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Using Single Leg Standing Time to Predict the Fall Risk in Elderly

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Abstract - **In clinical evaluation, we used to evaluate the fall risk according to elderly falling experience or the balance assessment tool. Because of the tool limitation, sometimes we could not predict accurately. In this study, we first analyzed 15 healthy elderly (without falling experience) and 15 falling elderly (1~3 time falling experience) balance performance in previous research. After 1 year follow up, there was only 1 elderly fall down during this period. It seemed like that falling experience had a ceiling effect on the falling prediction. But we also found out that using single leg standing time could be more accurately to help predicting the fall risk, especially for the falling elderly who could not stand over 10 seconds by single leg, and with a significant correlation between the falling experience and single leg standing time (r = -0.474, p = 0.026). The results also showed that there was significant body sway just before they falling down, and the COP may be an important characteristic in the falling elderly group.**

Keywords: Falling elderly, single leg standing, center of pressure

I. INTRODUCTION

Muscle weakness and balance instability may results in falling between elderly adult, and falling prevention has become an important issue in the preventive medicine. In clinical evaluation, falling experience and Berg balance test are used to predict the fall risk for the elderly. But some research showed that the ceiling effect of the assessment tool will affect the results [1]. Based on our previous data analysis, we suggest that single leg standing time will be simpler and more accurately than other assessments to help predicting the fall risk among elderly, and COP trajectory can characteristize the body stability during the single stand task.

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II. METHOD

A. To follow up the elderly postural control for one year

First, we analyzed 30 elderly adults in previous study. According to the falling experience, they were grouped into healthy elderly (HE) group and falling elderly (FE) group from the community volunteers, and table 1 showed the demographic data of fall experience, age, height, weight, Berg balance scale (BBS), single leg standing time, and COP trajectory between two groups [2].

Table 1: Demographic data in previous study

	HE group (n = 15)	FE group (n = 15)	*p*
Fall experience (time)	None	1~3 time in each subject	<0.001*
Gender	Female: 9 Male: 7	Female: 10 Male: 5	-
Age (yr)	70.87±4.91	72.46±4.66	0.363
Height (cm)	159.66±8.05	157.43±6.88	0.417
Weight (kg)	61.38±7.58	56.77±6.87	0.087
BBS	55.33±1.18	53.73±1.44	0.002*
BBS-single leg stand	3.80±0.41	3.60±0.91	0.730
Single leg standing time (sec)	17.58±3.40 (7.17~20)	13.91±4.92 (3.77~20)	0.087
COP trajectory (mm)	2.04±0.89	5.58±1.70	<0.001*

Then we followed up these subjects for one year, although there were significant difference in falling experience, but there was only one elderly falling

down during this period (table 2), and it seemed that falling experience may not be a good method to help grouping or predicting the falling. With the overlapping of single leg standing time between two groups 7.17~20 sec vs. 3.77~20 sec, we thought that maybe using the total score of BBS may not help discriminated the fall risk for independent walking elderly. And the one who fall down in the follow up period could stand for 10.67 sec, but the BBS total score is 55.

Table 2: Falling experience before and after 1 year

	HE group (n = 15)	FE group (n = 15)
Fall experience (time)	None	1~3
Fall experience after 1 year (time)	None	Only 1 elderly fall down 1 time

Finally, we suggested using single leg standing time to help grouping the healthy group and falling group. As previous study mentioned, the healthy elderly may stood over 20 seconds, and the elderly with fall risk may stood only 10 seconds or less.

B. To recruit elderly by single leg standing time

After the adjustments of grouping criteria, we recruited twenty four community elderly which could walk independently to attend this study. The subjects were between 65 to 75 years old, and had no musculoskeletal disease, neuromuscular disease, postural related problem, stroke history, et al. All of them were informed to stand by dominant leg for at least 30 seconds for 3 trials, and the standing time and the COP trajectory were acquired by 0.5m foot pressure plate (RSscan Inc., Belgium) in sampling rate 30Hz for 30 seconds.

For all data, using Kolmogorov-Smirnov analysis to test the normality, and if the data reveal normal distribution, independent t-test will be analyzed between groups. Statistical analyses are performed using SPSS version 12.0, and the *p* value of less than 0.05 is considered for statistical significant.

III. RESULTS

Based on previous study, we first found out that using falling experience and BBS could not predict the fall risk accurately for the walking indecently elderly. Furthermore, there was a ceiling effect in the single leg standing item. Both two groups had no difference in the score of single leg standing (3.80±0.41 vs. 3.60±0.91, $p = 0.730$), which meant they were able to lift leg independently and hold 5-10 seconds. Comparing to the actual standing time, the subjects could stand from 3.77 to 20 second, and these extremely difference could not reflect in the BBS single leg standing item.

So, in present study, after grouping the elderly by single leg standing time, the demographic data showed that there were significant difference between single leg standing time, falling experience, and COP trajectory (table 3). And in each 5 seconds interval, we also could find out that healthy elderly had stability postural control during single leg standing task (COP trajectory 0.49~0.60 mm), but the falling elderly showed significantly COP increased (from 1.49 to 2.52 mm) while they failed the single leg standing task (figure 1).

To compare the maximum medial-lateral, anterior-posterior COP displacement, and results showed that there were significant greater COP displacement in falling elderly than the healthy elderly (fig 2, fig 3).

We also found out that there was a significant correlation between falling experience and single leg standing time, the elderly with less falling experience had longer single leg standing time (fig 4).

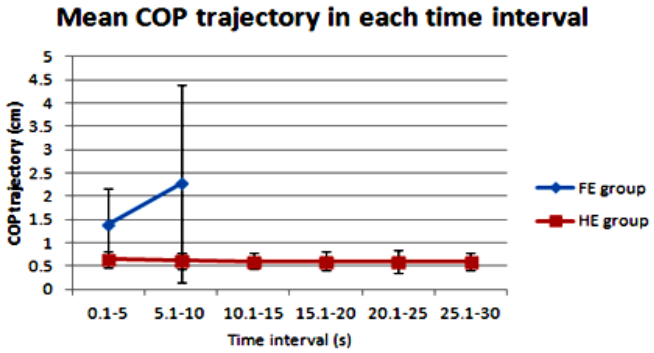

Figure 1: COP trajectory in each timing interval

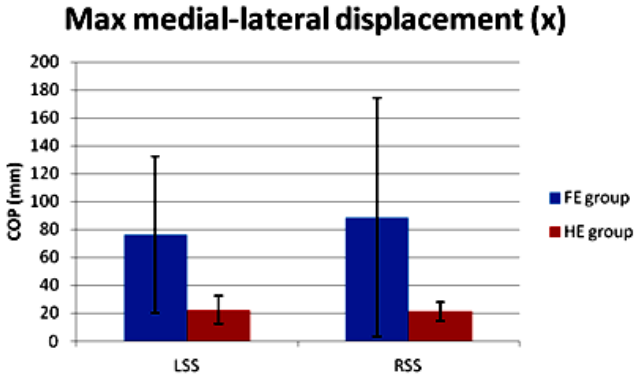

Figure 2: Max medial-lateral COP displacement

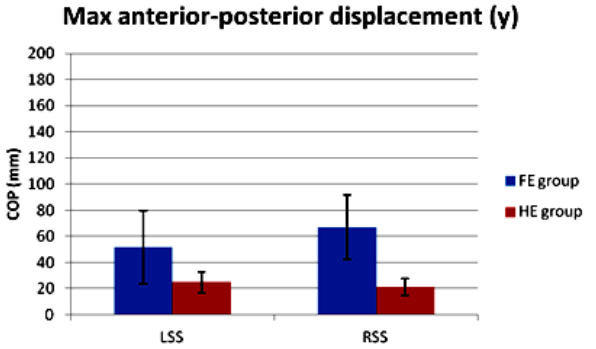

Figure 3: Max anterior-posterior COP displacement

Table 3: Demographic data in present study

	HE group (n = 9)	FE group (n = 11)	*p*
Single leg standing time (s)			
Right single leg stand	28.70±2.79 (22.01~30)	6.55±2.37 (2.69~9.58)	<0.001*
Left single leg stand	29.82±0.52 (28.53~30)	6.04±2.42 (1.88~9.78)	<0.001*
Gender	F: 8, M: 1	F: 8, M: 3	-
Age (yr)	67.78±1.72	71.91±2.70	0.001*
Height (cm)	157.68±3.75	156.05±8.83	0.615
Weight (kg)	56.40±9.23	59.10±8.72	0.511
Fall experience (time)	None	1~3 time in each subject	0.001*
COP trajectory (cm)			
Right single leg stand	0.59±0.19	1.81±1.32	0.015*
Left single leg stand	0.63±0.20	1.66±0.99	0.017*
Max. COP medial-lateral displacement (mm)			
Right single leg stand	21.24±6.58	88.90±85.20	0.030*
Left single leg stand	22.47±9.97	76.35±55.91	0.017*
Max. COP anterior-posterior displacement (mm)			
Right single leg stand	24.77±6.26	67.13±47.23	0.017*
Left single leg stand	27.84±8.09	51.78±40.18	0.119

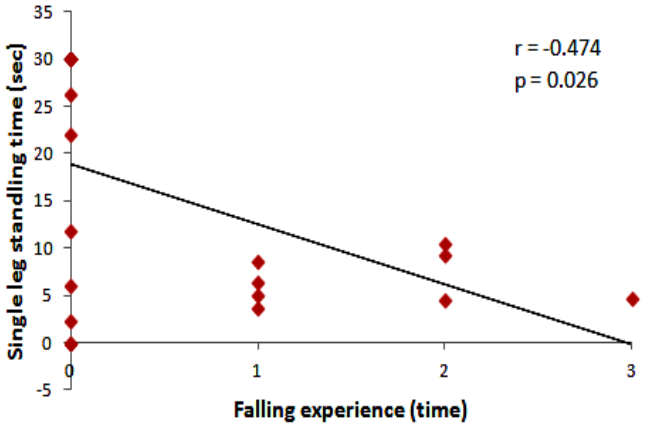

Figure 4: Correlation between fallling experience and single leg standing time

IV. Conclusions

It was our first study to use single leg standing time to discriminate the fall risk between elderly. The data showed that there was a significant difference in COP trajectory between healthy elderly and those with fall risk, and the single leg standing time also had a correlation with the falling experience. Due to the small sample size, there may be an age effect in our results, the falling group with less single leg standing time was also older than the healthy group. To confirm our prediction accurately, we should focus on the same range of age to help establishing the fall risk prevent model.

Acknowledgment

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