

Frequency of chemotherapy Induced Gait Deviations in Breast Cancer Female Survivors

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¹ ² Substantial contributions to the conception or design of the work for the acquisition, analysis or interpretation of data for the work, ¹ ² Drafting the work or reviewing it critically for important intellectual content, ² Final approval of the version to be published, ³ Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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A B S T R A C T

Background: Prolonged chemotherapy treatment in breast cancer patients can lead to the development of chemotherapy-induced peripheral neuropathy (CIPN). CIPN is a common adverse effect characterized by symptoms such as gait and balance impairments, as well as weakness in the lower extremities. These symptoms can significantly impact functional abilities and increase the risk of falls among patients. Importantly, these effects may persist even after completion of chemotherapy treatment, leading to long-term challenges in mobility and balance.

Objective: To determine the frequency of chemotherapy induced gait deviations in breast cancer female survivors.

Methodology: Descriptive cross-sectional survey was conducted Data from 168 breast cancer survivors were collected from different cancer care hospitals in Lahore. Data collection was done by videotaping patient gait from multiple views and using JAKC Observational Gait Analysis.

Results: Results via OGA scale showed deviations in ankle dorsiflexors 114 (67.9%) during mid-stance to terminal stance, inadequate extension of knee 86 (51.2%) during initial contact and inadequate flexion of thigh during initial contact 91(54.2%) and loading response 94 (56.0%).

Conclusions: The results revealed gait deviations due to chemotherapy induced peripheral neuropathy in breast cancer survivors which results in slower gait velocity and can predict risk of fall.

Keywords: BCS (breast cancer survivors) CIPN (chemotherapy induced peripheral neuropathy), OGA (Observational gait analysis), TUG (timed up and go).

Introduction

Breast cancer, the most prevalent malignancy in women, originates from breast tissue, commonly from milk ducts or lobules. In the United States, 1 in 9 women is diagnosed before age 85, with a current 5-year survival rate of 93%. Incidence increases with age, particularly between 40 and 55 years, more rapidly for Black and white women, plateauing post-

menopause. Disparities exist among racial and ethnic groups, with lower rates in Hispanic, Asian-American, and Native American women. Globally, breast cancer rates have risen, and Pakistan has the second-highest incidence among Asians. Categorically, breast cancer is hormone receptor positive, ERBB2 positive, or triple-negative. ¹⁻³

Breast cancer survivors face short- and long-term side effects despite high survival rates. In men, breast cancer is

rare, primarily affecting those with hormonal imbalances, radiation exposure, or a family history. Factors like menarche, pregnancies, and late menopause influence risk. Chemotherapy is a mainstay for metastatic breast cancer, evolving since the 1970s. Survivors often grapple with gait and balance issues, linked to fatigue, muscle weakness, and neuropathy. Up to 44% experience neuropathy at least two years post-diagnosis, elevating fall risk. Gait, the pattern of human movements during locomotion, and balance are vital for daily activities, and impairment poses a significant health concern, potentially leading to injury, hospitalization, and mortality. Gait analysis, studying human locomotion, becomes crucial in understanding deviations and identifying interventions for improved survivor outcomes.^{1, 4, 5}

In a 2019 observational study, researchers sought to compare gait and balance deficits in breast cancer survivors to age-matched controls. The methodology involved standardized data extraction, utilizing measurements such as the 8-foot and 3-meter Timed Up & Go (TUG), gait speeds, and the short physical performance battery gait score. The study identified gait and balance imbalances in breast cancer survivors compared to normative values, emphasizing the need of medical professionals assessing these parameters to improve functional independence and reduce fall-related risks.¹⁶

A 2018 epidemiology study published in the 'World Journal of Surgical Oncology' aimed to assess significant statistical differences in cancer incidence and prevalence in various regions of Pakistan based on ethnic makeup. The study utilized a Meta-analysis of Observational Studies in Epidemiology (MOOSE) checklist and χ^2 -based I² test for reporting and assessing heterogeneity, respectively. The conclusion highlighted an overall breast cancer prevalence of 31%, with individual studies ranging from 20 to 50% and a majority showing around 14%.⁶

In a 2022 RCT titled 'Assessing gait, balance, and muscle strength among breast cancer survivors with chemotherapy-induced peripheral neuropathy (CIPN),' the study aimed to determine the impact of chemotherapy-induced peripheral neuropathy on gait, balance, and muscle strength in breast cancer survivors. The methodology involved 312 women with symptomatic neuropathy who underwent taxane-based chemotherapy, randomly assigned to a 16-week Home- Based Physical Activity Intervention or an Educational Attention control group. Gait analysis, balance evaluation, and muscle strength measurements revealed significant effects on these parameters due to a decline in peripheral nerve function among breast cancer survivors.⁷

In a 2021 scoping review published in 'Rehabilitation Oncology,' the study aimed to comprehensively map literature on chemotherapy's impact on balance, gait, and falls among cancer survivors. Conducted across four databases, the review identified 30 papers, revealing adverse effects of chemotherapy on static and dynamic balance, gait, and falls throughout survivorship. The study highlighted knowledge gaps, particularly in areas like minority participants and alternative causal paths beyond chemotherapy-induced peripheral neuropathy (CIPN).⁸

If large fiber sensory modality is impaired, changes in gait and balance are expected, and they are not usually related to motor alterations which can be very mild or even not present.^{13,14} If loss of proprioception is relevant, in fact, a condition known as sensory ataxia is developed.¹⁴ Sensory ataxia due to CIPN is associated with increased patients' fear of falling¹⁵ and actual increased risk of falls¹⁶, and with a deterioration in quality of life after chemotherapy treatment completion

Observational gait analysis (OGA) utilizes a comprehensive form with 176 check-off options to identify gait deviations by observing the patient's gait through multiple views on videotape. An abbreviated form, JAKC OGA, with 66 check-off options is available. This analysis includes assessing stride length, walking speed, and cadence, enabling the documentation and subsequent evaluation of identified gait deviations and deficits.^{9,11}

The current study aims to assess spatial-temporal measures of gait (step time, width, and length) in cancer survivor female patients. Moreover, this study will be helpful to incorporate gait specific training in rehabilitation and assess changes in gait to identify those at risk for falls.

Methodology

Descriptive cross sectional survey has been conducted after approval of ethical committee of Lahore College of physical therapy (LMDC) ref no. DPT/ERB/08. Data from 168 breast cancer survivors were collected from different cancer care hospitals in Lahore. Non-probability convenience sampling was used to choose the sample of 168 patients. The sample size was calculated by using epi tool estimate through proportion $p = 0.3$, desired precision $e = 0.05$, confidence level $Z = 0.95$, n is equal to 168.¹²

A technique for measuring outcomes is observational gait analysis, or OGA is used to identify gait irregularities using a comprehensive body gait analysis form with 176 points. The 66 check-off option in the shortened version JAKC OGA. Video recordings were taken from various angles to observe the patient's stride. Step length, walking pace, and cadence all

were calculated using this form. Deficits were obtained after the deviations were recorded. The great validity of 0.94 is proven by observational gait analysis. Both the intra-observer and inter-observer reliability are rather good, at 0.89 and 0.76, respectively.



Figure 1: Gait Analysis of one of cancer patient.

Female patients (age 25-60) physician confirmed diagnosed with breast cancer stage 3 who received and completed neo-adjuvant or adjuvant chemotherapy treatment sessions were included. Patients having primary cancer other than breast cancer or having other treatment along with ongoing chemotherapy, having any disease (e.g., diabetes, human immunodeficiency virus) resulting in peripheral neuropathy or muscle weakness such as chronic fatigue syndrome, multiple sclerosis, spinal cord tumors or injuries, stroke or preexisting cardiopulmonary disease, bone metastasis that would preclude exercise or having symptomatic lymphedema or advanced disease at high risk for bone metastases and pathologic fracture were not included. Data was analyzed and reviewed through Statistical Package for Social Sciences (SPSS) version 26. Study variables were presented in form of descriptive statistics (tables, graphs, frequencies, and percentages).

Results

The mean age of patients reported to be 49.7440 years. The frequency of ankle deviations during weight acceptance is Flat foot – 78(46.4%), Inadequate DF – 63(37.5%), during loading response is Foot slap – 45(26.8%), Inadequate PF – 42(25.0%), During mid stance and Terminal stance phase is Early heel off – 21(12.5%) and there is insufficient DF from pre-swing to terminal swing - 114(67.9%) Toe drag – 39(23.2%), Inadequate DF – 108(64.3%) (Table I)

Table I: Frequency of ankle deviations.

	N	Minimum	Maximum	Mean Std. Deviation
Age	168	25.00	60.00	49.7440+6.14203
ANKLE				
WEIGHT ACCEPTANCE	SINGLE LIMB SUPPORT		SWING LIMB ADVANCEMENT	
INITIAL CONTACT	LOADING RESPONSE	MID STANCE AND TERMINAL STANCE		PRE-SWING TO TERMINAL SWING
Flat foot –	Foot slap –	Early heel off –		Toe drag- 39(23.2%)
78(46.4%)	45(26.8%)	21(12.5%)		Insufficient DF –
Inadequate DF –	Inadequate PF –	Inadequate DF-		108(64.3%)
63(37.5%)	42(25.0%)	114(67.9%)		

The frequency of knee deviations during initial contact is Inadequate extension –86(51.2%), During loading response is Inadequate flexion – 30(17.9%), Extensor thrust – 25(14.9%), during mid stance and terminal stance is Inadequate extension 67(39.9%), Extensor thrust 35(20.8%) Deficient flexion occurs from pre-swing to terminal swing – 87(51.8%), Excessive flexion – 31(18.5%), Inadequate extension – 68(40.5%), Extensor thrust – 28(16.7%) (Table II)

Table II: Frequency of knee deviations.

KNEE			
WEIGHT ACCEPTANCE	SINGLE LIMB SUPPORT	SWING LIMB ADVANCEMENT	
INITIAL CONTACT	LOADING RESPONSE	MID STANCE AND TERMINAL STANCE	PRE-SWING TO TERMINAL SWING
Insufficient extension –	Inadequate flexion –	Restricted extension 67(39.9%)	Limited flexion – 87(51.8%).
86(51.2%)	30(17.9%)	Hyperextension- 23(16.1%)	Extreme flexion – 31(18.5%).
	Overextension- 24(16.8%)	Extensor thrust – 35(20.8%).	Incompetent extension – 68(40.5%).
	Extensor thrust – 25(14.9%)		Extensor thrust – 28(16.7%).

The frequency of thigh deviations during initial contact is Inadequate flexion – 91(54.2%). during loading response Insufficient flexion – 94(56.0%) during intermediate and terminal stance Inadequate extension – 39(23.2%)., Medial rot – 29(17.3%)., Adduction – 8(4.8%), and from pre- swing to terminal swing Restricted flexion – 74(44.0%), Lateral rot – 6(3.6%). (Table III)

Table III: Frequency of thigh deviation.

THIGH			
WEIGHT ACCEPTANCE	ONE LIMB SUPPORT	SWING LIMB ADVANCEMENT	
INITIAL CONTACT	LOADING RESPONSE	INTERMEDIATE STANCE AND TERMINAL STANCE	PRE-SWING TO TERMINAL SWING
Inadequate flexion – 91(54.2%).	Inadequate flexion – 94(56.0%)	Inadequate extension 39(23.2%).	Inadequate flexion – 74(44.0%)
		Medial rot – 29(17.3%).	Lateral rot – 6(3.6%).
		Adduction – 8(4.8%).	

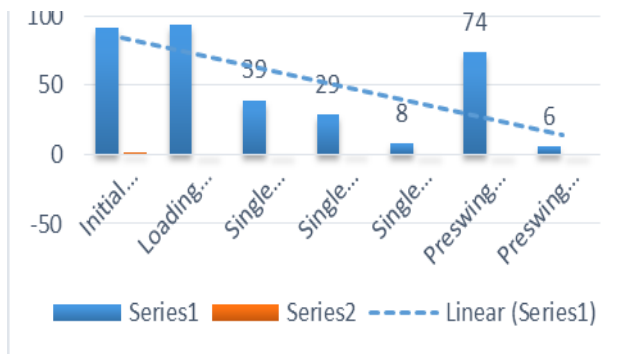


Figure 2. Frequency of Thigh deviation.

Discussion

The study aimed to examine gait deviations in breast cancer female survivors who underwent chemotherapy, a treatment known for its adverse effects, including peripheral neuropathy. Chemotherapy, with its powerful chemicals, can disrupt physical performance during and after treatment. This research focused on analyzing impairments in breast cancer survivors post-treatment. Gait deviations were assessed using the JACK OGA scale, with participants walking and their videotaped gait performances observed. The study aimed to understand the lingering impacts of chemotherapy on the physical abilities of breast cancer survivors.

The study's key findings reveal that participants predominantly experienced muscle weakness after chemotherapy, resulting in notable gait deviations during both stance and swing phases. These deviations included foot flat in the ankle, insufficient knee extension at initial contact and swing, as well as inadequate hip flexion during initial contact. Additionally, from Pre to Final swing, insufficient upward bending of ankle indicated weakness of dorsiflexors, accompanied by inadequate knee and hip flexion and forward leaning in the trunk, suggesting a compromise in concentric and eccentric muscle work. Muscle weakness emerged as a significant factor contributing to both gait deviations and a reduction in gait speed.

The Randomized Controlled Trial (RCT) aimed to evaluate the gait of breast cancer survivors experiencing chemotherapy-induced peripheral neuropathy (CIPN). The study highlighted that the loss of motor and sensory neurons in the lower extremities, impacting large muscle groups, leads to weakness. This weakness, attributed to lower peripheral motor neuron and muscle involvement, contributes to hypotonia and an unsteady gait. The study's conclusion emphasized the connection between lower extremity muscle weakness caused by chemotherapy and the resulting slower and deviated gait observed in breast cancer survivors.⁷

An observational study revealed evidence of gait impairments in breast cancer survivors, identifying a decrease in gait speed as an independent predictor of death in cancer patients. The study suggested that gait impairments might stem from fatigue, a common adverse effect of breast cancer treatment, indicating that cancer-related fatigue could contribute to slow walking (Hsieh et al., 2019b). Furthermore, the study concluded that slow gait speed was reported in breast cancer survivors post-chemotherapy treatment.¹

Our findings highlight the need for interventions beyond traditional strengthening and specific training to address biomechanical asymmetries and deviations during gait that persist widely among even the most rehabilitated patients. The evidence also tell the effects of resistance training on muscle strength in breast cancer survivors. Women who participated in the resistance impact training program significantly increased their maximum leg and bench press strength as compared to the stretching group.¹⁰

Conclusion

Observational gait analysis identified gait abnormalities such as Limited dorsiflexion, restricted extension of knee and Deficient flexion of thigh due to eccentric loss of ankle dorsiflexors, Muscles of thigh (quadriceps) and hamstrings due to chemotherapy induced peripheral neuropathy in breast cancer survivors which results in slower gait velocity and can predict risk of fall in breast cancer survivors after chemotherapy.

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