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RESEARCH LETTER

Changes in Blood Pressure Reactivity Against Physical Activity Evaluated by Multisensor-ABPM in Heart Failure Patients

The pathologic significance of blood pressure (BP) variability in patients with heart failure (HF) has not been fully elucidated. Although HF pathophysiology is known to involve cardiac function and autonomic nervous dysfunction, which may lead to a pathologic BP response to physical activity, assessment of the pathophysiology of HF remains challenging under an ambulatory condition. We previously described a patient with an increase in BP reactivity during physical activity after an improvement of cardiac function.[1] We propose the term "actisensitivity" to describe such BP reactivity in response to physical activity; this new aspect of BP variability can be evaluated using our recently developed device, a multisensor-ambulatory BP monitoring (ABPM) device (TM-2441, A & D Co) equipped with: 1) an actigraph that can detect physical movements in 3 directions using an accelerometer; 2) a thermometer; and 3) a barometer.[2] In the present study, actisensitivity is defined as the slope of the regression line that is calculated from 24-h ambulatory systolic BP (SBP) with the log-transformed value corresponding to the 5-minute average of physical activity just before each BP measurement (**Figure 1**).[1,2] In the present study, we prospectively assessed the changes in actisensitivity and ambulatory blood pressure (ABP) parameters between patients with and without improved cardiac function during the treatment of HF.

We assessed multisensor-ABPM data in 20 patients with diagnosed HF (mean age, 63.3 ± 14.1 years; male: 65%; ischemic heart disease: 15%; atrial fibrillation: 25%) just after initial or adjusted treatments, and reassessed the multisensor-ABPM data at follow-up from 6-12 months after tailored treatment. Second, we divided these patients into an improved (n = 11 patients) and a not-improved (n = 9) cardiac-function group; an increase in echocardiographic left ventricular ejection fraction (LVEF) of ≥10% as determined using the biplane method of disks was used as the cutoff.[3] We then compared the changes in actisensitivity and ABP parameters between the 2 groups. Multisensor-ABPM was measured automatically at 30-min intervals for 24 hours using an oscillometric method, and the daytime and nighttime were based on a diary. Patients were recruited during hospitalization or as outpatients. All examinations including multisensor-ABPM and echocardiography were measured in stable condition, ie, all patients could walk alone. Echocardiography was conducted within 1 month before and after the multisensor-ABPM measurements. This study was approved by the Institutional Review Board of the Jichi Medical University School of Medicine and informed consent was obtained from all participants.

LVEF at baseline and follow-up were 29.8% ± 7.2% and 44.9% ± 5.8% in the improved group (n = 11) and 40.8% ± 13.3% and 39.7% ± 12.5% in the not-improved group (n = 9), respectively. In the improved group, 24-hour and nighttime diastolic BP decreased at follow-up (24-hour BP at baseline vs follow-up: 115.5 ± 22.1/79.4 ± 16.4 mm Hg vs 113.7 ± 21.7/74.9 ± 13.0 mm Hg; $P = 0.606$ and $P = 0.040$ for SBP and diastolic BP, respectively; nighttime BP: 112.6 ± 21.6/78.8 ± 16.9 mm Hg vs 105.9 ± 20.8/69.6 ± 12.5 mm Hg; $P = 0.272$ and $P = 0.041$, respectively). These changes were not observed in the not-improved group. Parameters of ABP variability—ie, SD, coefficient of variation, and average real variability of SBP over 24 hours, daytime or nighttime—were not significantly different between baseline and follow-up in either group. Additionally, physical activity (G) did not change between baseline and follow-up in either group. However, the actisensitivity value tended to increase from baseline to follow-up in the improved group (1.0 ± 3.5 vs 4.5 ± 3.5; $P = 0.065$), but not in the not-improved group (3.2 ± 5.4 vs 2.0 ± 6.3; $P = 0.479$). The degree of changes in actisensitivity from baseline to follow-up tended to be higher in the improved group than the not-improved group (3.5 ± 5.6 vs −1.2 ± 4.8; $P = 0.059$). Moreover, in the overall patient group, the change of actisensitivity from baseline to follow-up was significantly related to the changes of LVEF ($r = 0.553$; $P = 0.011$) (**Figure 1**).

Although the present study was conducted in a small sample, to our knowledge this is the first study to prospectively observe the changes of ABP profiles and novel BP reactivity against physical activity actisensitivity in patients with HF using the new

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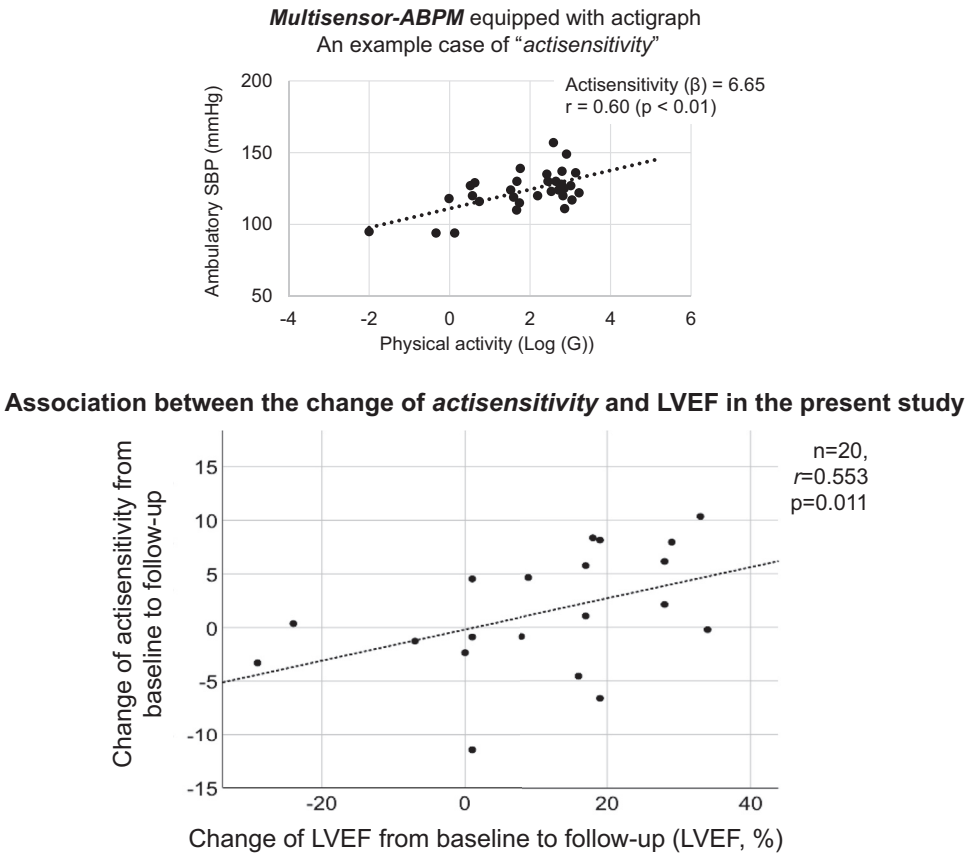
FIGURE 1 Changes of Actisensitivity and LVEF From Baseline to Follow-Up



(Top) Actisensitivity is calculated as the slope of the regression line of ambulatory SBP with the log-transformed value of physical activity before each BP measurement. **(Bottom)** The change of actisensitivity from baseline to follow-up was significantly associated with the change of LVEF in the present study. ABPM = ambulatory blood pressure monitoring; BP = blood pressure; LVEF = left ventricular ejection fraction; SBP = systolic blood pressure.

multisensor-ABPM device. The results showed that actisensitivity increased in patients with improved cardiac function despite a lack of change in ABP variability parameters. Patients with preserved LVEF exhibit elevated BP in response to physical activity compared with reduced LVEF.[4] In addition, a decreased peak BP level during exercise in a laboratory setting predicts poor prognosis in patients with reduced LVEF.[5] The increased actisensitivity in the improved group would be explained by the increased stroke volume responded to physical activity caused by improved cardiac function. Our findings should help to elucidate the relationships between BP variability/hemodynamics during physical activity and cardiac function in patients with HF.

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

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