

## Exercise oscillatory ventilation

Shingo Hashimoto\*; Tatsuya Kawasaki; Kenichi Kasai; Koji Kumano; Atsushi Shindo; Tadaaki Kamitani

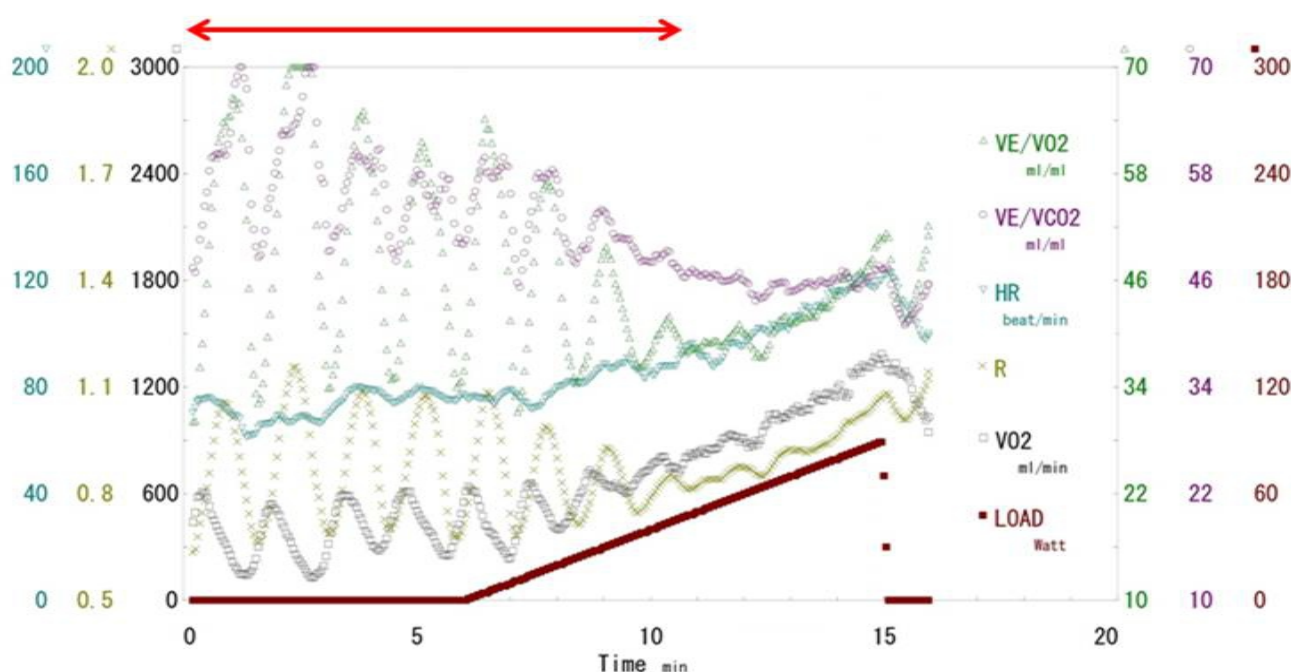
\*Shingo Hashimoto

Department of Rehabilitation, Matsushita Memorial Hospital, Osaka, Japan

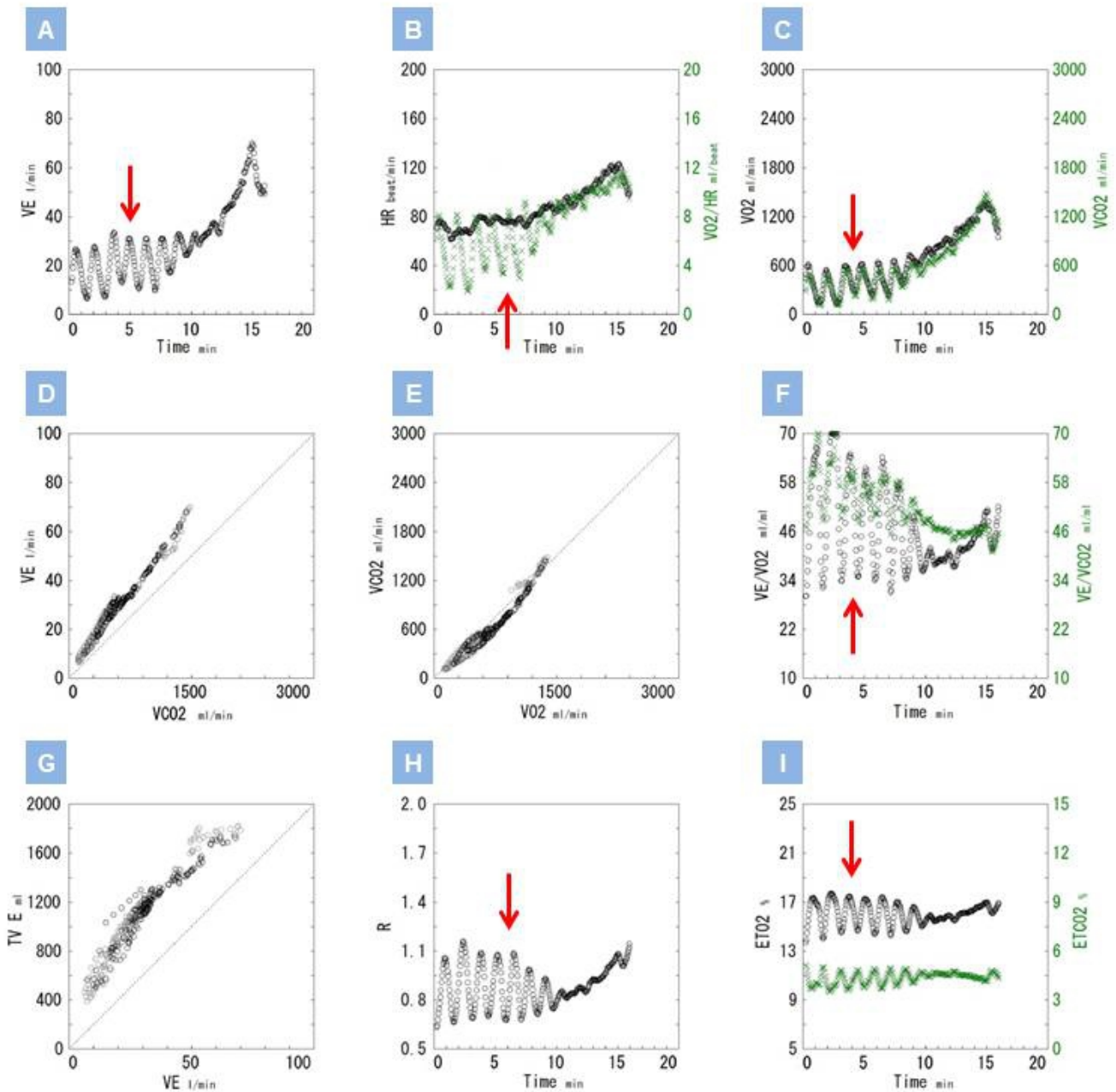
### Description

A 63-year-old man with non-ischemic dilated cardiomyopathy and atrial fibrillation was referred to undergo cardiopulmonary exercise testing (CPX). Echocardiography showed a left ventricular ejection fraction of 34% and a left ventricular end-diastolic volume of 163 ml. During the raw breath-by-breath CPX with a stationary cycle using a ramp protocol of 10 W per min, a notable feature was oscillatory ventilation (Figures 1 and 2). The peak oxygen uptake on maximal symptom-limited exercise was 17.5 ml/kg/min. Three months later, cardiopulmonary arrest due to ventricular fibrillation developed. Although cardiac resuscitation was successful with artificial ventilation, the patient had shown no neurological recovery. Exercise oscillatory ventilation has been reported to be an independent predictor of mortality in patients with heart failure [1,2], although the exact mechanism has yet to be elucidated.

### Figures



**Figure 1:** A notable feature is oscillatory ventilation, which is seen at rest (3 min), unloaded warm-up (3min), and the first half of exercise (between red arrows). Values were plotted based on every seven measurements during 3 min of rest, 3 min of unloaded cycling, and maximal symptom-limited exercise using a ramp protocol of 10 W per min. HR denotes heart rate, R respiratory exchange,  $VO_2$  oxygen uptake per minute,  $VE/VCO_2$  ventilatory equivalents for carbon dioxide,  $VE/VO_2$  ventilatory equivalents for oxygen.



**Figure 2:** A nine-panel plot of CPX shows that clear oscillatory patterns of minute ventilation (VE) are present at rest (3 min) and during warm up (3 min) and in the first half of exercise, as shown in panel A (arrow). Oscillatory ventilation is also seen on oxygen pulse or  $VO_2/HR$  in Panel B (arrow), on  $VO_2$  and carbon dioxide output per minute ( $VCO_2$ ) in Panel C (arrow), on  $VE/VO_2$  and  $VE/VCO_2$  in Panel F (arrow), on R in Panel H (arrow), and end-tidal oxygen ( $ETO_2$ ) and carbon dioxide ( $ETCO_2$ ) in Panel I (arrow), except for in the second half of exercise and recovery. Panel D, E, and G show VE versus  $VCO_2$  slope, relation between of  $VO_2$  to  $VCO_2$ , and relation of expiratory tidal volume (TV E) to VE, respectively. Other abbreviations as in Figure 1.

## References

1. Sun XG, Hansen JE, Beshai JF, Wasserman K. Oscillatory breathing and exercise gas exchange abnormalities prognosticate early mortality and morbidity in heart failure. *J Am Coll Cardiol.* 2010; 55: 1814-1823.
2. Dhakal BP, Lewis GD. Exercise oscillatory ventilation: Mechanisms and prognostic significance. *World J Cardiol.* 2016; 8: 258-266.