and standard deviations of the oscillations of the body's centre of mass pre- and post-intervention and comparing both groups. For statistical analysis, we used the BioEstat 5.3 software*.* To test the normality of the data, we used the D'Agostino test and, as both groups were normally distributed, we used the student t-test to obtain significance, considering a p-value of $p < .05$.

The results of the individual anthropometric values are in Table 1 below.

DISCUSSION

Proprioceptive training is a useful tool in clinical practice. We can demonstrate through literary analysis that it is a useful tool for improving the centre of mass oscillations.[3] Body balance is difficult to observe, and there are still no conclusive studies to clarify the best and most efficient posture, since the position is complex and is influenced by various entree routes.[3,9] One way to look at this balance is with stabilometry, which is an excellent methodology to measure the oscillation of the centre of body mass and the resulting balance deficit in reviews with one foot as bipedal.[10]

Table 1: Anthropometric values of the sample results

	Proprioception (n = 10)	Control (n = 8)	p-value
Sex (M/F)	2/8	1/7	.6930
Age	20.6 ± 2.1	21.5 ± 1.3	.3009
Height (cm)	166 ± 7	168 ± 9	.6655
Mass (kg)	61.8 ± 6.8	66.0 ± 12.8	.3834
BMI (kg / m²)	23.3 ± 5.4	26.6 ± 9.0	.3531

Chart 1 shows the body sway values †of the proprioception group and the control group. Note that the proprioception group showed a significant reduction in the mass centre of oscillation (in cm^2), $p < .002$. Even though the control group shows an increase in body sway, it was not significant ($p < .059$).

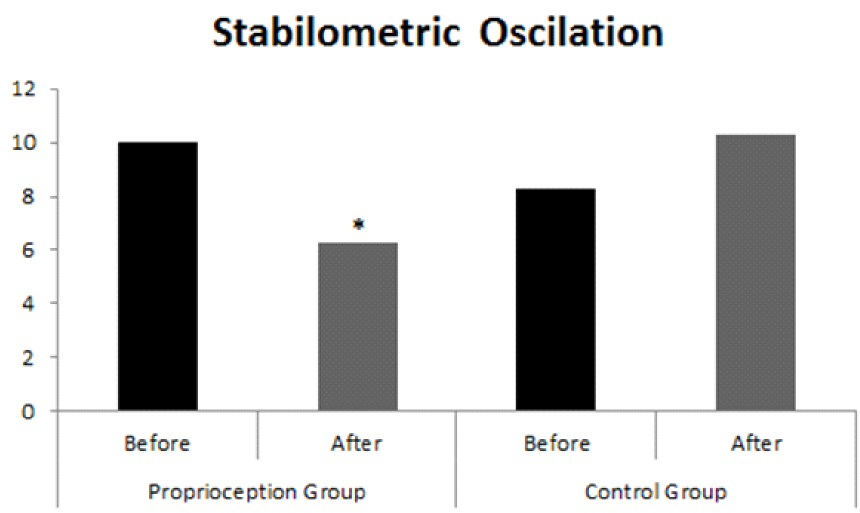

Figure 2. Body sway of proprioception group and the control group.
*significant difference

As the balance of a bipedal stance is more stable than with a single leg, we observed significant difference between them. That is, in unipedal fluctuations it is more difficult to maintain body balance, as there is a decrease in the support area. In conditions such as this, the body creates an imbalance by reducing its support base.[8] It was observed that the group that submitted to the proprioceptive training reduced their fluctuations; in stabilometric assessment of the control group, however, this study did not aim to compare the bipedal support with the single leg. It was also observed that even the individuals performing the training in one-leg form generated body stability in a bipedal balance, probably because, despite being only a single leg training, the CNS operates generally for balance and body posture correction and is an interconnected network. So, if a member is trained, the body receives afferent and efferent motor responses, which thus contribute to the control of upright posture and the maintenance of body balance.

When it comes to athletes, proprioceptive training is fundamentally important, because it enhances the uptake of postural control information, preventing the recurrence of lesions both in athletes and in non–athletes.[11] In addition, proprioceptive exercises can be used effectively for assessment, treatment, and prevention of injuries, while demonstrating high relevance in the maintenance of postural balance and coordination. Providing both short and long term effects, it requires greater sensory and kinaesthetic response to joint position, possibly improving athletic performance and facilitating sports practice.[4,5,12]

Furthermore, proprioceptive information protects joints from damage caused by movement exceeding the physiological range of motion, and thus it is effective in reducing lesions.[13,14] Although there were similar short-term results in non-athletes,the effects of long-term training were not considered. It is believed that the decrease of stabilometric oscillation after proprioceptive training is justified by the optimization of efferent vias due to efferent stimuli generated by proprioception and rocker disc.

Among the resources used for the proprioceptive training is a proprioceptive disk, a useful tool in training to reduce body sway that stimulates the various structures responsible for postural control.[3,9] In this study, the proprioceptive training using the proprioceptive disk proved to be effective in improving body sway and an important resource as a proprioceptive stimulus, but its use was associated with other equipment, the rocker.

Regarding the muscles used during the training with the proprioceptive disk, the electromyographic evaluation demonstrated activity in the tibialis anterior, posterior tibia, medial gastrocnemius, and peroneus longus and lateral. This activity is greater when maintaining one foot in appliances that generate instability than maintaining one foot on a stable surface. This is due to the increase in body oscillations that increase joint, ligament, and muscle movements, stimulating mechanoreceptors faster than the stable base[15] Even though the group that performed the proprioceptive training reduced the oscillations, we did not evaluate the muscles activity. It is believed that there was an increase, but the purpose of the study was to evaluate the oscillatory movement and not muscle activity.

Among the intrinsic factors that may influence postural control is fatigue, which can increase generation of a neuromuscular response in an attempt to overcome the instability caused by fatigue. Thus, postural control assessments should not be taken after physical activity.[16] As the control group did not perform prior physical activity, the group is credited with increased fluctuations due to extrinsic forces acting on the balance, which hinders the body's to maintain the zero sum of forces acting on it.

In addition, the lack of stimuli from mechanoreceptors in the practices of daily life or the non-operation of proprioceptive training, which consequently fail to send the proprioceptive information to the CNS, may cause an increase in joint instability, leading to weakness of the stabilizing muscles and generating an exacerbated body sway. Furthermore, proprioceptive training becomes effective and beneficial when done, because the stimulus is memorized in somestetic areas of the cerebral cortex, and this mechanism functions as a learning tool for practitioners, decreasing the body's oscillations.[15]

This study was limited to a convenience sample of young adults in Guarapuava, Paraná, and the acute evaluation of the effect of proprioceptive training. Furthermore, the small number of subjects reduces the power of the statistical analysis. We suggest continuing the study; the results of this research can be used to recalculate the sample and diversify times and proprioceptive training periods as well as conduct follow-up studies to evaluate medium and long-term effects of training.

CONCLUSION

We conclude that in the short term, the proposed proprioceptive unipedal training, through the exercises in the balancer and proprioceptive disk static form for 30 seconds, have been shown effective for improving proprioceptive control and reducing oscillatory displacement of the body centre of mass.

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RESUMO

Objetivo: identificar as alterações estabilométricas antes e após um programa de treinamento proprioceptivo.**Métodos:** um estudo clinico controlado randomizado foi realizado com 18 indivíduos, com idade média de 20,6 ± 2,1 anos de idade, de ambos os sexos, com índice de massa corporal médio de 23,3 ± 5,4 Kg/m², que foram avaliados na plataforma estabilométrica antes e após um programa de treinamento proprioceptivo, utilizando os aparelhos balancim e disco proprioceptivo,e divididos em grupo propriocepção (n = 10) e grupo controle (n = 8). O treinamento proprioceptivo foi composto de 10 intervenções com apoio unipodal, em semiflexão de joelho, durante 30 segundos,duas vezes por semana, durante cinco semanas, utilizando os aparelhos balancim e disco proprioceptivo. **Resultados:** foram realizados testes de D'Agostino, para testar a normalidade, ao qual observou-se que a amostra estudada obteve comportamento normal para ambos os grupo: propriocepção e controle, de tal forma que utilizou-se o teste T-Studentpara observação da significância do valor de p (<0,05). Ao término das intervenções os indivíduos foram reavaliados na plataforma estabilométrica na qual observou-se que no grupo propriocepção houve uma redução significativa da oscilação corporalem relação ao grupo controle (p = 0,002). **Conclusão:** a curto prazo o treinamento proprioceptivo unipodal demonstrou-se eficaz para a melhora do equilíbrio com a redução das oscilações corporais.

Palavras-chave: equilíbrio postural. terapia por exercícios. avaliação de resultados de intervenções terapêuticas.