

뇌신경재활

게시일시 및 장소 : 10 월 18 일(금) 13:15-18:00 Room G(3F)

질의응답 일시 및 장소 : 10 월 18 일(금) 16:05-16:09 Room G(3F)

P 2-30

Effects of unbalancing ergometer exercise on cardio-cerebral hemodynamics and muscle activation in

Eun Young Han^{1*}, Sang Hee Im², Seong-dae Kim³, Il-Kyu Jeong^{3†}

Jeju National University, Department of Rehabilitation Medicine¹, Severance Hospital, Yonsei University College of Medicine, Department and Research Institute of Rehabilitation Medicine², Hannam University, Department of Sports Sciences³

Objectives

To investigate the effects of unbalancing bicycle ergometer exercise on cardio-cerebral hemodynamics and muscle activation in hemiplegic stroke patients.

Methods

Thirteen young male volunteers (23.4±2.5 yrs) were enrolled in this study from January, 2019 to June, 2019. They were asked to perform the incremental bicycle ergometer exercise (SRH100H[®], NanoBioLife Inc, Seoul, Korea) (Monark Ergometer 881[®], Varberg, Sweden) in the upright and 45° recumbent (R) postures with a week interval, respectively. Balancing protocol was set initially at 50W and increased by 25W every 2 minutes to 150W and unbalancing protocol was set to maximal different exercise intensity bilaterally. (45W vs 150W) CBFV in middle cerebral artery (MCA) (SONARA Transcranial Doppler ultrasound[®], VIASYS Co. Ltd., USA) and arterial stiffness including cardio ankle vascular index (CAVI), ankle brachial index (ABI) and augmentation index (AIx) (VaSera VS-2000 instrument[®], Fukuda Denshi Co. Ltd., Tokyo, Japan) were measured at rest, 5 minutes, 10 minutes during exercise and 10 minutes recovery. EMG data (PolyG-A, LAXTHA Inc, Daejeon, Korea) were recorded from the volunteers' lower limb muscles (rectus femoris (RF), semitendinosus, tibialis anterior, and medial gastrocnemius muscles). EMG signals were normalized to the highest EMG signals recorded for the maximum voluntary isometric contractions (MVIC). The peak normalized EMG value, (root mean square, RMS) of the studied muscles over the average of the 10 pedal cycles was analyzed. Cardiovascular responses [(cardiac output (CO), heart rate (HR), stroke volume (SV))] were also measured,

Results

Unbalancing protocol induced significantly lower RMS of rectus femoris than balancing exercise (p<0.05), but another muscles did not show significant differences. There was no significant differences in cerebral blood flow velocity and CO between two protocols.

Conclusion

The unbalancing bicycle ergometer exercise in recumbent position induced low muscle activity in RF but it does not decrease cardio-cerebral blood flow. Therefore, it might suggest basic data for the development of bicycle exercise program and therapeutic approaches of hemiplegic stroke patients.

Acknowledgment :This work was supported by the Technology development Program(S2673714) funded by the Ministry of SMEs and Startups(MSS, Korea)

Table 1. Changes in RMS

Variables		Balancing Group			Unbalancing Group			F
		Time course 1	Time course 2	Time course 3	Time course 1	Time course 2	Time course 3	
Rectus femoris	Right	24.92±11.14	20.41±9.34	20.96±9.59	22.85±11.75	18.65±9.15	18.46±8.09	T:4.317 T×G:0.025 G:0.335
	Left	24.92±13.40	20.41±11.34	20.92±11.62	13.40±5.14‡	11.34±4.01‡	11.62±4.69‡	T:7.622 T×G:1.207 G:10.278*
Biceps femoris	Right	16.55±6.99	17.21±11.26	13.61±5.60	16.34±7.17	17.25±9.60	14.39±4.36	T:2.900 T×G:0.166 G:0.067
	Left	16.55±6.99	17.21±11.26	13.61±5.60	14.92±7.06	16.29±10.00	14.65±7.57	T:2.451 T×G:0.614 G:0.082
Gastrocnemius	Right	16.32±18.09	17.40±10.05	13.70±4.53	16.09±6.63	16.60±7.59	14.55±4.99	T:5.896* T×G:0.166 G:0.003
	Left	16.32±10.60	17.40±10.05	13.70±4.53	16.43±7.67	14.56±4.15	14.14±3.70	T:5.267* T×G:1.239 G:0.266

Values are presented as mean±standard variation.

F values are calculated by 2-way ANOVA with repeated measures.

Time course 1 indicates 0-5 minutes during exercise; Time course 2, 6-10 minutes during exercise; Time course 3, 11-15 minutes during exercise; RMS indicates root mean square; T, time; G, group.

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

†Significantly different from rest ($P < 0.05$).

‡Significantly different from Balancing group ($P < 0.05$).

§Significantly different from Balancing group ($P < 0.01$).

Table 2. Changes in cardiac output

Variables	Balancing Group				Unbalancing Group				F
	Rest	10min during exercise	15min during exercise	10min Recovery	Rest	10min during exercise	15min during exercise	10min Recovery	
SV (ml)	79.78±9.93	82.78±11.68	83.33±11.18	77.11±9.90	80.40±9.44	91.50±9.45	90.20±11.68	81.30±8.65	T:24.930** T×G:3.143 G:1.277
HR (beats/min)	80.00±7.85	123.33±13.23†	123.44±12.78†	71.11±7.16†	79.60±8.07	107.20±6.66§†	107.40±6.34§†	68.40±6.36†	T:341.862** T×G:10.778** G:6.721†
CO (L/min)	6.27±1.07	10.21±1.73†	10.24±1.62†	5.50±0.96†	6.21±1.28	9.80±1.21†	9.66±1.33†	5.57±1.03	T:301.549** T×G:1.153 G:0.196

Values are presented as mean±standard variation. †

F values are calculated by 2-way ANOVA with repeated measures.

SV indicates stroke volume; HR, heart rate; CO, cardiac output; T, time; G, group.

*P < 0.05, **P < 0.01, ***P < 0.001.

†Significantly different from rest (P < 0.05).

‡Significantly different from Balancing group (P < 0.05).

§Significantly different from Balancing group (P < 0.01).

Table 3. Changes in cerebral blood flow velocity

Variables	Balancing Group				Unbalancing Group				F	
	Rest	7min during exercise	immediately after exercise	10min Recovery	Rest	7min during exercise	immediately after exercise	10min Recovery		
Mean (cm/s)	Right	69.90±20.40	83.60±14.06	82.17±20.01	70.52±15.61	79.64±3.10	80.70±17.99	76.91±18.03	63.92±31.25	T:0.982 T×G:2.093 G:0.290
	Left	71.73±17.05	84.29±17.46†	71.54±19.23	73.96±10.06	67.04±1.75	78.77±18.99†	71.62±15.88	71.95±12.96	T:6.096** T×G:0.352 G:0.240
Peak (cm/s)	Right	121.35±37.00	138.16±21.96†	146.83±26.55†	113.25±22.34	116.73±18.98	136.13±31.70†	135.44±31.34†	120.60±20.28	T:11.318** T×G:1.116 G:0.089
	Left	114.22±26.35	145.55±23.99†	125.33±28.98	120.07±17.46	107.18±21.30	127.68±25.96†	123.56±32.47	111.31±18.59	T:10.968** T×G:0.921 G:0.763
EDV (cm/s)	Right	48.15±14.20	54.94±10.36	55.68±11.57	50.23±10.93	49.03±6.26	51.52±11.38	51.85±12.87	54.07±9.09	T:2.438 T×G:1.511 G:0.029
	Left	48.96±12.93	52.65±12.34	51.15±15.05	53.16±6.95	46.43±7.37	53.97±13.48	50.24±12.29	51.06±10.35	T:1.866 T×G:0.237 G:0.053

Values are presented as mean±standard variation.

F values are calculated by 2-way ANOVA with repeated measures.

Mean indicates mean flow velocity; Peak, peak systolic velocity; EDV, maximum end-diastolic velocity; T, time; G, group.

*P < 0.05, **P < 0.01, ***P < 0.001.

†Significantly different from rest (P < 0.05).

‡Significantly different from Balancing group (P < 0.05).

§Significantly different from Balancing group (P < 0.01).