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RAPID COMMUNICATION

Periodicity of Arrhythmias in Healthy Elderly Men at the Moderate Altitude

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Summary

The 24-hour periodicity of supraventricular (SVPB) and ventricular (VEB) extrasystoles in healthy elderly men (age 49-69 years) was studied at two altitudes during 24 h Holter ECG monitoring. At the low altitude (200 m, n = 26), SVPB were more frequent than VEB. The highest occurrence of SVPB was at 17:00 h, the lowest at 01:00 and 02:00 h ($P<0.001$). The highest occurrence of VEB was at 09:00 h, the lowest one at 04:00 h ($P<0.001$). At 1350 m (n=9) the incidence of both SVPB and VEB was approximately twofold higher compared to that at the low altitude ($P<0.001$). The highest occurrence of SVPB was at 13:00 h, the lowest at 06:00 h ($P<0.001$). VEB were the most frequent at 10:00 h and 13:00 h, while the lowest frequency was observed at 06:00 h ($P<0.001$). Our results indicate that the incidence of SVPB and VEB in healthy persons at the moderate altitude is twofold and its periodicity is shifted compared to the low altitude. The cause of increased occurrence of extrasystoles is probably due to β-adrenergic activation of the heart at the higher altitude.

Key words

Electrocardiography • Cardiac arrhythmias • Holter ECG monitoring • Biological rhythm • Altitude

The occurrence of supraventricular (SVPB) and ventricular extrasystoles (VEB) is proportional to the altitude (Kujaník *et al.* 1995). The aim of our study was to compare the 24-hour periodicity of SVPB and VEB at a low and a moderate altitude in healthy elderly men.

Two groups of cardiopulmonary healthy men (49-69 years) were studied, one in Košice (200 m, n=26), the other at Štrbské Pleso (1350 m, n=9). A 24-hour Holter ECG was recorded (PREMIER IV, Diagnostic Monitoring, USA), and the SVPB and VEB were evaluated each hour. The results at both altitudes were compared by the non-parametric statistics (the sign test).

At 200 m, only single SVPB and VEB were rarely found. The maximum occurrence of SVPB was at 17:00 h, that of VEB at 09:00 h, the minimum of SVPB was at 01:00 and 02:00 h (1.35 vs. 0.23, $P<0.001$), of VEB at 04:00 h (1.81 vs. 0.04, $P<0.001$). At the moderate altitude, the SVPB and VEB were also rare but their

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incidence was twofold compared to that at the low altitude (P<0.001). The maximum occurrence of SVPB was found at 13:00 h, that of VEB at 10:00 h and 13:00 h. The minimum incidence of SVPB occurred at 06:00 h (2.66 vs. 0.22, P<0.001) and that of VEB also at 06:00 h (1.77 vs. 0.33, P<0.001).

Table 1. Supraventricular (SVPB) and ventricular (VEB) extrasystoles at the lowland (n=26) and at the moderate altitude (n=9) in healthy men over 50 years old

Time (hours)	Košice (200 m)				Štrbské Pleso (1350 m)			
	SVPB		VEB		SVPB		VEB	
	Total	Average	Total	Average	Total	Average	Total	Average
7-8	18	0.69	21	0.81	15	1.66	5	0.55
8-9	18	0.69	47	1.81	19	2.11	14	1.55
9-10	23	0.88	36	1.38	11	1.22	16	1.77
10-11	15	0.58	13	0.50	19	2.11	10	1.11
11-12	20	0.77	19	0.73	17	1.88	11	1.22
12-13	14	0.54	21	0.81	24	2.66	16	1.77
13-14	20	0.77	24	0.92	8	0.88	7	0.77
14-15	17	0.65	6	0.23	13	1.44	8	0.88
15-16	25	0.96	8	0.31	13	1.44	13	1.44
16-17	35	1.35	4	0.15	15	1.66	12	1.33
17-18	21	0.81	5	0.19	15	1.66	11	1.22
18-19	29	1.12	7	0.27	13	1.44	8	0.88
19-20	12	0.46	6	0.23	10	1.11	5	0.55
20-21	10	0.38	3	0.12	11	1.22	8	0.88
21-22	15	0.58	14	0.54	10	1.11	10	1.11
22-23	10	0.38	10	0.38	11	1.22	7	0.77
23-24	13	0.50	10	0.38	12	1.33	6	0.66
24-01	6	0.23	16	0.62	5	0.55	7	0.77
01-02	6	0.23	6	0.23	9	0.99	12	1.33
02-03	17	0.65	9	0.35	8	0.88	8	0.88
03-04	10	0.38	1	0.04	5	0.55	6	0.66
04-05	12	0.46	7	0.27	4	0.44	6	0.66
05-06	16	0.62	7	0.27	2	0.22	3	0.33
06-07	22	0.85	23	0.88	7	0.77	4	0.44
24 hours	404		323		276		213	
Average per patient		15.54		12.42		30.67 P<0.001		23.67 P<0.001
Average per patient and hour		0.65		0.52		1.28 P<0.001		0.99 P<0.001
VEB/SVPB			0.799				0.772	

Total - summary values, Average - average values per patient.

Our results indicate that healthy elderly male subjects exhibit different 24-hour periodicity of SVPB and VEB at both altitudes. Because of the several-peaks course we could not use the cosinor analysis for statistical processing.

The moderate altitude produces hypoxemia, sympathetic activation and pulmonary hypertension in elderly subjects (Levine *et al.* 1997). An arrhythmogenic effect of hypoxia was demonstrated in numerous animal experiments. It reduces the ventricular fibrillation threshold (Szekeres and Papp 1967) and cardiac denervation abolishes the threshold reduction. Hypoxia supports the development of cardiac electrical heterogeneity and arrhythmias in experiments (Hayashi *et al.* 1997). In hypoxic patients, VEB are elicited easily and the application of oxygen decreases the cardiac ectopic activity, normalizes the ST segment depression on the ECG and shortens the QTc interval (Tirlapur and Mir 1982).

Increased sympathetic activation enhances the β-adrenergic cardiac influences (α-receptors are less frequent in the heart). It elevates the intracellular levels of calcium and supports the development of delayed after-depolarization (Aronson 1991). The sympathetic stimulation decreases the T wave amplitude and ST segment of ECG, impairs conduction in the heart and elevates VEB incidence (Henry and Meehan 1971).

The heart is a heterogeneous excitatory system under physiological conditions and in the elderly conditions at moderate altitude it can react by arrhythmias. Arrhythmia can become greater in response to an additional arrhythmogenic factor, such as exercise (Alexander 1995). The mechanism of arrhythmogenic influences probably involves alterations of ionic channel functions in cardiomyocytes.

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