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Original article

Assessment of energy expenditure, physical activity and sleep pattern in patients with frequent symptomatic ventricular ectopic beats☆

Évaluation de la dépense énergétique, de l'activité physique et du rythme de sommeil des patients souffrant d'extrasystoles ventriculaires symptomatiques

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Abstract

Background. – Ventricular ectopic beats (VEBs) are considered as benign ventricular arrhythmias in patients without structural heart disease. However, symptomatic frequent VEBs can adversely affect energy metabolism. The present study aimed to determine the effect of symptomatic frequent VEBs on energy expenditure, physical activity and sleep pattern.
Methods. – Thirty-seven patients with symptomatic frequent VEBs and no structural heart diseases were enrolled. Patients underwent simultaneous 24-hour-ambulatory Holter electrocardiogram monitoring and the BodyMedia armband device monitoring which measures energy expenditure. Data acquired from both devices were compared with the data acquired from healthy volunteers in the control group.
Results. – Total energy expenditure (TEE) was higher in the patient group than the control group (1470 ± 353 kcal vs 1125 ± 275 kcal, $P < 0.001$). Average metabolic equivalence (aMETs) (1.1 ± 0.2 vs. 1.3 ± 0.2, $P = 0.028$), physical activity duration (PAD) (0.35 vs. 0.48, $P = 0.007$) and sleep duration (SDN) (3.15 vs. 4.31, $P = 0.004$) were significantly lower in the patient group than control group. VEBs frequency was inversely correlated with only SDN ($r = -0.374$, $P = 0.027$).
Conclusion. – Total energy expenditure (TEE) is increased in patients with symptomatic frequent VEBs in comparison with healthy subjects while PAD, average metabolic equivalence (aMETs) and SDN are decreased. VEBs frequency was inversely correlated with SDN.

Keywords: Ventricular ectopic beats; Energy expenditure; Physical activity

Résumé

Les extrasystoles ventriculaires symptomatiques (EVS) sont considérées comme des arythmies ventriculaires bénignes dans le cas des patients sans trouble cardiaque structurel. Toutefois, les ESV symptomatiques fréquentes peuvent dégrader le métabolisme énergétique. L'étude présente a pour objet de déterminer quel est le lien entre les ESV symptomatiques fréquentes, la dépense énergétique, l'activité physique et le rythme de sommeil.
Méthodes. – Trente-sept patients avec ESV symptomatiques fréquentes et sans trouble cardiaque structurel ont été sélectionnés. Ils ont été placés pendant 24 h sous surveillance simultanée par élecrocardiogramme Holter ambulatoire et brassard BodyMedia qui mesure la dépense énergétique. Les données obtenues par les deux instruments ont été comparées avec celles de volontaires sains d'un groupe témoin.

☆ The study was conducted in the Cardiology Department of Medipol University Hospital.
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Résultats. – La dépense énergétique totale (DET) était plus élevée pour le groupe des patients, comparée à celle du groupe témoin (1470 ± 353 kcal/j versus 1125 ± 275 kcal/j, $p < 0{,}001$). Le niveau de dépense en équivalents métaboliques (aMETs) (1,1 ± 0,2 vs. 1,3 ± 0,2, $p = 0{,}028$), la durée d'activité physique (DAP) (0,35 versus 0,48 h/j, $p = 0{,}007$) et la durée de sommeil (DS) (3,15 versus 4,31 h/j, $p = 0{,}004$) étaient significativement réduits dans le groupe des patient, par rapport au groupe témoin. La fréquence des ESV était inversement corrélée seulement avec la DS ($r = -0{,}374$, $p = 0{,}027$).
Conclusion. – La DET augmente chez les patients qui ont des ESV symptomatiques fréquentes, par rapport aux sujets sains, tandis que le aMETs, la DAP et la DS sont réduits. La fréquence des ESV est inversement corrélée à la DS.

Mots clés : Extrasystoles ventriculaires ; Dépense énergétique ; Activité physique

1. Introduction

Ventricular ectopic beats (VEBs) are considered as benign ventricular arrhythmias in patients with no structural heart diseases. However, symptoms including such as palpitations, fatigue and dizziness are not uncommon in these patients. Frequency of VEBs and severity of symptoms play decisive roles in the treatment [1]. VEBs were shown to be associated with decreased exercise tolerance [2]. Besides, symptomatic VEBs may be linked to worsened quality of life.

The SenseWear Pro Armband is a portable device that can measure energy expenditure, physical activity and sleep duration (SDN) [3,4]. To our knowledge, alterations in energy expenditure in patients with symptomatic frequent VEBs have not been investigated before. In the present study, we aimed to assess the impact of symptomatic frequent VEBs on energy expenditure, physical activity and SDN.

2. Methods

The study group consisted of 50 patients with no structural heart disease who were referred to our outpatient clinic for symptoms of palpitation and sensation of abnormal pulsation (rapid, slow or irregular heartbeat) episodes at least 3 times in the last week. Patients were monitored with both 24-hour-ambulatory Holter electrocardiogram (ECG) and the BodyMedia armband device measuring energy expenditure simultaneously. Both devices collected and stored patient data for 24 hours. Thirty-seven patients with frequent VEBs documented by 24-hour-ambulatory Holter-ECG monitoring were recruited. The rest of the patients were excluded. Frequent VEBs were defined as the presence of more than 10 VEBs per hour [5]. Structural heart disease (myocarditis, coronary artery disease, valvular disease other than mild forms, heart failure, cardiomyopathy, arrhythmogenic right ventricular dysplasia, systemic disease (hypertension, diabetes mellitus, endocrine diseases such as hyperthyroidism and metabolic disorders), neoplastic diseases, anemia, neurological or psychiatric diseases, chronic pulmonary diseases, ion channelopathies (long-QT syndrome, Brugada syndrome, catecholaminergic ventricular tachycardia etc.), sustained and non-sustained ventricular tachycardia, supraventricular tachycardia or medical therapy with any drug were determined as exclusion criteria. ECG, transthoracic echocardiography and biochemical blood analyses were performed in all patients and exercise stress test was performed in patients with suspected coronary artery disease. Patients with abnormal exercise stress test were excluded. The control group consisted of healthy volunteers and their data obtained by both 24-hour-ambulatory Holter monitoring and the BodyMedia armband device were compared with the patient group. Participants in both groups were warned about not limiting and resuming their daily physical activities during the recording period.

2.1. Measurements

The SenseWear Pro 3 Armband (BodyMedia, Pittsburgh, USA) is multi-sensor device containing a three-axis accelerometer that tracks the movement of the upper arm and body and provides information about body position. The commercially available, lightweight sensor system was worn the left upper arm over the triceps muscle. A synthetic heat-flux sensor measures the amount of heat being dissipated by the body to the immediate environment. Skin temperature and armband-cover temperature are measured by sensitive thermistors. The armband also measures galvanic skin response (GSR), the conductivity of the wearer's skin, which varies due to sweating and emotional stimuli.

The recorded data is integrated, processed and analyzed by a software device (InnerViews ResearchSoftware, Professional Version 6.1, USA) which uses proprietary algorithms taking account of the individual's demographics (like age, height, weight, and sex), and validly calculates daily total energy expenditure (TEE), active energy expenditure (AEE), physical activity duration (PAD), SDN, average metabolic equivalence (aMETs) [3,4,6,7].

2.2. Statistical analysis

SPSS 23.0 statistical software (SPSS Inc., Chicago, IL, USA) were used for statistical analysis. Continuous variables were expressed as mean ± standard deviation (SD) or median and interquartile range as appropriate. Categorical variables were expressed as percentages. The Kolmogorov Smirnov test was used to test normality of distribution of continuous variables. Group means for continuous variables were compared with the use of Student's *t*-test or the Mann-Whitney U test, as appropriate. Pearson or Spearman correlation analysis was used for assessing correlation between total VEBs frequency and

Table 1
Comparison of clinical and metabolic parameters of patient and control groups.

	Patient group $n=37$	Control group $n=37$	P value
Age (years)	47 ± 17	49 ± 15	0.662
Gender, n (male %)	18 (48%)	17 (45%)	0.816
Weight (kg)	75 ± 14	78 ± 15	0.381
Height (cm)	167 ± 9	167 ± 9	0.990
BMI (kg/m^2)	26 ± 3	27 ± 5	0.251
Smoking, n (%)	25 (67%)	22 (59%)	0.630
TEE (kcal)	1470 ± 353	1125 ± 275	**< 0.001**
AEE (kcal)[a]	166 (85–256)	148 (78–333)	0.701
aMETs	1.1 ± 0.2	1.3 ± 0.2	**0.028**
PAD[a] (hour)	0,35 (0.22–0.45)	0.48 (0.27–1.06)	**0.007**
SDN[a] (hour)	3.15 (2.28–3.78)	4.31 (3.16–5.3)	**0.004**
maxHR[a] (beats/min)	135 (132–142)	139 (135–142)	0.145
minHR[a] (beats/min)	46 (43–49)	45 (43–48)	0.139
aHR[a] (beats/min)	74 (71–76)	72 (69–75)	0.180

AEE: active energy expenditure, aHR: average heart rate, aMETs: average metabolic equivalens, maxHR: maximum heart rate, minHR: minimum heart rate, BMI: body mass index, PAD: physical activity duration, SDN: sleep duration, TEE: total energy expenditure.
[a] Data was presented as interquartile range (IQR) and median.

continuous variables depending on Gaussian distributions. To account for the non-Gaussian distribution of AEE, PAD, SDN, maximum heart rate (maxHR), minimum heart rate (minHR), average heart rate (aHR), VEBs frequency, a log10 $\{x+1\}$ transformation was made. A P value of ≤ 0.05 was considered statistically significant.

3. Results

Comparison of clinical and metabolic parameters of the patient and control groups is shown in Table 1. There were no significant differences between the two groups with respect to age (47 ± 17 years vs. 49 ± 15 years, $P=0.662$), gender (male; 48% vs. 45%, $P=0.816$), body-weight, height, BMI and smoking rates. TEE was higher in the patient group than the control group (1470 ± 353 kcal vs 1125 ± 275 kcal, $P<0.001$). aMETs (1.1 ± 0.2 vs. 1.3 ± 0.2, $P=0.028$) PAD (0,35 vs. 0.48, $P=0.007$) and SDN (3.15 vs. 4.31, $P=0.004$) were significantly lower in the patient group than control group. Both groups were similar regarding AEE, maxHR, minHR and aHR rates.

Table 2 shows the association between VEBs frequency and metabolic parameters in the patient group. VEBs frequency was inversely correlated with only SDN ($r=-0.374$, $P=0.027$). SDN decreased as VEBs frequency increased (Fig. 1).

Table 2
Association between VEBs frequency and metabolic parameters in patient group.

Variables	r (correlation coefficient)	P value
TEE	+0.142	0.403
AEE	−0.051	0.765
PAD	−0.035	0.837
SDN	−0.374	**0.027**
aMETs	−0.056	0.789

AEE: active energy expenditure, aMETs: average metabolic equivalens, PAD: physical activity duration, SDN: sleep duration, TEE: total energy expenditure.

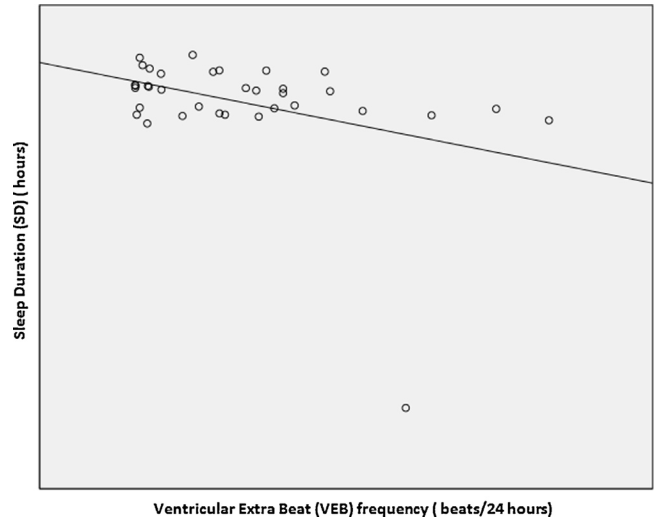

Fig. 1. Association between VEBs and sleep duration.

4. Discussion

We evaluated parameters including daily TEE, PAD, aMETs and SDN in patients with symptomatic frequent VEBs in the present study, as follows:

- TEE was significantly higher in patients with symptomatic VEBs when compared with healthy subjects;
- PAD and aMETs were found to be lower in the patient group;
- SDN was shorter in the patient group than the control group. VEBs frequency was negatively correlated with SDN.

VEBs is one of the most common arrhythmias in daily clinical practice. Although frequent VEBs might be associated with myocardial hypertrophy, cardiomyopathy and ischemic heart disease, it can be seen in patients without structural heart disease as well [8–12]. Symptomatic frequent VEBs can also impair quality of life. Heart rate was previously shown to be correlated with energy expenditure [13]. However, the impact of frequent VEBs on energy expenditure is unknown. TEE consists of three components: resting energy expenditure (REE), thermic effect of food (TEF) and AEE. REE and TEF compose 75% fraction of TEE. The remaining 25% includes AEE [14]. In the present study, although AEE was not different between patient and control groups, TEE was higher in the patient group and VEBs frequency was not associated with TEE. Anxiety induced by palpitation in patients with frequent VEBs is likely to cause activation of sympathetic nervous system and catecholamine surge thus increase REE. Increased energy expenditure in the patient group might be associated with anxiety-induced sympathetic discharge rather than the number of VEBs. We defined frequent VEBs as more than 10 VEBs per hour. We have recorded that symptomatic VEBs in this frequency influenced energy expenditure regardless of number of VEBs. Therefore, severity of symptoms should be taken into account rather than the number of VEBs while deciding for suppressive treatment of VEBs in patients with symptomatic VEBs.

Frequent VEBs was previously demonstrated to be associated with decrease exercise tolerance [2]. In our study, daily PAD and aMETs were found to be shorter in the patient group than the control group. Anxiety induced by irregular heartbeats might have played a role in shortened daily PAD.

The most common symptoms caused by VEBs, palpitation and sensation that heart has stopped beating, are secondary to hypercontractility and pause following VEBs [15]. Symptoms can be more prominent in silent environments or while sleeping and the patient can recognise these ectopic beats. In this study, we found that SDN was shorter in patients with symptomatic VEBs when compared with healthy subjects and also VEBs frequency was inversely correlated with SDN. This condition may be associated with sleeping disorder due to VEBs.

4.1. Study limitations

Data collected by ambulatory Holter-ECG and the Body-Media armband devices were acquired for a 24 hour period. Longer periods of recording could have provided more useful results. Although all participants were warned about resuming their daily physical activities, they might have limited their physical activity and also experienced an uncomfortable sleep due to discomfort of devices. This condition might have caused underestimation of TEE and SDN values for both groups. However, this interaction is equal for both groups. TEE consists of three components: resting energy expenditure (REE), thermic effect of food (TEF) and AEE. The thermo-regulation part of TEE being probably unchanged between the 2 groups. However, the thermic effect of food cannot be totally excluded, because populations have not experienced any survey concerning ingesta. Another limitation of our study is the relatively small sample size.

5. Conclusion

When compared with healthy subjects, daily TEE is increased in patients with symptomatic frequent VEBs while PAD, aMETs and SDN are decreased. VEBs frequency was inversely correlated with SDN. Symptomatic frequent VEBs are associated with impaired quality of life through their adverse effects on metabolism, physical activity and SDN.

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Disclosure of interest

The authors declare that they have no competing interest.

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