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Research Article

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# Postural Changes and Pain Levels in Patients with Unilateral Knee Injury

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***Abstract***

***Introduction:*** *Postural control is essential for balance and fall prevention but can be compromised by injuries such as anterior cruciate ligament (ACL) rupture and knee osteoarthritis (OA). ACL rupture affects proprioception and joint stability, while OA causes pain and stiffness, impacting mobility and muscle strength. The base of support, defined by the contact points of the body with the ground, is a crucial parameter in evaluating postural control. Objective: To assess changes in the base of support during bipedal postural control in young adults with complete ACL rupture and elderly individuals with unilateral knee osteoarthritis.*

***Methodology:*** *An observational and comparative study with 40 adults divided into two groups: G1 (elderly with unilateral knee osteoarthritis) and G2 (young adults with complete ACL rupture). The BaroScan® plantar pressure platform was used to collect data on the center of pressure (COP) and weight distribution. Pain perception was assessed using the Visual Analog Scale (VAS).*

***Results:*** *There was a significant difference in pain perception (VAS) between the groups ($p = 0.04$), with higher pain in G1. The mediolateral displacement of the COP (COPML) was also greater in G1 ($p = 0.03$). There was no significant difference in body weight distribution and anteroposterior displacement of the COP between the groups.*

***Conclusion:*** *Individuals with OA exhibit higher pain perception and greater mediolateral sway during postural control. Chronic pain and muscle strength loss may contribute to impaired postural control in the elderly with OA. In contrast, young individuals with ACL injuries may compensate for the injury with greater neuromuscular adaptation. Individual variability in response to pain and injury highlights the importance of personalized approaches in treatment and rehabilitation.*

**Keywords:** Postural Control, Base of Support, Knee Osteoarthritis, Anterior Cruciate Ligament, Pain

## 1. Introduction

Postural control, a complex process of sensory and motor integration essential for maintaining body balance and preventing falls is often compromised by injuries to the musculoskeletal system, such as anterior cruciate ligament (ACL) rupture and knee osteoarthritis (OA) [1-5].

ACL rupture, a common injury in young athletes, is characterized by joint instability and proprioceptive deficits, impairing the ability to detect and respond to balance disturbances. Paterno et al. (2010) demonstrated an increased incidence of new injuries in athletes who returned to sports after ACL reconstruction, suggesting that joint instability may persist even after surgical treatment [3]. The loss of ligament integrity can lead to a sense of joint insecurity, altering postural control strategy and increasing dependence on visual information to maintain balance [6].

In contrast, knee osteoarthritis, a prevalent degenerative condition in the elderly, causes joint pain and stiffness, limiting mobility and muscle strength. Pain, a prominent symptom of OA, can act as a detrimental factor for postural control, inducing the adoption of antalgic postures and reducing the range of motion, which can lead to increased body sway and risk of falls [4]. Roberts et al. (2023) evidenced that balance confidence and balance performance, but not fall history, are associated with quality of life in community-dwelling older adults, reinforcing the importance of postural control in this population [5]. The base of support, defined as the area delineated by the body's

points of contact with the ground, is a fundamental parameter in the assessment of postural control [1,2]. Changes in the base of support, such as increased distance between the feet or asymmetric weight distribution, may indicate postural instability and a higher risk of falls [1,2].

Therefore, this study aims to evaluate the alteration of the base of support of the feet during bipedal postural control in young adults diagnosed with complete ACL rupture and elderly individuals diagnosed with unilateral knee osteoarthritis. The comparative analysis between these two groups will allow the identification of specific characteristics of each population and provide a basis for developing more effective and personalized interventions to improve postural control and prevent falls.

## 2. Methodology

This study is observational and comparative in nature, aiming to analyze differences in postural control and pain perception between elderly individuals with unilateral knee osteoarthritis and young adults with a complete Anterior Cruciate Ligament (ACL) rupture.

### 2.1. Participant Subjects

In this study, 40 adults of both sexes were evaluated, divided into two groups: G1 and G2. Group G1 consisted of 20 elderly individuals diagnosed with unilateral knee osteoarthritis. The average age in Group G1 was 71.59 years (±3.14). Additionally, Group G2 comprised 20 young adults with an average age of 31.62 years (±6.23) and diagnosed with a total ACL rupture. Detailed data are presented in Table 1.

| GROUP | AGE (YEARS) | HEIGHT (CM) | BODY MASS (KG) | INJURED KNEE |
|---|---|---|---|---|
| G1 | 71.59 (±3.14) | 162 (±16.21) | 80.63 (±2.07) | Right |
| G2 | 31.62 (±6.23) | 173 (±8.41) | 72.15 (±4.09) | Left |
| **Legend**: Data expressed as mean ± standard deviation. G1: Elderly diagnosed with unilateral knee osteoarthritis; G2: Young adults diagnosed with complete ACL rupture. | | | | |

**Table 1: Sample Characterization**

### 2.2. Ethical Aspect

This study was conducted in accordance with the highest ethical standards, having been approved by the Research Ethics Committee number 24845019.2.0000.5083, in line with Resolution No. 466/2012 of the National Health Council (CNS). Both young adults and elderly participants expressed their consent to participate in the research by signing the Free and Informed Consent Form (TCLE), which contained clear and detailed information about the research, including its objectives, procedures, potential risks, and benefits. In line with the ethical principles of autonomy and respect for individual decision, participants were informed of their right to discontinue participation in the study at any time, without any prejudice.

Additionally, the study was conducted in accordance with the General Data Protection Law (LGPD, Law No. 13.709/2018), ensuring the proper collection, handling, and protection of all personal information of participants.

### 2.3. Variables Analyzed

Participants were instructed to stand barefoot, in a comfortable bipedal position respecting their natural base of support, on the BaroScan® plantar pressure platform by Podotech, Brazil. This platform, equipped with 4,096 capacitive sensors and a sampling frequency of 50Hz, enabled precise data collection. Following an auditory command, participants remained standing, motionless, and with their gaze fixed on a predetermined point for 60 seconds, thus initiating data collection.

During the collection, bipedal postural control was assessed through the Center of Pressure (COP), calculated as the weighted average of plantar pressures relative to the foot's contact area with the platform [7]. Anteroposterior (COPAP) and mediolateral (COPML) displacements of the COP were analyzed, indicating body oscillations in these directions, and the percentage of weight distribution between the right and left foot.

Pain perception was measured using the Visual Analog Scale (VAS), where values close to 0 indicate a low level of pain and values close to 10 indicate a high level [8].

### 2.4. Statistical Analysis

Data were analyzed using Minitab 21 software. The normality of distributions and homogeneity of data were verified. To determine differences between the evaluated groups, the non-parametric Tukey test was applied, considering a value of $p \leq 0.05$ as statistically significant. Results were presented as mean and standard deviation, providing a clear description of the data.

## 3. Results

Table 2 presents the results of the base of support behavior during bipedal postural control in two groups: elderly with unilateral knee osteoarthritis (G1) and young adults with complete ACL rupture (G2).

| VARIABLE | GROUP G1 | GROUP G2 | P VALUE |
|---|---|---|---|
| VAS | 9.76 (±8.99) | 3.76 (±3.41) | 0.04* |
| % Right Foot | 68.77 (±12.18) | 62.48 (±12.14) | 0.07 |
| % Left Foot | 31.23 (±3.80) | 37.57 (±12.14) | 0.07 |
| COPAP (cm) | 8.54 (±6.67) | 7.79 (±0.82) | 0.08 |
| COPML (cm) | 7.24 (±5.21) | 4.47 (±9.99) | 0.03* |
| **Legend**: VAS indicates the visual analog scale of pain; G1: elderly diagnosed with unilateral knee osteoarthritis; G2: young adults diagnosed with complete ACL rupture. Data are expressed as mean ± standard deviation. *significant Tukey test (p≤0.05). | | | |

**Table 2: Base of Support Behavior during Bipedal Postural Control**

A significant difference was observed between the groups in the perception of pain (VAS), being higher in group G1 (9.76 ± 8.99) compared to G2 (3.76 ± 3.41) (p = 0.04). Regarding body weight distribution, both groups showed a higher percentage on the right foot, with 68.77% ± 12.18% in G1 and 62.48% ± 12.14% in G2, but without a significant difference between them (p = 0.07).

As for the displacement of the center of pressure (COP), there was no significant difference between the groups in the anteroposterior displacement (COPAP) (p = 0.08). However, the mediolateral displacement (COPML) was significantly greater in group G1 (7.24 ± 5.21) compared to G2 (4.47 ± 9.99) (p = 0.03).

Therefore, the elderly with knee osteoarthritis showed a greater perception of pain and greater mediolateral displacement of the center of pressure during bipedal postural control compared to the young with ACL rupture. There was no significant difference between the groups in body weight distribution and anteroposterior displacement of the center of pressure.

## 4. Discussion

The analysis of data from this study revealed significant nuances in postural control among individuals with knee osteoarthritis (OA) and complete anterior cruciate ligament (ACL) rupture. The perception of pain was significantly higher in the OA group (p = 0.04), supporting literature that highlights pain as a crucial factor in functional limitation and quality of life in these patients [9]. Chronic pain associated with OA can induce biomechanical changes, such as the adoption of antalgic postures and reduced range of motion, negatively impacting postural control [10]. This impact is evidenced by the greater mediolateral oscillation (COPML) observed in the OA group (p = 0.03), suggesting a compensatory strategy to avoid pain in the affected joint.

The absence of a significant difference in body weight distribution between the groups (p = 0.07), despite the pain in the OA group, contrasts with some studies that report a tendency to offload weight on the non-affected limb in individuals with unilateral knee osteoarthritis [11]. This discrepancy could be attributed to individual variability in pain response and the presence of compensatory mechanisms that seek to maintain postural balance even in the presence of pain9. Chronic pain can trigger a vicious cycle where increased pain perception leads to greater muscle tension and joint stiffness, further complicating postural control and perpetuating the painful experience [12].

For elderly individuals, knee osteoarthritis presents an even greater challenge for postural control. Muscle strength loss and diminished neuromuscular responsiveness associated with aging can exacerbate balance issues [13]. Studies suggest that asymmetric muscle strength in the lower limbs can negatively affect gait performance and postural control in the elderly [14]. These factors make rehabilitation and pain management even more critical in this population to prevent falls and improve quality of life.

In the ACL group, the lower pain perception and less mediolateral COP oscillation can be explained by the absence of chronic pain and greater neuromuscular adaptability in younger individuals [15]. Neural plasticity and motor learning capabilities may allow these individuals to develop effective compensatory strategies to maintain postural control even after a ligament injury [16]. Studies also suggest that proper rehabilitation can improve postural control and reduce the risk of further injuries [17,18]. However, it is important to consider that even young athletes may present persistent deficits in postural control, especially if rehabilitation is not complete or adequate [19].

Nevertheless, the literature on postural control in individuals with ACL injury is controversial. While some studies report persistent deficits in postural control even after rehabilitation [16], others find no significant differences compared to healthy individuals [15]. This divergence could be attributed to factors such as the duration of the injury, the type of treatment performed, and adherence to the rehabilitation program [17,20]. The complexity of postural control mechanisms and individual variability in responses to injury and rehabilitation suggest the need for personalized approaches for the treatment and rehabilitation of patients with ACL injuries.

In elderly patients with OA, the combination of chronic pain and muscle strength loss can lead to significantly impaired postural control, increasing the risk of falls and further injuries. Interventions focused on improving muscle strength, pain control, and personalized rehabilitation strategies are essential for this population [13,14]. In contrast, young patients with ACL injuries may benefit from rehabilitation programs that emphasize neuromuscular recovery and motor learning to restore postural control [18].

## 5. Conclusion

The data from this study highlight the complexity of postural control in individuals with knee osteoarthritis (OA) and anterior

cruciate ligament (ACL) injury, emphasizing the importance of pain as a determining factor in functionality and quality of life for patients. The chronic pain observed in the OA group, associated with greater mediolateral oscillation, indicates that compensatory strategies are adopted to minimize discomfort, negatively affecting postural balance. On the other hand, the lower perception of pain and better postural control in the ACL group suggests a greater capacity for neuromuscular adaptation, especially in younger individuals.

The absence of a significant difference in body weight distribution between the groups, despite the pain in the OA group, suggests the presence of individual compensatory mechanisms that maintain postural balance. However, the literature indicates that pain response and compensation mechanisms vary widely among individuals, highlighting the need for personalized therapeutic approaches.

For elderly individuals with OA, the combination of chronic pain and muscle strength loss can result in significantly impaired postural control, increasing the risk of falls. Interventions focusing on muscle strengthening, pain control, and personalized rehabilitation strategies are crucial for improving the quality of life for these patients. In contrast, young individuals with ACL injury may benefit from rehabilitation programs that emphasize neuromuscular recovery and motor learning.

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