ORIGINAL ARTICLE

Heart Failure

Effect of Short-Duration Adaptive Servo-Ventilation Therapy on Cardiac Function in Patients With Heart Failure

Takashi Koyama, MD; Hiroyuki Watanabe, MD; Gen Igarashi, MD; Yoshikazu Tamura, MD;
Ken Ikeda, MD; Shigenori Terada, MD; Hiroshi Ito, MD

Background: The aim of this study was to investigate whether short-duration adaptive servo-ventilation (ASV) therapy improves cardiac function in heart failure (HF) patients.

Methods and Results: Consecutive HF patients (n=86) were divided into 3 groups: group A, ASV for a mean of ≥ 4h; group B, ASV for ≥ 1 to <4h per day; and group C, no ASV or ASV <1h. The frequency of ASV use did not significantly differ between groups A (79.3±19.2%) and B (70.9±17.4%). After 6 months, a significant increase in left ventricular ejection fraction (LVEF), significant decrease in plasma brain natriuretic peptide (BNP) and decrease in LV end-diastolic volume (LVEDV) were observed in groups A (LVEF, 5.0±8.1%; BNP, −24.9±33.7%; LVEDV, −6.2±10.1%) and B (LVEF, 3.5±5.5%; BNP, −16.5±24.6%; LVEDV, −5.1±8.2%) as compared with group C (LVEF, −1.5±6.0%, P=0.004, P=0.017; BNP, 2.8±10.2%, P=0.002, P=0.017; LVEDV, 0.8±9.1%, P=0.031, P=0.043). Significant correlation was seen between the total ASV time and changes of LVEF (r=0.369, P=0.002), BNP (r=−0.445, P<0.001), and LVEDV (r=−0.374, P=0.001). Admission rate was lower in groups A (4.1%) and B (7.1%) than in group C (25%, log-rank test; P=0.042, P=0.045). Multivariate analysis showed that the frequency of ASV use was a strong parameter for the improvement of LVEF (coefficient=0.284, standard error=0.035, P=0.019).

Conclusions: Even a short-duration of ASV therapy may improve cardiac function in HF patients. (*Circ J* 2012; 76: 2606–2613)

Key Words: Adaptive servo-ventilation; Cardiac function; Heart failure; Short-duration

Table 1. Baseline Characteristics of the HF Subjects

	Group A (n=24)	Group B (n=42)	Group C (n=20)	P value
Age (years)	56.9±11.4	66.4±12.0	70.7±6.4	0.481
Male	22 (91.7)	34 (80.9)	16 (80.0)	0.460
BMI (kg/m²)	24.0±2.1	23.4±4.3	23.3±2.1	0.135
NYHA class II	19 (79.2)	27 (64.3)	12 (60.0)	0.333
Hypertension	20 (83.3)	31 (73.8)	17 (85.0)	0.498
Diabetes mellitus	8 (33.3)	9 (21.4)	5 (25.0)	0.585
Dyslipidemia	10 (41.7)	15 (35.7)	7 (35.0)	0.867
Underlying heart disease				
Ischemic heart disease	5 (20.8)	16 (38.1)	7 (35.0)	0.342
Valvular heart disease	5 (20.8)	13 (30.9)	4 (20.0)	0.536
Cardiomyopathy	6 (25.0)	14 (33.3)	4 (20.0)	0.513
Heart rhythm disorder				
Atrial fibrillation	10 (41.7)	11 (26.2)	8 (40.0)	0.351
Pacemaker	5 (20.8)	12 (28.6)	5 (25.0)	0.765
Blood pressure				
Systolic (mmHg)	115.8±15.8	116.2±17.0	111.6±19.9	0.753
Diastolic (mmHg)	63.7±11.1	61.0±11.4	63.7±11.2	0.618
Heart rate (beats/min)	66.5±8.6	65.1±5.6	69.1±7.0	0.109
Medication				
ACEI/ARB	22 (91.7)	41 (97.6)	18 (90.0)	0.402
β-blocker	19 (79.2)	39 (92.9)	17 (85.0)	0.262
Aldosterone antagonist	16 (66.6)	33 (78.6)	12 (60.0)	0.278
Diuretic	17 (87.5)	39 (92.9)	17 (85.0)	0.595
Calcium antagonist	13 (54.2)	17 (40.5)	10 (50.0)	0.526
Statin	12 (50.0)	21 (50.0)	8 (40.0)	0.735
Echocardiography data				
LVEF (%)	41.2±8.8	40.2±9.8	42.4±9.4	0.717
LVEDV (ml)	157.1±34.0	160.5±44.8	158.1±34.8	0.630
LVESV (ml)	93.5±30.6	98.6±46.1	92.6±33.2	0.945
Laboratory data				
Plasma BNP (pg/ml)	215.1±141.5	314.0±171.7	285.9±186.8	0.091
hs-CRP (mg/dl)	0.21±0.15	0.17±0.14	0.22±0.16	0.324
eGFR (ml·min⁻¹·1.73 m⁻²)	57.6±20.6	52.2±18.1	60.6±24.9	0.424
Polysomnography data				
AHI (n/h)	30.2±13.7	26.4±13.9	24.1±12.8	0.224
AI (n/h)	12.3±10.9	11.9±11.5	9.5±7.4	0.671
Central type (n/h)	4.2±4.7	5.7±6.2	4.6±5.3	0.615
Obstructive type (n/h)	6.1±8.7	3.8±4.6	3.8±6.2	0.658
HI (n/h)	18.0±12.1	14.9±8.4	14.5±8.1	0.654
Mean SaO₂ (%)	94.5±1.8	93.5±2.3	93.8±2.7	0.128
Arousal index (n/h)	28.5±11.5	32.6±12.0	26.8±10.4	0.372
Total sleep time (h)	5.3±1.1	5.5±0.9	5.2±1.1	0.251

Data are mean±SD or n (%).
HF, heart failure; BMI, body mass index; NYHA, New York Heart Association; ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin-receptor blocker; LVEF, left ventricular ejection fraction; LVEDV, left ventricular end-diastolic volume; LVESV, left ventricular end-systolic volume; BNP, brain natriuretic peptide; hs-CRP, high-sensitivity C-reactive protein; eGFR, estimated glomerular filtration rate; AHI, apnea-hypopnea index; AI, apnea index; HI, hypopnea index.
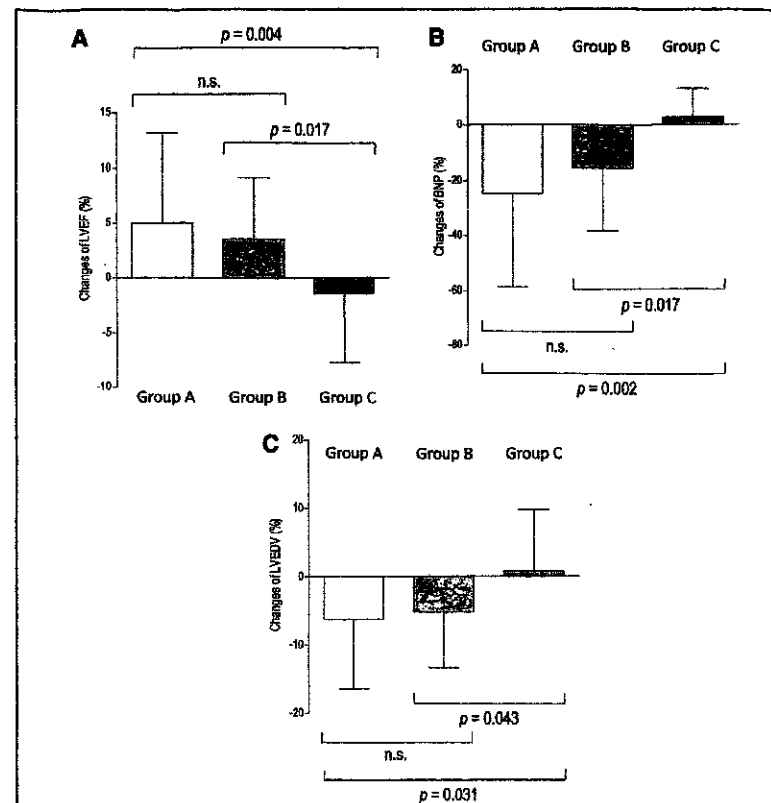

Figure 2. (A) Change in LVEF, (B) plasma BNP concentration and (C) LVEDV during the 6-month follow-up period. Group A: patients using ASV therapy for ≥4h/day; Group B: patients using the ASV device for ≥1 to <4h during the day. Group C: patients who refused ASV therapy or who could not use the ASV device for ≥1h. ASV, adaptive servo-ventilation; BNP, brain natriuretic peptide. LVEF, left ventricular ejection fraction; LVEDV, left ventricular end-diastolic volume.
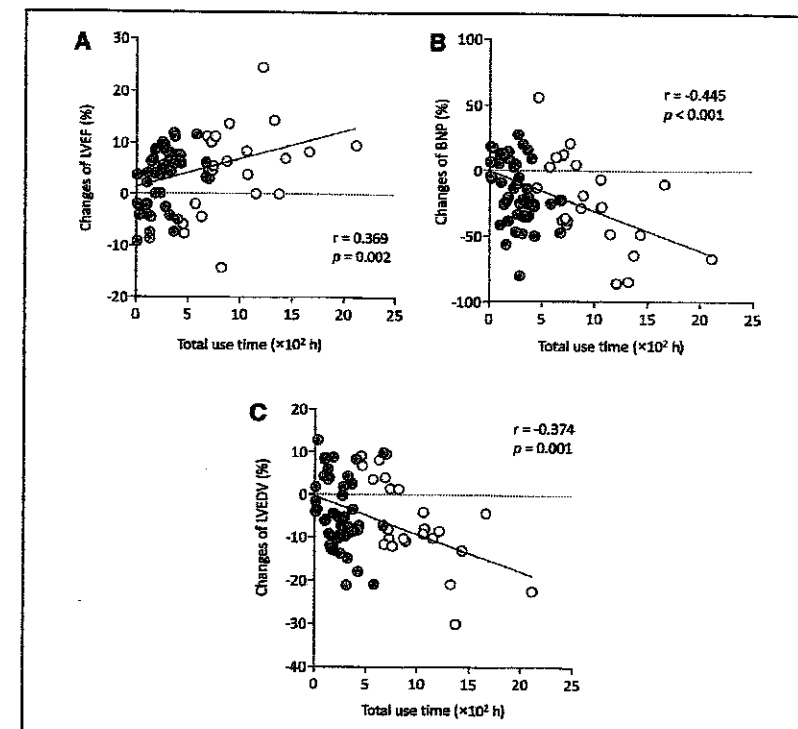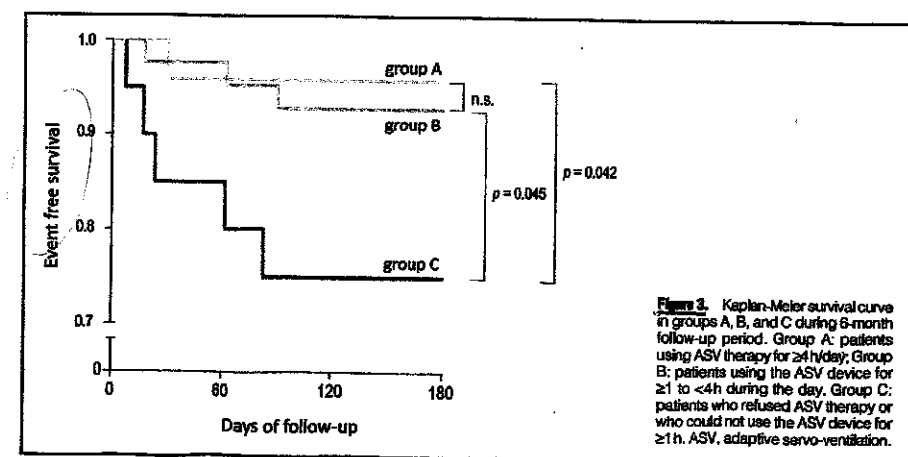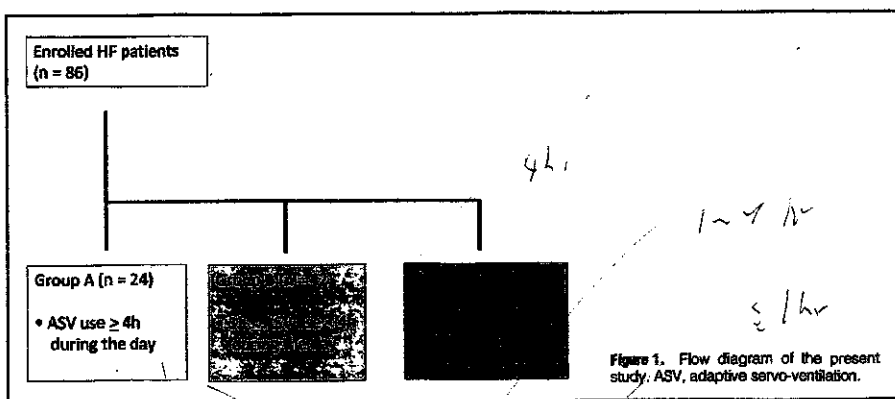

Figure 1. Flow diagram of the present study. ASV, adaptive servo-ventilation.

Table 2. Characteristics of ASV Device Use by HF Patients

	Group A	Group B	Group C	A vs. B	A vs. C	B vs. C
				P value		
Frequency of ASV use, %	79.3±19.2	70.9±17.4	4.6±8.6	0.115	<0.001	<0.001
ASV use time, h/day	6.7±1.8	2.2±0.9	0.1±0.2	<0.001	<0.001	<0.001

Group A: ASV use ≥4h/day; Group B: 1h/day<ASV use<4h/day; Group C: ASV use <1h/day or discontinue. ASV, adaptive servo-ventilation; HF, heart failure.

Figure 3. Kaplan-Meier survival curve in groups A, B, and C during 6-month follow-up period. Group A: patients using ASV therapy for ≥4h/day; Group B: patients using the ASV device for ≥1 to <4h during the day. Group C: patients who refused ASV therapy or who could not use the ASV device for ≥1h. ASV, adaptive servo-ventilation.

Figure 4. Correlations between total time of ASV use and changes in LVEF (A), plasma BNP concentration (B), and LVEDV (C) in HF patients with ASV therapy. Yellow circle: group A. Orange circle: group B. Blue circle: group C. ASV, adaptive servo-ventilation; LVEF, left ventricular ejection fraction; BNP, brain natriuretic peptide; LVEDV, left ventricular end-diastolic volume; HF, heart failure.