Relationship Between Pelvic Cross Syndrome, Gait, and Balance Impairments

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ABSTRACT

Background: Pelvic Cross Syndrome (PCS) is characterized by muscle imbalances around the pelvis, leading to postural distortions, abnormal gait, and balance impairments. Understanding its impact on gait and fall risk is crucial for improving patient outcomes.

Objective: To explore the relationship between Pelvic Cross Syndrome and gait/balance impairments.

Methods: A cross-sectional study was conducted with 138 participants aged 25-60 years, diagnosed with PCS and recruited from hospitals in Lahore. Participants were assessed using the Berg Balance Scale and Functional Gait Assessment (FGA) by an experienced physical therapist. Data were analyzed using SPSS 23, with descriptive statistics and Chi-square tests to evaluate associations between PCS and balance/gait impairments.

Results: The mean age of participants was 44.62 years. FGA scores averaged 17.00 (SD = 4.31), indicating moderate gait impairment; 18.8% had normal gait, 14.5% mild, 58.7% moderate, and 8.0% severe impairments. On the Berg Balance Scale, 63.8% were high fall risk, 20.3% medium, and 15.9% low. A significant association between PCS and high fall risk was observed ($p = 0.000002$).

Conclusion: The study confirmed that individuals with PCS are at significant risk of gait and balance impairments, emphasizing the need for targeted rehabilitation interventions.

INTRODUCTION

Pelvic Cross Syndrome (PCS), commonly referred to as Lower Crossed Syndrome (LCS), is a musculoskeletal condition characterized by a distinctive pattern of muscle imbalances around the pelvis and lower spine, leading to significant postural and biomechanical distortions. The syndrome manifests through weakened muscles, such as the abdominals and gluteus maximus, and tight muscles, including the iliopsoas and spinal extensors, creating a crossed pattern of muscle dysfunction across the pelvis and lumbar region (1). This imbalance often results in an exaggerated lumbar lordosis and anterior pelvic tilt, which disrupts normal biomechanics and can have widespread effects on gait and balance, impacting overall mobility and increasing the risk of falls (2). These imbalances may lead to compensatory postural changes, such as thoracic hyperkyphosis and alterations in cervical spine curvature, further complicating functional mobility (7).

PCS is typically categorized into two subtypes: Type A, which primarily affects the hips, and Type B, which is more evident in the lower back. These subtypes can present with similar muscular imbalances but differ in their regional manifestations and myofascial activation patterns (4). The anterior pelvic crossed syndrome is marked by anterior tilt of the pelvis, hyperextension of the knees, and a compensatory increase in thoracic kyphosis, which negatively impacts gait and balance. Conversely, the posterior pelvic crossed syndrome is characterized by dominance of the axial extensors, anterior pelvic tilt, and increased thoraco-lumbar extensor activity, resulting in compensatory hyperlordosis of the lumbar spine and reduced postural control (8, 9). The implications of these postural changes are significant, as they can alter the center of mass and disrupt the stability required for effective gait, leading to increased fall risk (10).

In individuals with PCS, the altered biomechanics of the pelvis and spine often result in compensatory gait patterns. For instance, weak gluteal and abdominal muscles, combined with tight hip flexors and lumbar extensors, can diminish stride length and reduce overall gait efficiency (11). These impairments hinder the ability to perform fundamental movements such as pushing off the ground during walking, which is critical for forward propulsion. Furthermore, an anteriorly tilted pelvis disrupts normal lower extremity kinematics, forcing compensatory motions that affect gait and balance (12). As a result, individuals with PCS frequently exhibit gait deviations such as reduced stride length, overactivity of the hip flexors, and compromised pelvic stability during ambulation (13). These abnormalities not only diminish functional mobility but also elevate the risk of falls, which is a major concern in clinical populations affected by PCS.

The current study aims to elucidate the relationship between PCS and its impact on gait and balance impairments, focusing on how these biomechanical changes contribute to increased fall risk. Given the high prevalence of gait abnormalities and balance deficits

observed in this population, there is a critical need for early detection and targeted interventions to address these impairments and enhance patient outcomes. Previous studies have highlighted the role of musculoskeletal imbalances in contributing to gait and balance disturbances; however, comprehensive evaluations specifically targeting PCS are limited (18). This gap in research underscores the importance of a holistic approach in assessing and managing the multifaceted challenges faced by individuals with PCS, as the condition's impact extends beyond isolated muscle weaknesses to involve complex interactions between postural control, gait mechanics, and overall functional capacity (19). This study seeks to bridge this gap by providing a detailed analysis of the interplay between PCS, gait impairments, and fall risk, thereby informing the development of tailored rehabilitation strategies aimed at improving mobility and reducing the incidence of falls in this vulnerable population. The insights gained from this research are expected to contribute to the broader body of knowledge in musculoskeletal rehabilitation, supporting the advancement of evidence-based practices and the refinement of clinical guidelines for managing PCS and its associated functional impairments (20).

MATERIAL AND METHODS

The study employed a cross-sectional design, involving a convenient sample of 138 participants recruited from various hospitals in Lahore over a six-month period. Participants were included if they were aged between 25 and 60 years of either gender, and had a clinical diagnosis of Pelvic Cross Syndrome accompanied by gait and balance impairments. Exclusion criteria included individuals with neurological conditions, pregnancy, recent history of spine, hip, or lower limb surgery, or any other musculoskeletal problems. All participants provided written informed consent prior to enrollment in the study, and the study was conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained from the relevant institutional review board.

Assessment of balance and gait impairments was conducted using the Berg Balance Scale and the Functional Gait Assessment (FGA). The Berg Balance Scale, a 14-item assessment tool, evaluates balance performance across various tasks, with each item scored on a five-point ordinal scale ranging from 0 (lowest performance) to 4 (highest performance). The tasks included sitting to standing, standing unsupported, sitting unsupported, standing to sitting, transfers, standing with eyes closed, standing with feet together, reaching forward with an outstretched arm, retrieving an object from the floor, turning to look behind, turning 360 degrees, placing alternate feet on a stool, standing with one foot in front, and standing on one foot. The total score ranged from 0 to 56, with lower scores indicating a higher risk of falls (13).

The Functional Gait Assessment was used to evaluate gait impairments. This tool consists of 10 items, each scored from 0 (severe impairment) to 3 (normal ambulation). The items assessed included gait on a level surface, changes in gait speed, gait with horizontal and vertical head turns, gait with pivot turn, step over obstacles, gait with a narrow base of support, gait with eyes closed, ambulating backwards, and climbing stairs. The total score ranged from 0 to 30, with lower scores indicating greater impairment in gait functionality (15). All assessments were performed by a licensed physical therapist with over ten years of experience in managing neuro-musculoskeletal disorders.

Data collection involved direct observation and scoring of participants' performance on the Berg Balance Scale and FGA by the physical therapist. Demographic and clinical information, including age, gender, and specific characteristics of PCS, were also collected through structured interviews and medical record reviews. The data were recorded on standardized forms and subsequently entered into a secure database for analysis.

Statistical analysis was conducted using SPSS version 25. Descriptive statistics, including means, standard deviations, and frequencies, were calculated to summarize demographic and clinical characteristics of the study population. The prevalence of gait impairments and balance deficits was described using frequency distributions. Associations between PCS and gait or balance impairments were analyzed using the Chi-square test, with statistical significance set at a p-value of less than 0.05. Additionally, mean scores on the Berg Balance Scale and FGA were calculated to assess the overall extent of impairment among participants.

The study followed rigorous ethical guidelines, ensuring that participants were fully informed about the study procedures and potential risks. Confidentiality of participant data was maintained throughout the study, and all data were anonymized prior to analysis to protect participant privacy. The findings of this study are intended to contribute to a better understanding of the impact of Pelvic Cross Syndrome on gait and balance, thereby informing future interventions aimed at reducing fall risk and improving mobility outcomes in affected individuals.

RESULTS

The analysis of 138 participants with Pelvic Cross Syndrome (PCS) revealed significant associations between balance impairments and fall risks, as summarized in Table 1. The mean age of participants was 44.62 years, with a standard deviation of 9.65, ranging from 25 to 60 years.

Table 1: Descriptive Statistics of Age and FGA Scores

Characteristics	Mean	Std. Deviation	Minimum	Maximum
Age	44.62	9.65	25.00	60.00
FGA Score	17.00	4.31	10.00	28.00

The Functional Gait Assessment (FGA) scores, which evaluate gait functionality, had a mean of 17.00 with a standard deviation of 4.31. These scores indicated that most participants exhibited moderate gait impairments, with the distribution of scores suggesting a prevalence of moderate to severe gait issues among the study population. In Table 2, the BERG Balance Scale scores are presented, categorizing participants into different fall risk groups. A notable 63.8% of participants were classified as having a high fall risk (scores between 0 and 20), 20.3% fell into the medium fall risk category (scores between 21 and 40), and 15.9% were identified as low fall risk (scores between 41 and 56). The analysis revealed a statistically significant association between PCS and high fall risk, with a p-value of 0.000002, indicating a strong relationship between balance impairments and increased fall risk in this population.

Table 2: BERG Balance Scale Total Scores with p-values

Risk Category	Frequency	Percentage	p-value
High Fall Risk (0-20)	88	63.8%	0.000002
Medium Fall Risk (21-40)	28	20.3%	0.000002
Low Fall Risk (41-56)	22	15.9%	0.000002

The results demonstrate a significant prevalence of gait impairments and balance deficits among individuals with PCS. The high proportion of participants categorized as high fall risk underscores the critical need for early detection and targeted rehabilitation strategies. The statistically significant p-value supports the hypothesis that there is a meaningful association between PCS and an increased risk of falls, emphasizing the importance of comprehensive assessments and personalized interventions to improve gait and balance in this vulnerable population. These findings provide valuable insights for clinical practice, highlighting the necessity of addressing the multifaceted challenges posed by PCS to enhance patient outcomes and reduce fall-related risks.

DISCUSSION

The findings of this study demonstrated a significant association between Pelvic Cross Syndrome (PCS) and impairments in gait and balance, highlighting the heightened risk of falls in individuals with this musculoskeletal condition. The majority of participants exhibited moderate to severe gait impairments, and a substantial proportion were classified as high fall risk, supporting the hypothesis that PCS significantly affects functional mobility and stability. These results align with previous studies that have identified musculoskeletal imbalances, such as those seen in PCS, as critical contributors to gait abnormalities and balance deficits (1). The observed prevalence of high fall risk among participants underscores the clinical relevance of PCS as a condition that requires comprehensive assessment and intervention to mitigate its impact on daily functioning and quality of life. In this study, the use of standardized assessment tools such as the Functional Gait Assessment (FGA) and the BERG Balance Scale provided robust and reliable measures of gait and balance impairments, allowing for a nuanced understanding of the extent of functional limitations in individuals with PCS. The results corroborate findings from other research that reported similar patterns of gait and balance dysfunction in populations with musculoskeletal disorders (16). The high prevalence of gait impairments in this cohort reflects the characteristic muscle imbalances of PCS, including weakened abdominals and gluteal muscles alongside tight hip flexors and lumbar extensors, which disrupt normal biomechanical patterns and contribute to compromised gait (2). Moreover, the significant association between PCS and fall risk observed in this study is consistent with previous literature that has linked postural abnormalities and muscle imbalances to increased fall susceptibility (17).

Despite the strengths of this study, including the use of validated assessment tools and a clear focus on a clinically relevant population, several limitations must be acknowledged. One limitation is the cross-sectional design, which precludes the ability to establish causal relationships between PCS and the observed functional impairments. Longitudinal studies would be beneficial in elucidating the temporal dynamics of PCS progression and its impact on gait and balance over time. Additionally, the reliance on a convenience sample from specific hospitals in Lahore may limit the generalizability of the findings to broader or more diverse populations. Future research should aim to include a more representative sample and consider exploring the effects of PCS in different settings and demographic groups (18). Another potential limitation is the reliance on observational assessments, which, although standardized, may not capture all aspects of gait and balance dysfunction. Incorporating objective measures such as motion analysis or wearable technology could provide a more comprehensive understanding of the biomechanical alterations associated with PCS (19).

The study's findings have important implications for clinical practice, particularly in the development of targeted rehabilitation strategies aimed at improving gait and balance in individuals with PCS. Given the high prevalence of functional impairments and fall risk identified in this population, it is crucial to prioritize early detection and intervention to address the underlying muscle imbalances and postural deviations that characterize PCS. Rehabilitation programs focusing on strengthening weakened muscles, such as the abdominals and gluteals, alongside stretching and flexibility exercises for tight muscle groups, may be effective in restoring balance and improving gait mechanics (20). Furthermore, the integration of balance training and fall prevention strategies into rehabilitation protocols could enhance overall functional outcomes and reduce the incidence of falls in this at-risk population.

In conclusion, this study adds to the growing body of evidence that highlights the significant impact of Pelvic Cross Syndrome on gait and balance, reinforcing the need for comprehensive and individualized approaches in the management of this condition. While the study provides valuable insights into the functional impairments associated with PCS, further research is warranted to explore the long-term effects of targeted interventions and to establish standardized guidelines for the assessment and treatment of gait and balance dysfunctions in individuals with PCS. The incorporation of more sophisticated assessment tools and broader population studies would enhance the understanding of PCS and support the development of evidence-based practices that can improve the quality of care for affected individuals.

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