Abstract: Change in respiratory muscle strength predicts clinical events in patients with chronic heart failure

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Background: Respiratory muscle weakness, frequently observed in patients with chronic heart failure (CHF), has been documented as a predictor for poor prognosis. Several studies have reported that respiratory muscle training increases respiratory muscle strength and consequently improves exercise tolerance and quality of life in these patients. However, the relationship between the change in respiratory muscle strength and prognosis is still unclear.

Purpose: We aimed to investigate whether the change in respiratory muscle strength following cardiac rehabilitation predicts the incidence of clinical events in CHF patients.

Methods: We studied 348 patients with CHF who were hospitalized because of decompensated heart failure and received 5-month cardiac rehabilitation during hospitalization and after hospital discharge. Clinical characteristics including aetiology of heart failure, comorbidity conditions, medications, blood examination and echocardiographic variables were obtained from clinical records. We also measured maximal inspiratory pressure (PImax) as respiratory muscle strength at hospital discharge and 5 months later. The change of PImax (ΔPImax) between the 5-month observation period was examined. We followed up the patients after the observation period and investigated the incidence of all-cause mortality or all-cause unplanned readmission. In statistical analysis, patients were divided into two groups based on the median value of ΔPImax. We compared the event-free survival rate between the two groups using the Kaplan-Meier method with a log-rank test. We also performed the Cox proportional hazard model to clarify whether the ΔPImax was an independent predictor for the incidence of clinical events.

Results: Over a median follow-up of 1.6 years, 121 patients (34.8%) died or readmitted, and their rate of incidence was 21.7/100 person-years. The higher ΔPImax was associated significantly with a higher rate of event-free survival (Log-rank: 8.085, P = 0.004, Figure 1). In univariate Cox proportional hazard model, ΔPImax was a significant predictor for the all-cause mortality/readmission (unadjusted hazard ratio for PImax increase of 10 cmH2O: 0.842, 95% CI: 0.763 - 0.931, P = 0.001). Even after adjustment for clinical confounding factors including baseline PImax, ΔPImax remained significant and independent predictor for the all-cause mortality/readmission (adjusted hazard ratio for PImax increase of 10 cmH2O: 0.862, 95% CI: 0.763 - 0.974, P = 0.017, Figure 2).

Conclusion: This study is the first to demonstrate that the change in respiratory muscle strength following cardiac rehabilitation independently predicts the incidence of clinical events in patients with CHF. The increase in PImax of 10 cmH2O was associated significantly with a 14% decrease in the rate of all-cause mortality or readmission.
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Figure 1 Relationship between ΔPImax and event-free survival
ΔPImax: maximal inspiratory pressure

Figure 2 Cox proportional hazard models of ΔPImax for all-cause mortality or unplanned readmission
- Model 1: univariate analysis
- Model 2: Model 1 adjusted for age, sex and BMI
- Model 3: Model 2 adjusted for ischemic heart disease, atrial fibrillation, chronic kidney disease, use of beta-blockers, LVEF, BNP and baseline PImax
PImax: maximal inspiratory pressure, BMI: body mass index, LVEF: left ventricular ejection fraction, BNP: brain natriuretic peptide