INTRODUCTION

Chemotherapy-induced peripheral neuropathy (CIPN) is a neurotoxic side effect of several classes of common chemotherapy agents including taxanes. CIPN is associated with a decreased quality of life due to symptoms including pain and impaired function [1]. Similar to peripheral neuropathies in other populations, an increased risk of falling has been observed in patients with CIPN that suggests underlying balance deficits are likely present [2,3]. However, it is unknown how these balance deficits progress as patients proceed through chemotherapy. Establishing the natural history of postural instability in this population may elucidate balance parameters that are able to identify patients early in treatment who are likely to subsequently develop severe symptoms. Improved ability to quantify the effects of CIPN may also better enable researchers to evaluate and develop effective interventions that have remained elusive to date.

The purpose of this pilot study was to establish the feasibility of implementing quantitative, objective balance measures into the clinical setting. We proposed to gain insight into the natural history of postural instability in breast cancer patients being treated with taxane-based chemotherapy.

METHODS

At the time of analysis, 29 breast cancer patients (f/m = 28/1; age = 47.1 ± 11.2 years; mass = 75.1 ± 20.3 kg; height = 1.64 ± 0.08 m) being treated with taxane-based chemotherapy for the first time had been accrued for this study after providing IRB-approved informed consent.

Patients were assessed at 5 timepoints: within 1 month of starting chemotherapy (timepoint 1), at the beginning of subsequent chemotherapy cycles (timepoints 2-4), and 1-3 months after completing their chemotherapy regimen (timepoint 5). At each visit, patients filled out patient-reported outcomes and performed balance and gait tasks. All data was collected by trained clinical research coordinators in the clinic where the patients were receiving treatment. Balance tasks consisted of quiet standing with eyes open (1 trial for 30 sec), quiet standing with eyes closed (1 trial for 30 sec), limits of stability (1 trial), functional reach with foot (5 trials for maximum distance), and functional reach with hand (3 trials for maximum distance), as shown in Figure 1.

Figure 1. Standing balance tasks collected in the clinic. A. Quiet standing; B. Functional reach with foot; C. Limits of stability; D. Functional reach with hand.
both feet flat on the balance plate. Foot measurements and standardized positioning enabled estimation of each patient's boundaries of support.

Center of pressure (CoP) data was collected during all balance tasks through a Bertec BP5046 balance plate. A custom LabVIEW interface was developed to guide clinical personnel through the protocol and collect CoP data. Processing of balance data was performed through custom Matlab scripts with all CoP data low-pass filtered at 20 Hz using a 4th order Butterworth filter. Preliminary analysis of the data was performed using linear mixed model least squares means for repeated measures to estimate changes in balance parameters over time.

RESULTS AND DISCUSSION

The results of this pilot study support the feasibility of implementing balance measures into a clinical setting to quantify postural instability in breast cancer patients. Testing in the clinic was performed without interfering with normal operations. At the time of analysis, patients were at varying stages of the study with more than half of the patients having completed timepoint 4. Five of the 29 patients dropped out of the study (n=4 after timepoint 1, n=1 after timepoint 2). The preliminary results presented here are for the quiet standing with eyes closed task at timepoints 1-4 using 95% confidence ellipse area of CoP trajectory. Progressive increases in ellipse area were observed, as shown in Figure 2.

Table 1. Change in 95% confidence ellipse area from timepoint 1 during quiet stance with eyes closed.

<table>
<thead>
<tr>
<th>Timepoint Comparison</th>
<th>% Change from Timepoint 1</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1→2</td>
<td>40%</td>
<td>0.046</td>
</tr>
<tr>
<td>1→3</td>
<td>37%</td>
<td>0.058</td>
</tr>
<tr>
<td>1→4</td>
<td>97%</td>
<td>0.004</td>
</tr>
</tbody>
</table>

Higher 95% confidence ellipse areas have been associated with balance deficits [4]. The changes observed in this pilot study suggest that patients become progressively less stable as they continue through chemotherapy treatment. This result is consistent with a loss of proprioception and/or vestibular acuity. Further analysis will be conducted after completing testing of the breast cancer cohort including comparing changes in balance measures with changes in patient-reported CIPN symptoms. Future research will evaluate this approach in other cancer populations as well as in a larger sample of breast cancer patients to further assess the scope of these findings.

CONCLUSIONS

Balance testing in the clinical setting with trained clinical personnel was conducted in this pilot study, which supports the feasibility of this approach. Preliminary analysis showed a progressive increase in 95% confidence ellipse area during quiet stance with eyes closed.

REFERENCES


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![Figure 2. Least squares means ± standard error of 95% ellipse area during eyes closed task.](image-url)