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Posturography parameters in patients with the history of ankle sprain – a pilot study

Joonhyun Park[1*], Woo Kyung Park[1], Hyun Seok Kwak[1], Mi Ri Suh[1,2], Kyunghoon Min[1,2†]

CHA Bundang Medical Center, CHA University School of Medicine, Department of Rehabilitation Medicine[1], CHA University, Rehabilitation and Regeneration Research Center[2]

Introduction
The ankle is the most common area for a ligament injury. Previous ankle sprain is associated with a 2.3-fold greater recurrence. Chronic ankle instability is characterized by recurrent ankle sprain and leads to the sensation of "giving way" suggesting decline in balance ability. The posturography is a technique that measures balance in certain postures. In this study, we aimed to reveal the pattern of balance parameters in patients with the history of ankle sprain through the posturography.

Method
From the database of our institute between 2014 and 2018, patients who were diagnosed with ankle sprain were extracted. Among them, those who underwent the posturography test were included. Patients with known neurological disorders were excluded. Data was collected by the static posturography device Tetrax® (Sunlight Medical Ltd) in 8 standardized positions. One sample t-test was done to compare each parameters to known mean values. Statistical analysis was done with SPSS (IBM, version 21).

Results
A total of 10 patients were included for the analysis. First, by comparing the results at the basic posture (normal eyes open, NO) with known normal reference value, we found significant differences in Fourier index (FI) of frequency ranges F2, F5 and F6 (Table 1). The stability index (ST) and weight distribution index (WDI) were also significantly different from the normal mean values. The Fourier Power spectrum (Figure 1) shows the FIs of low frequency (F1) and high frequency (F7-8) are reduced compared to normal profile while FIs of the medium frequency (F2-4 and F5-6) take up more portion. When defining values less than -1 or greater than 1.5 standard deviations from the average as abnormal cases, F2-4 results were all abnormal in postures with the position change of head in 7 out of 10 patients. At head lateral tilting postures, the synchronized indices (SI) were abnormal in 27.8% of total cases. Compared to SI in other postures, SI in head tilting posture appeared to have higher sensitivity (Figure 2).

Conclusion
In this study, several posturography abnormalities were observed in patients with the history of ankle sprain. The medium-frequency FI was sensitive in assessing overall ankle instability, while SI was sensitive in assessing balance decline caused by unilateral ankle

instability. Further study with larger number of patients will be necessary to develop more accurate indicator for assessing chronic ankle instability.

Table 1. Parameters of posturography comparing the patients and normal group in basic posture

	Total (n=10)	Reference value	p-value
ST	49.4 ± 5.0	17.4 ± 8.3	0.058
WDI	5.0 ± 2.3	9.1 ± 3.2	< 0.001*
F1	13.8 ± 5.2	17.4 ± 8.3	0.035*
F2	12.0±3.7	9.1 ± 3.2	0.035*
F3	6.4 ± 2.6	6.7 ± 2.2	0.750
F4	5.4 ± 2.0	4.2 ± 1.2	0.092
F5	3.2 ± 0.7	2.6 ± 0.8	0.014*
F6	2.3 ± 0.6	1.8 ± 0.9	0.027*
F7	0.6 ± 0.2	0.7 ± 0.3	0.079
F8	0.1 ± 0.1	0.2 ± 0.1	0.147

All parameters were measured in basic posture (normal eyes open ;NO),
*p<0.05 by one sample t-test comparing the mean value of sample data with mean reference values,
Abbreviations: ST;General stability index, WDI;Weight Distribution Index F1 - F8; Fourier indices of specific frequency range (F1; 0.01-0.1Hz, F2; 0.1-0.25Hz, F3; 0.25-0.35Hz, F4; 0.35-0.5Hz, F5; 0.5-0.75Hz, F6; 0.75-1.0Hz, F7; 1-3Hz, F8; 3Hz and above)
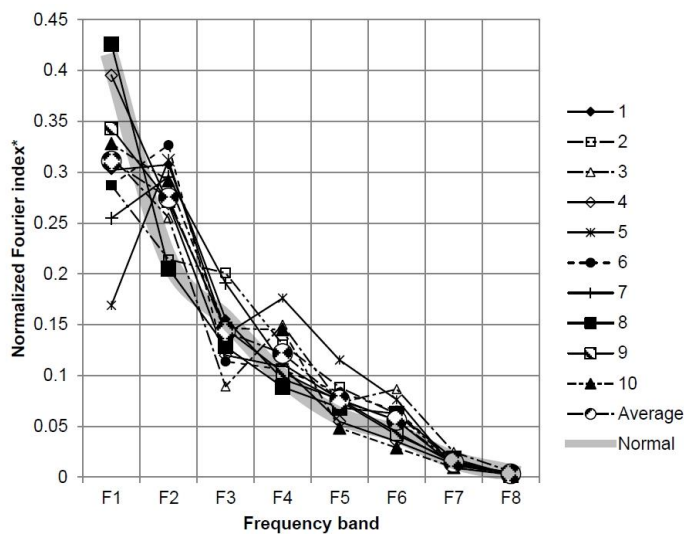
F1 = 0.01-0.1Hz, F2 = 0.1-0.25Hz, F3 = 0.25-0.35Hz, F4 = 0.35-0.5Hz, F5 = 0.5-0.75Hz, F6=0.75-1.0Hz, F7=1-3Hz, F8= 3Hz and above.
*Normalized FI = FI divided by summation of FI F1~F8

Figure 1. The Fourier Power spectrum of postural sway pattern (at normal eyes open position)
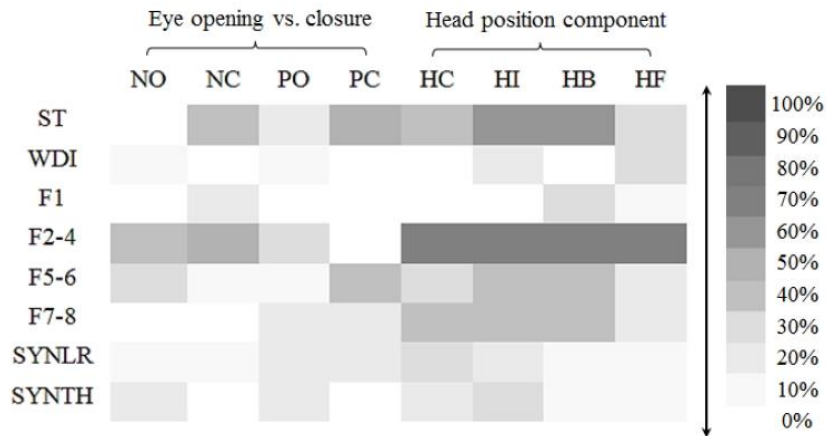
NO = normal eye open, NC = normal eye close PO = pillow with eye open, PC = pillow with close eye, HC = head tilt to the contralateral side of affected limb, HI = head tilt to the ipsilateral side of affected limb, HB = head back, HF = head forward, ST = stability index, WDI = weight distribution index, F1 = Fourier index(FI) of 0.01-0.1Hz, F2-4 = FI of 0.1-0.5Hz, F5-6 = FI of 0.5-1Hz, F7-8 = FI of 1Hz and above, SYNLR = synchronization index of left to right, SYNTH = synchronization index of toes to heel

Figure 2. Percentage of abnormal posturography parameters in different postures (n = 10)