Relationship between balance function and QOL in cancer survivors and healthy subjects

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Abstract
A previous study reported that cancer survivors exhibit decreased postural stability compared to age-matched controls. Another study showed that cancer survivors have a lower quality of life (QOL) compared to healthy subjects, and there was a significant relationship between muscle strength and QOL in cancer survivors. We aimed to investigate differences in the associations between balance function and QOL in cancer survivors and healthy subjects.

Forty-one cancer survivors and 33 healthy subjects were included. Balance function was evaluated using the timed up and go test, and body sway was tested using a force platform. QOL was assessed using the medical outcome study 36-item short-form health survey.

Cancer survivors exhibited significantly higher timed up and go lower QOL than that of healthy subjects ($P < 0.05$). There was a significant association between body sway and QOL ($P < 0.05$) among cancer survivors. However, healthy subjects had subscales for QOL related to the body sway test parameters more frequently than cancer survivors ($P < 0.05$).

Cancer survivors’ balance function may have little effect on QOL, unlike in healthy subjects.

Abbreviations: CoP = center of pressure, GH = general health, PF = physical functioning, PR = physical role function, QOL = quality of life, RMS = root mean square, TUG = timed up and go.

Keywords: balance function, cancer survivors, physical therapy, quality of life, rehabilitation

1. Introduction
A previous study reported that cancer survivors exhibit decreased postural stability compared to age-matched controls.\textsuperscript{[1]} Another previous study reported that cancer survivors have reduced balance function when compared to healthy subjects.\textsuperscript{[2]} Other

2. Methods
This was a prospective, observational study of balance function and QOL in cancer survivors and healthy subjects. Subjects were recruited between August 2017 and September 2018. Forty-one cancer survivors and 33 healthy subjects were included, all of whom were assessed once. The survivors’ cancer diagnoses included breast (n = 22), colorectal (n = 3), acute leukemia (n = 3), endometrial (n = 2), lung (n = 1), retroperitoneal sarcoma (n = 1), Ewing sarcoma (n = 1), tongue (n = 1), cervical (n = 1), ovarian (n = 1), bladder (n = 1), testicular (n = 1), and malignant lymphoma (n = 1). The time since the cancer diagnosis of all survivors was > 1 year. The Niigata University of Health and Welfare Institutional Committee on Human Research (Approval No. 18065-180820) approved the study. Written informed consent was obtained from all subjects.

2.1. Balance function
2.1.1. Timed up and go (TUG) test. Timed up and go (TUG) is a reliable, valid test for quantifying functional mobility.\textsuperscript{[3]} The time taken to complete the test was recorded. Participants performed
the TUG twice, and the faster of the 2 measurements was used for analysis.

2.1.2. Body sway testing. Body sway was measured using a gravicorder force platform (GS-10, Anima Inc, Tokyo, Japan) to investigate postural stability among the subjects. Subjects stood for 30 seconds while looking at a 3 cm-diameter round mark placed 2 m away at eye level. The center of pressure (CoP), as the index for postural stability, was measured once using the gravicorder at a 20-Hz sampling rate. Tasks were performed with eyes both opened and closed. The total CoP length (cm), length per area (cm/cm²), environmental CoP area (cm²), rectangular CoP area (cm²), and root mean square (RMS) of the CoP (cm²) were calculated.

2.2. Health-related QOL

General health (GH)-related QOL was assessed using the medical outcome study 36-item short-form health survey. The 36-item short-form health survey assesses physical and mental health components across 8 domains: physical functioning (PF), physical role function (PR), bodily pain, GH, vitality, social functioning, emotional role function, and mental health. This self-administered questionnaire is widely used, particularly among cancer survivors. [6]

2.3. Statistical analysis

The results are presented as means±standard deviations. We compared demographic data between cancer survivors and healthy subjects using Student t test for continuous variables and Pearson chi-squared test for ordinal variables. Two-tailed unpaired t tests were used to compare balance function and QOL between the 2 groups. Pearson r was used to evaluate the association between balance function and QOL. Statistical analysis was performed using SPSS 19.0J (SPSS Japan Inc., Tokyo, Japan). P-values < .05 were considered statistically significant.

### 3. Results

#### 3.1. Clinical and demographic characteristics

No significant difference was observed in the mean age (standard deviation), male-to-female ratio, mean height, body weight, or body mass index between the 2 groups (Table 1).

#### 3.2. Balance tests

TUG time was significantly higher in the cancer survivors than in the healthy subjects (P < .05, Table 1). There were no significant differences in body sway test parameters between cancer survivors and healthy subjects (P > .05), regardless of the testing conditions (ie, eyes open or closed).

#### 3.3. Health-related QOL

PF, PR, and GH were significantly lower in cancer survivors than in healthy subjects (P < .01). No significant differences in other subscales were observed between the 2 groups.

#### 3.4. Associations between balance function and QOL

When cancer survivors had their eyes open, the length per area, environmental CoP area, rectangular CoP area, and CoP RMS were significantly correlated to PF (P < .05, Table 2). Additionally, the length per area was significantly correlated to PR (P < .05). However, the other parameters were not significantly associated with the QOL subscales. When healthy subjects had their eyes open, the environmental CoP area and rectangular CoP area were significantly correlated to PF (P < .05). Similarly, with their eyes closed, the CoP length and environmental CoP area were significantly correlated to PF (P < .05). When healthy subjects had their eyes open, the CoP length, environmental CoP area, rectangular CoP area, and CoP RMS were significantly correlated to GH (P < .05). With eyes both opened and closed, the environmental CoP area and rectangular CoP area were
Correlations between balance function and quality of life among cancer survivors and healthy subjects.

| Group                  | Physical functioning | Role-physical | Bodily pain | General health | Vitality | Social functioning | Role-emotional | Mental health |
|------------------------|----------------------|---------------|-------------|----------------|----------|--------------------|----------------|---------------|
| Timed up and go test (s) | Cancer survivors (n=41) | Healthy subjects (n=33) |             |                |          |                    |                |               |
| Body sway testing eyes open condition | Cancer survivors (n=41) | Healthy subjects (n=33) |             |                |          |                    |                |               |
| Length of CoP (cm)      | Cancer survivors (n=41) | Healthy subjects (n=33) | 0.31*       | 0.32*          | -0.39** |                    |                |               |
| Environmental area of CoP (cm²) | Cancer survivors (n=41) | Healthy subjects (n=33) | -0.44**     | -0.48**        | -0.36*  | -0.44**            | -0.40*         |               |
| RMS of CoP (cm²)        | Cancer survivors (n=41) | Healthy subjects (n=33) | -0.39*      | -0.49**        | -0.42*  | -0.36*             |                |               |
| Body sway testing eyes closed condition | Cancer survivors (n=41) | Healthy subjects (n=33) |             |                |          |                    |                |               |
| Length of CoP (cm)      | Cancer survivors (n=41) | Healthy subjects (n=33) | -0.35*      |                |          |                    |                |               |
| Environmental area of CoP (cm²) | Cancer survivors (n=41) | Healthy subjects (n=33) | -0.38*      | -0.50**        | -0.46** |                    |                |               |
| RMS of CoP (cm²)        | Cancer survivors (n=41) | Healthy subjects (n=33) | -0.44**     |                | -0.39*  |                    |                |               |

Significantly correlated to emotional role function and PR (P < 0.05). When healthy subjects had their eyes open, the environmental CoP area was significantly correlated to mental health (P < 0.05).

4. Discussion

In this study, we showed that cancer survivors had longer TUG times and lower QOL regarding some subscales compared to those of healthy subjects. Furthermore, we found that body sway parameters were significantly correlated to some QOL subscales in both groups. However, healthy subjects had QOL subscales related to the body sway parameters more frequently than cancer survivors. This suggests that there are characteristic differences in balance function and QOL among cancer survivors and healthy subjects.

TUG has been used to assess mobility and requires both static and dynamic balance. Our findings suggest that cancer survivors have decreased mobility balance function when compared to healthy subjects. However, there were no significant differences in the body sway test parameters, which measured postural stability between the 2 groups.[7,8] One study showed that cancer survivors exhibited longer mediolateral RMS and increased CoP velocity than those of age-matched healthy subjects.[1] Another study showed that adult survivors of childhood cancer who were treated with <12 years of chemotherapy had significantly poorer postural control compared to healthy subjects.[9] However, there was no significant difference in postural control between those treated with >12 years of chemotherapy and healthy subjects.[9]

To date, few studies have investigated postural stability among cancer survivors, the results of which are not in agreement.

One study investigated the relationship between postural stability and QOL in elderly adults and reported that QOL could be explained by postural sway variables.[10] We initially expected that cancer survivors would have a more prominent relationship between any parameter in the body sway test and QOL than the healthy subjects would. However, cancer survivors had a minimal relationship between some parameters in the body sway test and QOL when compared to healthy subjects. Our study has a limitation. Our study group was relatively small, and was recruited from a single region, therefore reducing the statistical effectiveness of the findings.

5. Conclusion

Cancer survivors had significantly increased TUG and decreased QOL; however, there were no significant differences in the body sway tests between the 2 groups. There was an association between the body sway parameters and QOL among cancer survivors; however, these associations were weaker than those observed among healthy subjects. Cancer survivors’ balance function may have little effect on QOL, unlike in healthy subjects. As previously reported,[1] cancer survivors’ QOL tends to rely on muscle strength opposed to balance function. Future studies should focus on a single cancer diagnosis and use a larger sample size for improved analysis.

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