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Research Article

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Importance of Strength Training in Elderly Diagnosed With Unilateral Osteoarthritis in Postural Stability And Fall Risk Prevention

Marcel El Andere[1], Pedro Henrique Vieira Partata[1], Matheus Brito Rocha[1], Haroldo Bandeira de Matos Filho[1] and Fernanda Grazielle da Silva Azevedo Nora[2*]

[1]Department of Orthopedics and Traumatology, Hospital Municipal Antonio Giglio - Osasco/SP, Brazil

[2]Faculty of Physical Education and Dance, UFG – Universidade Federal de Goiás, Goiânia, Avenida Esperança s/n, Campus Samambaia, Goiânia, Goiás, Brazil

[*]Corresponding Author
Fernanda Grazielle da Silva Azevedo Nora, Faculty of Physical Education and Dance UFG – Universidade Federal de Goiás, Avenida Esperança s/n, Campus Samambaia, Goiânia, Goiás, Brazil Orcid: 0000-0002-0880-1326

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Abstract

Unilateral knee osteoarthritis is a common condition in the elderly that can compromise postural control and increase the risk of falls. This study investigated the effects of strength training on postural control in elderly individuals with this condition. Forty participants were assessed, divided into a strength training group (STG) and a sedentary group (SG). The results showed that the STG had a lower Center of Pressure (COP) oscillation amplitude and reduced COP displacement area compared to the SG, both with eyes open and closed. These findings suggest that regular strength training may improve postural control in elderly individuals with unilateral knee osteoarthritis, thus contributing to reducing the risk of falls in this population.

Keywords: Strength Training, Postural Control, Unilateral Knee Osteoarthritis, Elderly, Fall Prevention

Introduction

Osteoarthritis (OA) is a common degenerative condition that predominantly affects the joints, resulting in pain, stiffness, and decreased motor function, especially in the elderly. This condition can be particularly debilitating when it occurs unilaterally in the knee, exacerbating postural imbalance and increasing the risk of falls. Falls in the elderly represent a critical problem due to the potentially serious consequences for health and quality of life [1,2]. Strength training has been widely recognized as an effective intervention to improve postural stability and reduce the risk of falls in the elderly.

Recent studies show that regular practice of weightlifting exercises not only strengthens the muscles but also improves proprioception and coordination, essential elements for maintaining balance [3,4]. A study published by Mikesky et al. demonstrated that resistance programs significantly increase muscle strength in the elderly with knee OA, resulting in improvements in physical function and balance [5]. Particularly in the elderly diagnosed with unilateral knee osteoarthritis, strength training can offer additional benefits, acting directly on the specific deficiencies caused by the condition. By strengthening the muscles around the affected joint, it is possible to improve load distribution and minimize the impact of mechanical imbalance, thus contributing to better postural stability [6].

A study by Tanaka et al. found that a 12-week strength training program significantly improved muscle strength and physical function in the elderly with knee OA, suggesting that such programs may be essential for conservative management of the disease [7]. In addition, the inclusion of strength exercises in the rehabilitation program of these individuals can have positive effects in reducing pain and improving joint functionality, promoting greater independence in daily activities and, consequently, a better quality of life [8]. Fransen et al. reviewed several studies and confirmed that resistance exercises are effective in reducing pain and improving function in patients with knee OA [8].

In this context, the assessment of bipodal postural control emerges as a valuable complementary tool for the non-surgical conservative treatment of the elderly with unilateral knee osteoarthritis. The analysis of postural control can provide detailed information about the balance and stability of patients, allowing a more personalized and effective approach in planning and executing strength training programs [9].

A study conducted by Lim et al. showed that postural assessment can detect subtle imbalances that may not be apparent in routine clinical evaluations, underlining its importance as a diagnostic and monitoring tool [10]. Given this context, the objective of this article is to analyze the bipodal postural stability of the elderly who practice weightlifting to prevent the risk of falls.

2. Methodology

The study was approved by the Research Ethics Committee in Human Beings of the Federal University of Goiás (UFG), as determined by Resolution No. 466 of December 12, 2012, under number 6.232.443.

2.1 Participating Subjects

Forty subjects of both sexes participated in the present study, divided into two groups. The first group (GS) was composed of sedentary elderly, diagnosed with unilateral knee osteoarthritis, who did not perform physical activity, with an average age of 65 years. The second group (GP) was formed by elderly diagnosed with unilateral knee osteoarthritis, practitioners of weightlifting for at least one year, also with an average age of 65 years.

2.2 Experimental Procedures

During bipodal postural control, the magnitudes of the vertical component of the ground reaction force and the behavior of the center of pressure (COP) were measured by a force platform EMEGSYSTEM BRASIL model Biomec 400. Before the start of the procedure, the subjects received a detailed explanation about the research and had their personal data collected, including name, age, weight, height, and time of practice of weightlifting. Then, the participants performed three attempts of 60 seconds each in two conditions: eyes open and eyes closed.

Eyes Open: Initially, the subjects performed three attempts of 60 seconds each, standing in the bipodal position on the platform, looking in a fixed direction, and without moving. There were rest intervals of approximately 30 seconds between each attempt. Participants were instructed to report if they felt any discomfort, such as dizziness or anxiety, so that the collection would be interrupted.

Eyes Closed: In the second condition, the subjects repeated the procedure, but with their eyes closed, again for 60 seconds in three attempts. The same instructions and care regarding discomfort were maintained.

2.3 Variables Analyzed

A code was developed in a Matlab environment (Mathworks version 12) to calculate the center of pressure and the variables of interest. The raw data from the force platform were collected at a frequency of 100 Hz per channel and filtered with a fourth-order low-pass Butterworth filter with a cutoff frequency of 5 Hz.
The variables analyzed were:

• Oscillation Amplitude of the COP in the anteroposterior (COPAP) and mediolateral (COPML) directions, in centimeters.

• COP Displacement Area, in square centimeters. The calculations of the variables related to the behavior of the COP followed methods described in more recent studies to ensure the accuracy and relevance of the analyses.

• The displacement amplitude of the COP was calculated by the distance between the maximum and minimum positions in the mediolateral and anteroposterior directions. The displacement area of the COP was calculated by the elliptical area of oscillation of the COP during the support base (support base of bipodal control). The methods used are based on updated references, such as Lafond et al., Ruhe et al., Hufschmidt et al., and Pasciuto et al., which provide a solid and updated basis for the analysis of the behavior of the center of pressure [11-14].

2.4 Statistical Analysis

The statistical analysis was performed using SigmaPlot 12.0 software (Systat Software Inc). After verifying the normality of the distributions and the homogeneity of the data through the Shapiro-Wilks test, non-parametric Kruskal-Wallis tests with Dunn's post-hoc were applied to verify differences between the three groups for the selected variables. A significance level of 5% ($p \leq 0.05$) was used. The variables are presented as mean values.

3. Results

In the present study, bipodal postural control, with open and closed eyes, was compared between two groups of subjects. One group of elderly diagnosed with unilateral osteoarthritis and sedentary (GS) and a group of elderly with unilateral knee osteoarthritis practitioners of weightlifting (GP), both with an average age of 65 years. Table 1 and Table 2 present the displacement amplitude of the COP in the anteroposterior (AP) and mediolateral (ML) directions during bipodal postural control, with open and closed eyes.

Conditions	Variables	GP	GS	P Value
Open Eyes	COPAP (cm)	0.22	2.82	P < 0.001*
Closed Eyes	COPML (cm)	0.40	1.41	P < 0.001*

Data are expressed as mean. *Significant post Dunn's test (p <0.05).

Table 1: Displacement amplitude of the COP during postural control open eyes

Conditions	Variables	GP	GS	P Value
Closed Eyes	COPAP (cm)	0.43	2.69	P < 0.001*
Open Eyes	COPML (cm)	0.29	1.19	P < 0.001*

Data are expressed as mean. *Significant post Dunn's test (p <0.05).

Table 2: Displacement amplitude of the COP during postural control closed eyes

The displacement area of the Center of Pressure (COP) during bipedal postural control, with eyes open and closed, is presented in Table 3.

Conditions	Variables	GP	GS	P Value
Open Eyes	Area (cm²)	1.09	2.01	P = 0.008*
Closed Eyes	Area (cm²)	0.89	1.34	P = 0.008*

Data are expressed as mean. *Significant post Dunn's test ($p < 0.05$).

Table 3: Displacement area of the COP during postural control open and closed eyes

For the displacement area of the COP during bipodal postural control with open eyes, the GP group presents statistically lower values than the GS group ($p = 0.008$). However, when comparing the same group during bipodal postural control with closed eyes, no statistically significant differences were observed.

4. Discussion

The results of this study indicate that the group of elderly practitioners of weightlifting (GP) presented a better postural control compared to the group of sedentary elderly (GS), both with open and closed eyes. This finding is consistent with previous studies that highlight the benefits of regular physical exercise, especially weightlifting, in postural control and in reducing the risk of falls in the elderly.

Table 1 shows that the GP group presented a significantly lower displacement amplitude of the COP in the anteroposterior (COPAP) and mediolateral (COPML) directions compared to the GS group during bipodal postural control with open eyes. Specifically, the COPAP values were 0.22 cm for GP and 2.82 cm for GS, while the COPML values were 0.40 cm for GP and 1.41 cm for GS. These results suggest that the practice of weightlifting can improve postural stability, probably due to the strengthening of the muscles and the improvement of proprioception.

This finding is corroborated by a recent study that reports that strength training programs are effective in improving muscle function and postural stabilization in the elderly [15]. In addition, Granacher et al. observed that resistance exercises can improve postural control and neuromuscular function in older individuals [16].

Table 2 indicates that, even with closed eyes, the GP group maintained a lower displacement amplitude of the COP in both directions compared to the GS group. The COPAP values were 0.43 cm for GP and 2.69 cm for GS, and the COPML values were 0.29 cm for GP and 1.19 cm for GS.

These data highlight the efficacy of weightlifting in promoting postural stability even in more challenging conditions, where visual information is eliminated, and proprioception and the vestibular system become paramount. Recent studies, such as that of Silva et al., show that resistance exercises, including weightlifting, can significantly improve proprioception and balance in the elderly, thus reducing the risk of falls in environments with low visibility or lighting [17].

These results are particularly important, as the ability to maintain balance even without Unilateral knee osteoarthritis can compromise joint stability and increase the risk of falls in elderly patients. However, regular exercise, especially weightlifting, can play a crucial role in improving joint stability and preventing falls.

The results of this study suggest that weightlifting can be an effective intervention to improve postural control in patients with unilateral knee osteoarthritis, thus contributing to reducing the risk of falls in this vulnerable population.

Table 3 presents the displacement area of the COP, where it was observed that the GP group presented significantly lower values compared to the GS group during bipodal postural control with open eyes. However, no statistically significant differences were found between the groups with closed eyes. The displacement area of the COP for open eyes was 1.09 cm² for GP and 2.01 cm² for GS, while for closed eyes it was 0.89 cm² for GP and 1.34 cm² for GS. Studies such as that of Muehlbauer et al. indicate that the reduction in the displacement area of the COP is associated with a better ability to maintain static and dynamic balance, reflecting a lower postural oscillation and, consequently, a lower risk of falls [18].

The findings of this study suggest that regular practice of weightlifting can be an effective intervention to improve postural control in the elderly with unilateral knee osteoarthritis. The lower oscillation amplitude of the COP and the smaller displacement area of the COP observed in the GP group indicate that these individuals have a better ability to maintain postural stability, both in normal and challenging conditions.

The current literature supports these results, highlighting that weightlifting not only strengthens the muscles but also improves neuromuscular coordination and proprioception. Corcos et al. and Granacher et al., highlight that strength training programs can bring significant benefits to postural stability and fall prevention in the elderly [15,16]. In addition, the improvement in postural control with closed eyes, as observed in our study and corroborated by Silva et al., suggests that weightlifting can improve proprioceptive function, which is crucial for maintaining balance in situations where visual information is limited [17].

5. Conclusion

In summary, the results of this study highlight the effectiveness of regular weightlifting practice in improving postural control in elderly diagnosed with unilateral knee osteoarthritis. Both in conditions with open eyes and closed eyes, the group of elderly weightlifting practitioners demonstrated a smaller oscillation amplitude of the Center of Pressure (COP) and a reduced displacement area compared to the group of sedentary elderly.

These findings suggest that weightlifting not only strengthens the muscles, but also improves proprioception and joint stability, which is crucial for fall prevention, especially in patients with unilateral knee osteoarthritis.

The reduction of fall risk is of utmost importance for the health and quality of life of these patients, contributing to greater independence and mobility.

Thus, the inclusion of weightlifting programs in rehabilitation interventions and fall prevention in elderly with unilateral knee osteoarthritis can be highly beneficial, providing significant improvements in postural control and reducing the risk of adverse events associated with falls.

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