Effect of Balance Training on Walking Speed and Cardiac Events in Elderly Patients With Ischemic Heart Disease

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Summary
The purpose of this study was to clarify the effect of standing balance training on walking speed (short-term outcome) and cardiac events (long-term outcome) in elderly ischemic heart disease (IHD) patients. This was a retrospective cohort study. Ninety-two elderly (≥ 65 years) IHD patients who underwent an inpatient cardiac rehabilitation program were assigned to two groups: a balance group that received standing balance training in addition to conventional (aerobic and resistance) training and a conventional group. Standing balance was assessed by one-leg standing time and a postural stability index reflecting dynamic balance, and normal walking speed was measured at baseline and hospital discharge. Patients were followed for up to 3 years or until a cardiac event occurred. There were no significant differences in clinical characteristics between the groups. Both groups showed a significant change in normal walking speed from baseline to hospital discharge (P < 0.001, respectively), and normal walking speed was significantly higher in the balance group compared to the conventional group (P = 0.001). The postural stability index improved significantly only in the balance group (P = 0.005). Multivariable analyses using Cox proportional hazards model confirmed that standing balance training (hazard ratio [HR]: 0.408; 95% confidence interval [CI]: 0.162-1.029; P = 0.058) and fast walking speed (HR: 0.362; 95% CI: 0.137-0.957; P = 0.041) were associated with cardiac events. These findings show that standing balance training improves walking speed and reduces cardiac events, and suggests that such training can be an effective intervention for elderly IHD patients. (Int Heart J 2014; 55: 000-000)

Key words: Coronary artery disease, Standing balance, Aging, Secondary prevention, Cardiac rehabilitation

Decreased walking speed in elderly people is closely related to physical inactivity, difficulty performing physical activities of daily living, and health-related events.1) A 3-year prospective cohort study showed that well-functioning elderly people with a slow walking speed (≤ 90 m/minute for men and ≤ 81 m/minute for women) have an almost 3-fold higher risk of cardiovascular mortality compared to those with a fast walking speed (> 111 m/minute for men and > 90 m/minute for women).1) Therefore, walking speed is considered a valuable parameter for assessing lower extremity functional status and prognoses such as disability, institutionalization, and/or mortality after adverse health-related events in community-dwelling elderly.

In the clinical setting, walking speed tests at maximal or normal pace over 6 or 10 meters are also quick, safe, inexpensive, and reliable assessment tools. Oster, et al10) reported that cardiac patients have approximately a 5- to 8-fold greater degree of deterioration in lower extremity performance, including walking during hospitalization, compared to well-functioning elderly people. Moreover, clinical data5) at hospital discharge reveal that walking speed in patients with acute myocardial infarction (AMI) is approximately 70% of well-functioning, community-dwelling people regardless of age and sex, and 30% of men and 40% of women who were elderly AMI patients had a walking speed slower than those reported in the cohort study mentioned above. Thus, walking speed is a brief, quantitative estimate of health and functional decline in clinical populations of elderly patients.

Our previous cross-sectional study5) showed that the most powerful factors associated with walking speed in AMI patients at hospital discharge are motor functions, regardless of age and sex after adjusting for clinical characteristics. The only motor function associated with walking speed in middle-aged AMI patients is leg strength, whereas both leg strength and standing balance are associated with walking speed in elderly AMI patients. However, very few studies have reported on an exercise regimen directed to improving walking speed among elderly patients.

The purpose of this study was to clarify the effect of an inpatient cardiac rehabilitation program that includes standing balance training on the following outcomes: 1) future walking speed and 2) cardiac events in elderly patients with ischemic...
Methods

Study design and participants: This was a retrospective cohort study conducted at the Cardiovascular Center of Kitasato University Hospital. We recruited a consecutive series of elderly patients with IHD (≥ 65 years) admitted to the Cardiovascular Center of Kitasato University Hospital from July 2006 to November 2009. These patients underwent percutaneous coronary intervention or coronary artery bypass surgery following coronary angiography to detect significant coronary lesions. All patients participated in a supervised cardiac rehabilitation program during hospitalization.

We included patients who could walk without assistance, with a perfect score on the Barthel index at hospital discharge. We excluded patients who had any of the following conditions: previous hospitalization for heart failure, uncontrolled arrhythmias, uncontrolled hypertension, end stage kidney disease (estimated glomerular filtration rate < 15 mL/minute/1.73 m²), required hemodialysis, peripheral artery disease, diabetic retinopathy, required assistance to walk at hospital discharge or had other conditions that limited walking ability (eg, dementia, low vision or blindness, orthopedic abnormalities, and paralysis due to stroke). Moreover, patients were excluded if they performed additional exercise training (eg, yoga or calisthenics exercises) other than the prescribed exercise program after hospital discharge. Consequently, 92 elderly patients with IHD were eligible for inclusion in the study.

The study protocol was approved by the Ethics Committee of Kitasato University, and we obtained written informed consent from all participants after the study protocol was explained in detail. This study was conducted in accordance with the standards set forth by the latest revision of the Declaration of Helsinki.

Supervised exercise training programs for inpatient and outpatient cardiac rehabilitation: The supervised inpatient cardiac rehabilitation program consists of two exercise stages. All patients participated in the first stage of the program and were divided into two groups at the second stage: a conventional group that received conventional training combined with aerobic and resistance training between July 2006 and October 2007, and a balance group that received standing balance training in addition to conventional training between November 2007 and November 2009.

The first stage of the program comprises basic activity training, such as sitting up in bed, sit-to-stand motions, self-care, and walking within the ward, which are usually started on the second day after hospital admission. Patients proceeded to the second stage after they complete the first stage of the program. Exercise training in the second stage consists of 5 minutes of stretching, two sets of 10 repetitions of resistance training such as half squats and heel raises using the patient’s own weight, and 20-30 minutes of aerobic training by cycling ergometer or treadmill walking including a warm-up and cool-down. Exercise intensity, exercise time and repetition frequency for both types of training were prescribed for patients at 1) heart rate (HR) ≤ 120 beats/minute, 2) HR at rest + 20 beats/minute as the upper limit, or 3) rating of perceived exertion (RPE) of 11-13 on the Borg RPE scale of 6 to 20 according to the American College of Sports Medicine’s guidelines for exercise testing and prescription and/or the Japanese Circulation Society’s guidelines for rehabilitation in patients with cardiovascular disease (JCS 2007). For the balance group, 5 minutes of standing balance training that consisted of tandem standing and one-leg standing were added to conventional training at the second stage of the program. Tandem standing is defined as standing with one foot placed in front of the other with the heel touching the toe while the patient’s eyes are open. Patients were instructed to hold the one-leg standing and tandem standing positions without falling for 10 seconds each.

Patients in both groups participated in the cardiac rehabilitation program for one hour 5 times a week during hospitalization unless they developed adverse symptoms or events after coronary intervention.

After hospital discharge, some patients participated in the outpatient cardiac rehabilitation program. At hospital discharge, diabetics and pharmacists gave each patient dietary and medication instructions, respectively, while nurses educated each patient on cardiovascular risk factors and smoking cessation. Physical therapists prescribed aerobic walking training and resistance training (eg, half squats and heel raises), as necessary. Patients in both groups were individually instructed to do home-based exercises corresponding to the exercise content and intensity prescribed from hospital discharge to 3 months after hospital discharge. Furthermore, all patients were followed up regularly every month for 3 months after hospital discharge, and every 3 or 6 months thereafter for about 3 years in order to assess treatment compliance (eg, prescribed rehabilitation program) and possible adverse events. These assessments were carried out by cardiologists at the outpatient department of Kitasato University Hospital. At follow-up interviews, cardiologists asked outpatients several questions regarding the type, mode, and frequency of home-based exercises. Moreover, the cardiologists had arranged to order the cardiac rehabilitation staff (eg, physical therapist and/or nurse) to check the exercise program if the patients have changed the prescribed exercise program after 3 months of the outpatient cardiac rehabilitation program.

Clinical characteristics: Age, sex, body mass index (BMI), comorbidities (hypertension, diabetes mellitus, and dyslipidemia), numbers of patients with acute coronary infarction (AMI) and coronary artery bypass graft surgery (CABG), left ventricular ejection fraction (LVEF) by echocardiography, and peak serum creatine kinase (CK) were assessed at baseline. Brain natriuretic peptide (BNP), hemoglobin, estimated glomerular filtration rate (eGFR), and medications including calcium antagonists, β-blockers, angiotensin converting enzyme inhibitors or angiotensin II receptors blockers (ACE/ARB), diuretics, and statins were assessed at hospital discharge. In addition, we used clinical records to assess the duration of cardiac rehabilitation, hospital stay, and percentage of patients who participated in the outpatient cardiac rehabilitation program for 3 months.

Short-term outcomes of cardiac rehabilitation program including standing balance training Assessment of motor function: We used leg strength and standing balance to assess motor functions as indicators of short-term outcomes.

Assessment of leg strength: Maximum voluntary isometric knee extensor strength was measured twice with a hand-held dynamometer (μTas MT-1; Anima, Tokyo) with participants
seated in a chair with the hip and knee flexed at 90 degrees. We evaluated leg strength at the end of the supervised cardiac rehabilitation program and expressed it as a percentage of body weight (%BW) by dividing the average value of the right and left maximum isometric leg strength by body weight.

**Assessment of standing balance:** Standing balance was evaluated at the end of the supervised cardiac rehabilitation program using two balance indices: one-leg standing time and the postural stability index. For one-leg standing time, we used a stopwatch to measure the time of each trial. Participants were asked to stand on one leg with their eyes open while holding their hands on their waist, without any aid or falling. The measurement was assessed as the time that participants could stand on one leg for 60 seconds in the first trial. The postural stability index reflects the ability to shift the center of pressure in a desired direction as far as possible within the base of support, and hold the center of pressure at the farthest position in the desired direction without falling. A stabilometer (gravicorder G-6100; Anima, Tokyo) was used to measure the postural stability index. We first asked participants to stand on the stabilometer platform barefoot for 10 seconds with a stance width of 10 cm, their eyes open, and their arms relaxed at their sides (neutral position). Then we instructed participants to shift their center of pressure in the anterior, posterior, right, and left directions as far as possible, and hold the center of pressure at the farthest position in each direction for 10 seconds without lifting their feet off the stabilometer platform. The following equation was used: postural stability index = log [(area of stability limit + area of postural sway) / (area of postural sway)]. A low index score indicates poor standing balance.

**Assessment of walking speed:** We measured normal and maximal walking speeds twice while participants walked a distance of 10 m at a normal and maximum speed without running, respectively. The highest values for each walking speed, expressed in meters per minute, were recorded. The measurement of normal walking speed was performed at baseline and discharge, and maximum walking speed was performed only at discharge. We also assessed the number of patients with a fast walking speed at discharge. Fast walking speed was defined as > 90 m/minute for men and > 81 m/minute for women.

**Long-term outcome of cardiac rehabilitation program including standing balance training Assessment of cardiac events:** We assessed cardiac events as indicators of long-term outcome. The participants were followed for up to approximately 3 years or until the following cardiac events occurred: cardiac death, admission for heart failure, or myocardial infarction. Diagnoses for primary cause of admission were recorded using the International Classification of Diseases, 10th revision (ICD-10). Heart failure is defined as ICD-10 code I50. Myocardial infarction is defined as ICD-10 codes I21-I22. Cardiac event-free times indicated the times from hospital discharge to the occurrence of the cardiac event or the end of follow-up.

**Statistical analysis:** Differences in clinical characteristics and leg strength between the conventional and balance groups were assessed for significance using the unpaired Student’s t-test and chi-square test. We analyzed between-group differences from baseline to discharge using two-way repeated-measures ANOVA.

Kaplan-Meier analysis was used to estimate a long-term effect, and we analyzed the statistical significance of the difference in cardiac event-free times between groups using the log-rank test. Multivariable analysis was performed using the Cox proportional hazards method to estimate the independent prognostic effect of standing balance training on cardiac events. For short-term outcome, we had 30 patients in the conventional group and twice as many patients in the balance group. We assumed that an improvement in walking speed to be 6 m/minute in the conventional group and 16 m/minute in the balance group, with a standard deviation of 10 m/minute. This sample size would provide a power of > 87% with alpha (Type-1 error rate) set at 0.05. The Power and Sample Size Calculation Version 3.0.24 (PS; Department of Biostatistics, Vanderbilt University, TN, USA) was used for the sample size calculation. For long-term outcome, there were 20 cardiac events, which allowed up to two variables to be included in a multivariable regression model. To avoid over-fitting, we reduced all potential confounding factors in addition to standing balance training to a single composite characteristic by applying a propensity score. For further sensitivity analysis, the Kaplan-Meier method and Cox proportional hazards method were also applied to long-term effects for walking speed. We used the conventional P-value of 0.05 or less to determine the level of statistical significance. All analyses were performed using the Statistical Package for Social Sciences (SPSS version 12.0; SPSS, Chicago, IL, USA).

**Results**

**Participant characteristics:** Table I shows the clinical characteristics of participants in both groups. There were no significant differences in age, percentage of men, percentages of participants with AMI and CABG, BMI, LVEF, comorbidities, duration of cardiac rehabilitation and hospital stay, clinical laboratory data, or medications between the groups. After discharge from the hospital, 77.8% of the conventional group and 78.6% of the balance group participated in the outpatient cardiac rehabilitation program for 3 months. There was no significant difference in adherence between the groups.

**Short-term effects of cardiac rehabilitation program including standing balance training:** Table II shows leg strength, standing balance, and walking speed in both groups. There were no significant differences in leg strength and maximum walking speed at discharge between the groups, but the percentage of participants with fast walking speed was significantly higher in the balance group compared to the conventional group (P = 0.033).

There were no significant differences in one-leg standing time, postural stability index, or normal walking speed at baseline between the groups. No group × time effects were observed for one-leg standing time, and one-leg standing times in both groups significantly improved from baseline to discharge (P < 0.001, time effect). On the other hand, there were significant group × time effects for the postural stability index and normal walking speed (P = 0.033 and P < 0.001, respectively). The postural stability index of the conventional group did not change significantly from baseline to discharge, but that of the balance group significantly improved (P = 0.005). Normal running speed at discharge between the groups, but the percentage of participants with fast walking speed was significantly higher in the balance group compared to the conventional group (P = 0.033).
Walking speeds of both groups were significantly improved from baseline to discharge ($P < 0.001$, time effect), but that of balance group at discharge was significantly faster than that of the conventional group ($P = 0.001$).

**Long-term effects of cardiac rehabilitation program including standing balance training:** The overall follow-up periods ranged from 1 to 43 months. Eleven patients (36.7%) in the conventional group and 9 patients (14.5%) in the balance group were readmitted due to a cardiac event during the follow-up period. Of these, 3 patients in the conventional group and 1 patient in the balance group had myocardial infarction; 8 patients in the conventional group and 7 patients in the balance group had heart failure; and 1 patient in the balance group died of myocardial infarction. Standing balance training was significantly associated with higher event-free survival for IHD patients ($P = 0.036$; Figure 1). Moreover, 9 patients (37.5%) among those with slow walking speed and 11 patients (16.2%) among those with fast walking speed were readmitted due to a cardiac event during the follow-up period. Fast walking speed was significantly associated with higher event-free survival for IHD patients ($P = 0.025$; Figure 2).

Table III shows a Cox proportional hazards model. With univariable analyses, standing balance training (hazard ratio (HR): 0.402; 95% confidence interval (CI): 0.166-0.970; $P = 0.043$), normal walking speed (HR: 0.653; 95% CI: 0.447-0.955; $P = 0.028$), and fast walking speed (HR: 0.378; 95% CI: 0.156-0.913; $P = 0.031$) were significantly associated with cardiac events. With multivariable analyses using the propensity score, the HRs of standing balance training, normal walking speed, and fast walking speed changed to 0.408 (95% CI: 0.162-1.029; $P = 0.058$), 0.662 (95% CI: 0.449-0.974; $P = 0.037$), and 0.362 (95% CI: 0.137-0.957; $P = 0.041$), respec-

### Table I. Clinical Characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Conventional group ($n = 30$)</th>
<th>Balance group ($n = 62$)</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>73.1 ± 5.9</td>
<td>72.6 ± 6.9</td>
<td>0.725</td>
</tr>
<tr>
<td>Men, $n$ (%)</td>
<td>20 (66.7%)</td>
<td>47 (75.8%)</td>
<td>0.618</td>
</tr>
<tr>
<td>BMI (kg/m$^2$)</td>
<td>21.6 ± 3.1</td>
<td>22.6 ± 2.9</td>
<td>0.130</td>
</tr>
<tr>
<td>LVEF (%)</td>
<td>45.6 ± 12.3</td>
<td>48.7 ± 13.6</td>
<td>0.296</td>
</tr>
<tr>
<td>Hypertension, $n$ (%)</td>
<td>21 (70.0%)</td>
<td>45 (72.6%)</td>
<td>0.809</td>
</tr>
<tr>
<td>Diabetes mellitus, $n$ (%)</td>
<td>9 (30.0%)</td>
<td>26 (41.9%)</td>
<td>0.360</td>
</tr>
<tr>
<td>Dyslipidemia, $n$ (%)</td>
<td>13 (43.3%)</td>
<td>39 (62.9%)</td>
<td>0.116</td>
</tr>
<tr>
<td>AML, $n$ (%)</td>
<td>22 (73.3%)</td>
<td>40 (64.5%)</td>
<td>0.481</td>
</tr>
<tr>
<td>CABG, $n$ (%)</td>
<td>8 (26.7%)</td>
<td>8 (12.9%)</td>
<td>0.142</td>
</tr>
</tbody>
</table>

### Table II. Short-Term Effects on Standing Balance Training

<table>
<thead>
<tr>
<th>Variable</th>
<th>Conventional group at baseline</th>
<th>Balance group at baseline</th>
<th>$P$ (T × G)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leg strength (%BW)</td>
<td>NP</td>
<td>38.5 ± 9.9</td>
<td>NP 42.5 ± 10.4</td>
</tr>
<tr>
<td>Standing balance</td>
<td></td>
<td></td>
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<tr>
<td>One leg standing time (seconds)</td>
<td>24.1 ± 22.9</td>
<td>34.8 ± 24.5$^*$</td>
<td>29.7 ± 24.3 $^*$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.06 ± 0.43</td>
<td>1.15 ± 0.39 $^*$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30.5 ± 11.7</td>
<td>36.4 ± 23.8 $^*$</td>
</tr>
<tr>
<td>Walking speed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal walking speed (m/minute)</td>
<td>55.2 ± 11.7</td>
<td>61.0 ± 11.2$^*$</td>
<td>52.0 ± 11.7 $^*$</td>
</tr>
<tr>
<td>Maximum walking speed (m/minute)</td>
<td>90.0 ± 20.5</td>
<td>100.7 ± 15.0</td>
<td>100.7 ± 15.0</td>
</tr>
<tr>
<td>Fast walking speed, $n$ (%)</td>
<td>18 (60.0%)</td>
<td>51 (82.3%)</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

Data are mean ± SD. BMI indicates body mass index; LVEF, left ventricular ejection fraction; AMI, acute myocardial infarction; CABG, coronary artery bypass graft; CK, creatine kinase; BNP, brain natriuretic peptide; eGFR, estimated glomerular filtration rate; ACE, angiotensin converting enzyme inhibitor; and ARB, angiotensin II receptor blocker.
to our knowledge, this is the first study that adopted an exercise regimen to improve walking speed for a cardiac rehabilitation program including standing balance training. Our previous cross-sectional study indicated that walking speed in elderly patients with IHD is influenced by standing balance as well as leg strength, whereas motor function associated with walking speed was only associated with leg strength in middle-aged IHD patients, regardless of sex. Therefore, we considered improved walking speed to be associated with significant restoration of dynamic standing balance in our study. Moreover, several randomized controlled trials confirmed that 45-60 minutes of standing balance training significantly improves the walking speed of community-dwelling elderly people. However, the present study demonstrated that even 5 minutes of standing balance training could be sufficient to improve walking speed of elderly patients with IHD. The reason for this might be that the standing balance function of elderly patients with IHD is initially much lower than that of community-dwelling elderly people.

For long-term effects, we analyzed the effect of standing balance training on cardiac events after hospital discharge. In the present study, both univariable and multivariable analyses confirmed that cardiac events after hospital discharge were significantly associated with standing balance training, increase in normal walking speed, and fast walking speed in IHD patients. In particular, increase in normal walking speed and fast walking speed for IHD patients were strong prognostic indicators of cardiac events. Afifalo, et al reported that fast walking speed was a prognostic indicator of cardiac events for elderly patients undergoing cardiac surgery. In addition, Hardy, et al reported that improvement in walking speed predicted a substantial reduction in mortality in community-dwelling elderly people. A reduction in cardiac events after hospital discharge in the present study was associated with improvement in walking speed.

Why would a reduction in cardiac events be associated with improved walking speed? Walking speed might reflect time spent in habitual physical activity, especially physical activity with moderate intensity. Moreover, walking is the preferred physical activity at home after hospital discharge for elderly patients because it requires no special exercise equipment. Increased time spent in moderate-intensity physical activity is associated with increased high-density lipoprotein levels, lower levels of inflammatory markers (eg, tumor necrosis factor alpha, C-reactive protein, and interleukin-6), increased vascular endothelial function, and decreased progression of intima-media thickness. Collectively, improved walking speed during hospitalization might lead to the maintenance of physical function, aerobic and resistance training; Balance group, aerobic, resistance and standing balance training.

**Figure 1.** Cumulative event-free probability of patients with IHD according to walking speed estimated by the Kaplan-Meier method. Conventional group, aerobic and resistance training; Balance group, aerobic, resistance and standing balance training.

**Figure 2.** Cumulative event-free probability of patients with IHD according to walking speed estimated by the Kaplan-Meier method. Fast walking speed was > 90 m/minute for males and > 81 m/minute for females.

### DISCUSSION

The main findings of this retrospective cohort study were that an inpatient cardiac rehabilitation program including standing balance training improved walking speed during hospitalization more effectively than a program based solely on aerobic and resistance training, and furthermore could reduce cardiac events in elderly patients with IHD. Many studies have shown that a cardiac rehabilitation program consisting of aerobic and resistance training is an effective intervention to restore physical function and exercise capacity, and to reduce difficulty in daily living in cardiac patients. Several meta-analyses of randomized trials have also confirmed that a cardiac rehabilitation program consisting of lifestyle modification and prolonged exercise training in the recovery phase (after hospital discharge) is more effective in reducing morbidity and mortality in cardiac patients. However, to our knowledge, this is the first study that adopted an exercise regimen to improve walking speed for a cardiac rehabilitation program during hospitalization, and that assessed the effects of inpatient cardiac rehabilitation on both walking speed at hospital discharge (short-term outcome) and cardiac events after hospital discharge (long-term outcome) in elderly patients with IHD.

For short-term effects, we analyzed the effect of an inpatient cardiac rehabilitation program that included standing balance training on walking speed at hospital discharge. The present study demonstrated that the postural stability index improved from baseline to discharge only in IHD patients who underwent standing balance training. The postural stability index, which reflects dynamic balance within the base of support of the body, is thought to be more strongly associated with walking speed compared to one-leg standing time, which reflects static balance. In addition, normal walking speed and the number of patients with a fast walking speed (> 90 m/minute for men and ≤ 81 m/minute for women) at hospital discharge were higher than for IHD patients who had a conventional training program during hospitalization. Our previous cross-sectional study indicated that walking speed in elderly patients with IHD is influenced by standing balance as well as leg strength, whereas motor function associated with walking speed was only associated with leg strength in middle-aged IHD patients, regardless of sex. Therefore, we considered improved walking speed to be associated with significant restoration of dynamic standing balance in our study. Moreover, several randomized controlled trials confirmed that 45-60 minutes of standing balance training significantly improves the walking speed of community-dwelling elderly people. However, the present study demonstrated that even 5 minutes of standing balance training could be sufficient to improve walking speed of elderly patients with IHD. The reason for this might be that the standing balance function of elderly patients with IHD is initially much lower than that of community-dwelling elderly people.

For long-term effects, we analyzed the effect of standing balance training on cardiac events after hospital discharge. In the present study, both univariable and multivariable analyses confirmed that cardiac events after hospital discharge were significantly associated with standing balance training, increase in normal walking speed, and fast walking speed in IHD patients. In particular, increase in normal walking speed and fast walking speed for IHD patients were strong prognostic indicators of cardiac events. Afifalo, et al reported that fast walking speed was a prognostic indicator of cardiac events for elderly patients undergoing cardiac surgery. In addition, Hardy, et al reported that improvement in walking speed predicted a substantial reduction in mortality in community-dwelling elderly people. A reduction in cardiac events after hospital discharge in the present study was associated with improvement in walking speed.

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**Figure 2.** Cumulative event-free probability of patients with IHD according to walking speed estimated by the Kaplan-Meier method. Fast walking speed was > 90 m/minute for males and > 81 m/minute for females.
a fast walking speed in activities of daily living after hospital discharge, which might induce a cycle of increased physical activity that has a direct effect on cardiac events.

In contrast to improved walking speed, the present study demonstrated that medication was not associated with cardiac events. The Japanese Coronary Artery Disease Study (JCAD)\(^27\) indicated that while statins are significantly beneficial for IHD patients in Japan, calcium antagonists, beta-blockers, and ACE/ARBs are not. However, statins were not significantly beneficial in the present study. While most IHD patients in our study were prescribed statins, only a few patients were prescribed statins in the JCAD cohort study.\(^27\) The larger proportion of patients taking statins may, in part, account for the lack of a significant effect of statins on cardiac events in our study.

We instituted a progressive combined training program involving resistance and aerobic training according to AHA\(^28\) guidelines for elderly patients with IHD. However, few guidelines are available on improving walking speed in elderly patients with IHD. A specific exercise regimen aimed at improving standing balance should be recommended in formal cardiac rehabilitation programs for elderly patients with IHD.

This study has some limitations. First, since this study is a retrospective cohort study, we were unable to control for all confounding factors. However, we applied a propensity score that reduced all potential confounding factors to a single composite characteristic. Future prospective cohort studies or rand-
omized controlled trials should investigate the effects of standing balance training on walking speed and cardiac events after hospital discharge in elderly patients with IHD. Second, we could not check or verify any changes in home-based exercise programs 3 months or more following completion of the outpatient cardiac rehabilitation program because post-discharge monitoring was limited. However, we believe that very few patients in both groups had some additional exercise program (eg, yoga or calisthenics exercises) to directly improve standing balance through self-reported data obtained during our study period. Third, this study includes only a small number of patients. Therefore, a large-scale prospective study is warranted. Nevertheless, we feel that our study provides important evidence for cardiac rehabilitation exercise training because it is the first report that shows the effect of standing balance training on walking speed and cardiac events in elderly patients with IHD.

In conclusion, an inpatient cardiac rehabilitation program that includes standing balance training seems to be an effective intervention to improve walking speed and reduce cardiac events after discharge. This underscores the need for elderly patients with IHD to perform standing balance training in addition to aerobic and resistance training.

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