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Effect of Hybrid Cardiac Rehabilitation Using a Smart Device: a Randomized Controlled Trial

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Objective

Although cardiac rehabilitation (CR) has been proven to be effective in secondary prevention for patients with cardiovascular diseases, the actual participation in CR is still unsatisfactory. While home-based CR is a promising alternative that is as effective as center-based CR, it has not garnered enough attention due to a lack of proper communication, concerns about unexpected adverse events caused by non-monitored exercises, and the absence of supporting insurance services. We utilized a smart ring with a photoplethysmography to monitor heart rate. Recorded data were stored on a website where the researchers could remotely access and check the uploaded measurements. This study aims to identify the clinical effects of hybrid CR by weekly telephone counseling based on the patients' actual physical activities obtained from the device.

Materials and Methods

The patients with cardiovascular disease were educated on concrete methods of home-based CR, including the type, intensity, and time of exercise as well as precautions. The patients were given a smart ring, which they were instructed to wear during exercise. The patients were randomly enrolled into two groups: intervention and observation groups. The patients of the intervention group were given weekly telephone counseling and encouraged to maintain optimal physical activities. In the observational group, only exercise data were recorded without additional interventions. Before and after three months of training, the results of the symptom-limited cardiopulmonary exercise test between the two groups were compared.

Results

A total of sixty-four patients were enrolled (thirty-two in each group). The subjects were 59.8 ± 9.0 years old and fifty-three (82.8%) were male. There were no significant differences in diagnosis and results of baseline symptom-limited cardiopulmonary exercise test between the two groups (Table 1). After three months of training, peak oxygen consumption was significantly improved in both groups. However, the improvement was greater in the intervention group compared to the observation group (Table 2).

Table 1. Demographics of the participants

	Total (N=64)	Intervention (N=32)	Observation (N=32)	*P*
Age (years)	59.8 ± 9.0	59.8 ± 9.9	59.7 ± 8.2	0.967
Male sex	53 (82.8%)	26 (81.3%)	27 (84.4%)	0.740
Diagnosis				0.436
Stable angina	22 (34.4%)	13 (40.6%)	9 (28.1%)	
Unstable angina	9 (14.1%)	4 (12.5%)	5 (15.6%)	
NSTEMI	18 (28.1%)	10 (31.3%)	8 (25.0%)	
STEMI	15 (23.4%)	5 (15.6%)	10 (31.3%)	
Peak VO_2 (mL/kg/min)	27.9 ± 5.5	27.9 ± 5.8	27.9 ± 5.4	0.979
RER	1.08 ± 0.07	1.08 ± 0.07	1.08 ± 0.07	0.930
HRrest (beat/min)	69.3 ± 9.4	69.6 ± 9.0	69.0 ± 9.9	0.803
HRmax (beat/min)	148.8 ± 17.9	151.1 ± 18.5	146.6 ± 17.4	0.327
HRmax%	93.0 ± 10.8	94.3 ± 10.3	91.6 ± 11.3	0.318

NSTEMI, non-ST elevation myocardial infarction; STEMI, ST elevation myocardial infarction; VO2, oxygen consumption; RER, respiratory exchange ratio; HRrest, heart rate at rest; HRmax. maximal heart rate; HRmax%, percentage of age-predicted maximal heart rate

Table 2. Comparison of the symptom-limited cardiopulmonary exercise test in intervention and observation groups before and after home-based cardiac rehabilitation

	Intervention (N=26)				Observation (N=28)				Differences between groups
	Baseline	3 months	In group change	*P*	Baseline	3 months	In group change	*P*	
Peak VO_2 (mL/kg/min)	27.9 ± 5.1	31.1 ± 5.6	3.2 ± 2.0	<0.001	27.8 ± 5.4	29.1 ± 5.5	1.2 ± 2.8	0.025	0.004
RER	1.07 ± 0.07	1.08 ± 0.07	0.01 ± 0.05	0.227	1.08 ± 0.07	1.07 ± 0.07	-0.01 ± 0.05	0.163	0.065
HRrest (beat/min)	69.9 ± 9.0	68.6 ± 9.0	-1.2 ± 8.1	0.446	69.2 ± 10.1	68.6 ± 10.3	-0.6 ± 8.6	0.727	0.773
HRmax (beat/min)	151.7 ± 17.4	153.7 ± 16.8	2.0 ± 14.1	0.477	147.1 ± 16.5	148.8 ± 19.2	1.6 ± 8.7	0.327	0.911
HRmax%	94.9 ± 9.0	96.2 ± 9.0	1.3 ± 8.9	0.473	91.6 ± 11.4	92.6 ± 12.3	0.9 ± 5.4	0.370	0.861

VO2, oxygen consumption; RER, respiratory exchange ratio; HRrest, heart rate at rest; HRmax. maximal heart rate; HRmax%, percentage of age-predicted maximal heart rate

Conclusion

Home-based CR using a smart device was effective in improving oxygen consumption. For home-based CR to be more effective, proper monitoring and timely counseling by medical experts are necessary.

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