# RELATIONSHIPS BETWEEN QUIET STANDING AND LIMITS OF STABILITY ASSESSMENTS IN CANCER SURVIVORS

Jeremy D. Smith[1], Abigail L. Carpenter[1], Gary D. Heise[1], Chris P. Repka[1], & John H. Challis[2]

[1]Rocky Mountain Cancer Rehabilitation Institute, University of Northern Colorado, Greeley, CO
[2]The Pennsylvania State University, University Park, PA
email: jeremy.smith@unco.edu

## INTRODUCTION

Common side effects of chemotherapy and radiation treatments in cancer survivors include peripheral neuropathy and vestibular dysfunction. These side effects can lead to a loss of balance, increasing the risk of falling. However, balance and posture in a cancer population has received little to no attention in the research literature. Previous results in a cancer population demonstrate that traditional center of pressure (COP) based measures during quiet standing are sensitive to changes in surface and vision conditions [1,2].

Research has suggested that quiet standing assessments are not associated with an ability recover balance after a balance perturbation [3,4,5]. In cancer survivors who exhibit deficits in posture and balance it is important to understand whether quiet standing assessments alone are enough to identify individuals who may be at a greater risk of falling. Limits of stability (LOS) tests are another means of assessing postural stability. In these assessments, an individual's willingness to approach the stability boundary is assessed by quantifying how far a person is willing to displace his or her COP in both anterior/posterior (AP) and medial/lateral (ML) directions. LOS, however, typically require the availability of some type of harness system to provide support in case of a loss of balance during the assessment. These harness systems may not be available in a clinical setting.

Thus, the purpose of this study was to determine whether measures from LOS and quiet standing assessments are related and essentially provide practitioners with the same information. It was hypothesized that more demanding tasks during quiet standing (e.g., standing on a foam surface with eyes closed) would exhibit higher correlation coefficients with LOS measures given the increased fluctuations of the COP during these types of assessments.

## METHODS

Quiet standing was measured in cancer survivors (n=11; mass = 75.6 ± 22.1 kg; height = 1.60 ± 0.05 m; age = 56 ± 14 years) during four different conditions. For quiet standing assessments, participants stood on a rigid surface with eyes open (RSEO), a rigid surface with eyes closed (RSEC), a compliant surface with eyes open (CSEO), and a compliant surface with eyes closed (CSEC). In addition, participants performed a LOS assessment that involved individuals leaning forward, backward, left, and right as far as possible without losing their balance. Participants were instructed to use an ankle only strategy to perform the movements, and when movements at the other joints were observed, the test was repeated. Figure 1 presents an example stabilogram for each condition.

Force data were sampled at 1000 Hz for 30 s during all assessments. Traditional COP based measures of postural steadiness were calculated in accordance with previous literature [6]. Time-to-boundary measures were also included and were based on previous literature [7]. A lower TTB is indicative of lower postural steadiness given that less time would be available for individuals to recover from a perturbation to their balance.

Root-mean-squares (RMS) of the AP and ML COP, total excursion of the AP and ML COP, mean velocity of the AP and ML COP, 95% confidence ellipse area, mean frequency of AP and ML COP, 95% power frequency of the AP and ML COP, fractal dimension of the confidence ellipse, and absolute minimum TTB were investigated.

COP measures were correlated between LOS assessments and each of the quiet standing assessments. For a two-tailed test, the critical r-value for determining statistical significance was 0.60 (n = 11; $\alpha = 0.05$).

## RESULTS AND DISCUSSION

A total of 52 correlations (13 COP measures x 4 contrasts) were analyzed and only two were statistically significant: RMS distance of the ML COP (RSEO) and LOS (r = 0.61); mean frequency of the ML COP (CSEO) and LOS (r = 0.60).

The lack of correlation between static assessments and LOS, a dynamic assessment, is consistent with previous results in the literature. Mackey and Robinovitch reported that postural steadiness during quiet stance was not related to the ability to recover balance from a maximum lean test [3]. Maki et al [4] found that quiet standing measures did not correlate with induced sway during force platform translations. Owings et al. [5] concluded that postural steadiness during quiet standing was independent of the ability to recover balance after a tethered release and after an unexpected trip. Others [3] have suggested that the lack of correlation between static and dynamic postural assessments may be due to differences in control strategies between the two tasks. Our results agree with this interpretation and suggest that the control strategy during quiet stance was different than the control strategy during the LOS assessment. Both quiet standing and some form of dynamic assessment (e.g., LOS) should be used to assess postural steadiness in cancer survivors.

## CONCLUSIONS

Our hypothesis that more demanding tasks during quiet standing would exhibit higher correlation coefficients with LOS measures was rejected. COP measures during LOS assessments and quiet standing appear to be independent of each other.

## REFERENCES


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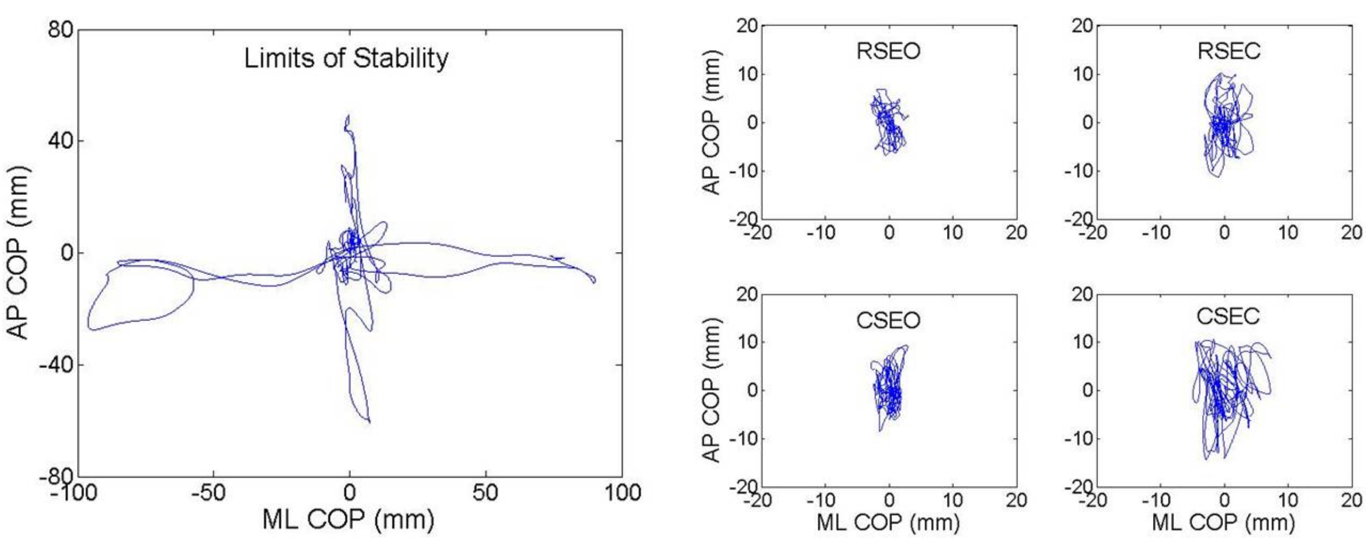


**Figure 1.** Stabilograms of the LOS (left panel), RSEO (top, middle panel), RSEC (top, right panel), CSEO (bottom, middle panel), and CSEC (bottom, left panel) conditions. These data are from one participant that was chosen at random to illustrate the characteristic differences in COP trajectories during the five tests.