Heart Rate Variability

Heart rate and blood pressure variability in orthostatic syncope.

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Abstract

The pathogenetic role of autonomic nervous system in the neurally mediated orthostatic vasodepressive syncope is unclear: upright tilt was used to assess the characteristics of autonomic tone during orthostatic stress. We studied 18 patients (mean age 26 ± 5 years) suffering from vasodepressive orthostatic syncope and with positive response to a 30-minute 60° upright tilt and a comparable control group with a negative response to the upright tilt test.

Blood pressure and heart rate (RR interval) were measured beat by beat; ECG, systolic (SAP) and diastolic arterial pressure (DAP) and respiration trace were recorded for spectral analysis.

The most important result of the work is a different pattern of the parameters evaluated, between fainters and controls, in the last period of tilt test, just before the syncope, and in the fainters group between the first (at the beginning) and the last period (just before syncope) of tilting.

Baseline heart rate, arterial pressure and spectral Indices were similar and increased with tilting in both groups (Low Frequency; LF; High Frequency; HF; LF/HF ratio). Just before the syncope, we observed in fainters group a decrease of heart rate, blood pressure, LF-RR, HF-RR, LF/SAP, LFMF-RR and an increased HF/RR and of total power where compared to in the same subjects in the first period of tilt and in front of controls in the same period of tilt.

The novel aspect of the work, regarding the autonomic control of heart rate and arterial pressure by spectral fluctuations and by haemodynamic parameters, is consistent with a reduced sympathetic reserve in the immediate pre-syncope period.

INTRODUCTION

Vasodepressive syncope is a reflex event, whose effect on cardiovascular function is hypotension and bradycardia, as consequence of a decline in total peripheral resistences. It causes a decreased cerebral perfusion and a loss of consciousness [1], but it is unclear what is the stimulus and the sequence of cardiovascular events leading to the loss of consciousness and postural tone preceding the reflex arc: usually there is an associated condition (like emotional distress, orthostatism, neural pain) which starts the series of events.

We describe the results of non invasive tests of neurocardiovascular function in young people who fainted while standing up. The study was done to determine if the fainters differed from non fainters in 4 different situations, each characterized by different variability expressed by spectral fluctuations and by pathophysiological mechanism underlying the reflex arc.

MATERIALS AND METHODS

The study was performed in 18 patients (7 females, mean age 28 ± 5 years), referred to the emergency room of our hospital, suffering for vasodepressive orthostatic syncope (VDS) and in 18 (7 females, mean age 28 ± 4 years) healthy volunteers. Informed consent was obtained by each subject admitted to the study.

The diagnosis of VDS was established by a detailed history of the event, neurologic and cardiologic clinical examination, electroencephalographic, electrocardiographic (ECG), echocardiographic, Holter ECG monitoring for 24 hours, computed tomographic scan of the brain. All tests were normal. Routine hematologic and blood chemistry laboratory test were normal. No neurological or cardiac causes of syncope were identified. All subjects had a normal physical fitness without any special sport training, non-smokers, did not use any medication and had normal dietary habits.

During tilt all the 18 patients underwent a transient loss of consciousness characterized by bradycardia and hypotension in according to the diagnosis of VDS. All the control subjects were tilt negative for syncope, for orthostatism, for sleep loss.

The experimental procedure started at 12 a.m. in a room with constant ambient temperature (22°C): patients and controls were placed on a tilt table (Elektro-Werke, Type 1.73-006, Hanning Germany) and simultaneous recordings were obtained of ECG tracing (Spaceclabs 9000, Redmond, WA - USA) of systolic (SAP) and diastolic arterial pressure (DAP) beat by beat - from III or IV fingers of the left hand (Finapres Omehda, Englewood Cliffs, Co - USA). Respiratory activity was measured by a piezoelectric transducer as previously described [2].

Recordings were observed for two periods of 30 minutes, lying down and passive tilting (60°); to have traces without emotional interferences it was excluded the period of passive moving from down to up (20 seconds) and the three minutes after. All subjects sustained a tilting train for three times before starting the test. The signals were sampled at 250 Hz/channel with a multifunction OI board (AT-MIO-16FS National Instruments, Austin - USA) and stored in a personal computer (Zenith Z-486/33ET, Zenith data system spa, USA).

Spectral analysis of R - R interval, SAP and DAP was performed by an autoregressive model [3] at periods of 256 beats. The order of autoregressive model was 12 as previously established [3]. The power of each component was obtained by measuring the area below each peak [4] and the values obtained in each subject were averaged in both lying down and tiltting conditions.

In the spectral analysis of all signals we considered Total power expressed as ms2/Hz and two peaks indetified as Low Frequency (LF; 0.03-0.15) and High Frequency (HF - 0.15-4.0) expressed as total oscillatory power and normalized units (n.u.); the HF peak was identified by correspondence with the peak on the respiratory spectrum; normalized units allowed a comparison among different subjects and different situations, each characterized by different variability [4,5]; only for R-R signals we considered the LF/HF ratio.

Statistical analysis

For the statistical analysis we choosed in fainters the first three minutes of clinostatism, the three minutes of head up tilt before the syncope (HUT 2) and the three minutes just before (HUT 1); in controls we choosed the last three minutes of the tilt (HUT 2), the three minutes immediately before (HUT 1) and the first three minutes of clinostatism.

We made statistical analysis between the two periods of the same group (HUT 2 vs HUT 1) and of the same period in the two groups (HUT 2 vs HUT 2).

The results are expressed as mean ± s.d. The statistical significance of the difference in means was evaluated by analysis of variance for paired groups (ANOVA) and significant level was chosen at p<0.05.

In clinostatic position the values of each variable considered were similar in the two groups.

Also during tilting there was not any significant difference; the results showed what we attended, that is a reduction of RR interval, a slight reduction of SAP and a slight increase of DAP.

Spectral analysis showed an increased trend for LF-RR, LF/HF, LF-SAP, LF-DAP, HF-SAP, HF-DAP in both groups with anyone statistical difference.

A decreased trend was observed for HF-RR with anyone difference between the groups.

The results are shown in Tab 1.

Table 1: Haemodynamic parameters and spectral indices of different periods of tilt in fainters and in controls

<table>
<thead>
<tr>
<th></th>
<th>REST</th>
<th>HUT 1</th>
<th>HUT 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>RR ms</td>
<td>933 ± 126</td>
<td>118</td>
<td>119</td>
</tr>
<tr>
<td>TP ms²</td>
<td>1694 ± 952</td>
<td>2320</td>
<td>1580</td>
</tr>
<tr>
<td>LF nu.</td>
<td>62 ± 45</td>
<td>145</td>
<td>88</td>
</tr>
<tr>
<td>HF nu.</td>
<td>37 ± 18</td>
<td>54</td>
<td>13</td>
</tr>
<tr>
<td>LF/HF</td>
<td>2.4 ± 1.9</td>
<td>0.9</td>
<td>0.4</td>
</tr>
<tr>
<td>SAP mmHg</td>
<td>76 ± 12</td>
<td>75 ± 8</td>
<td>78 ± 14</td>
</tr>
<tr>
<td>LF mmHg²</td>
<td>4.2 ± 2.2</td>
<td>7.1</td>
<td>7.4</td>
</tr>
<tr>
<td>HF mmHg²</td>
<td>0.7 ± 0.8</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td>SAP mmHg</td>
<td>136 ± 13</td>
<td>132 ± 16</td>
<td>122 ± 20</td>
</tr>
<tr>
<td>LF mmHg²</td>
<td>9.9 ± 15</td>
<td>6.3</td>
<td>13</td>
</tr>
<tr>
<td>HF mmHg²</td>
<td>2.7 ± 3.4</td>
<td>1.9</td>
<td>1.1</td>
</tr>
<tr>
<td>Time of syncope min</td>
<td>11</td>
<td>(3-24)</td>
<td></td>
</tr>
</tbody>
</table>

RR = ECG interval; TP = Total power; LF nu. = Low Frequency expressed as normalized units; HF nu. = High Frequency expressed as normalized units; LF/HF = Low Frequency/High Frequency ratio; DAP = SAP = Diastolic adn Systolic Arterial Pressure;
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LF and HF ms2Hz = Low and High Frequency expressed as absolute value.

§ $p<0.05$ controls vs fainters in the same period (HUT2 vs HUT1)

§§ $p<0.01$ controls vs fainters in the same period

* $p<0.05$ in the same group HUT1 vs HUT2

** $p<0.01$ in the same group HUT1 vs HUT2

# $p<0.05$ controls vs fainters from rest to HUT1

In controls vs fainters the mean value of three minutes selected for statistical analysis, clinostatic and orthostatic, did not differ from the mean for all the periods (p NS) except for LF-DAP from rest to tilt ($p<0.05$).

The response to prolonged tilting, evaluated in the last three minutes (HUT2), demonstrated in fainters vs. controls:

a) a reduction of DAP and SAP

b) a decrease of LF-SAP ratio

c) an increase of Total power

d) a decrease of LF-RR ($p<0.05$) and LFHF ratio ($p<0.05$), of LF-DAP ($p<0.01$), LF-SAP ($p=0.05$) and increase of HF-RR ($p<0.01$)

In other words, there is no state difference neither in the haemodynamic and spectral parameters in the two periods of tilting in controls, nor in HUT1 between fainters and controls. The only statistical difference in the increase of LF-RR values from rest to tilt ($p<0.05$). The significant statistical difference appear in HUT2, as difference in the group of fainters for HUT2 vs HUT1 and inter groups between fainters and controls in the same period HUT2.

DISCUSSION

The present study was aimed to characterize the changes in spectral indexes during head up tilt to understand better the role of autonomic nervous system in patients who suffer from vasodepressive fainting. Data of spectral analysis were related to haemodynamic parameters: as expected, patients and controls had an increase of heart rate from rest to tilting. This fact is aimed to sustain an adequate cardiac output since the latter is reduced by the overfilling of veins of the legs. Others Authors [6-8] underline a progressive increase of heart rate in controls and not in patients during tilt: we can confirm a mean constant level of R-R interval in controls but we did not observe a progressive increase of heart rate from the beginning of tilt as log as the fainting, because the time of fainting was different among patients (range 3-24'). For this reason we can affirm that in pre syncopal phase (HUT2) a decrease of DAP and SAP is not followed by an increase of heart rate, as the factor responsible for further rising was exhausted.

The significant difference in controls between the first phase of tilt and the second phase (HUT2) manifests a significant variation during the pre-fainting phase. In our study the differences are not more marked in patients than in controls, as expected, patients and controls had an increase of heart rate from rest to tilting. This fact is aimed to sustain an adequate cardiac output since the latter is reduced by the overfilling of veins of the legs. Others Authors [6-8] underline a progressive increase of heart rate in controls and not in patients during tilt: we can confirm a mean constant level of R-R interval in controls but we did not observe a progressive increase of heart rate from the beginning of tilt as log as the fainting, because the time of fainting was different among patients (range 3-24'). For this reason we can affirm that in pre syncopal phase (HUT2) a decrease of DAP and SAP is not followed by an increase of heart rate, as the factor responsible for further rising was exhausted.

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alteration in autonomic control, responsible of a gradual onset of those mechanisms which became greater at the time of fainting. This could open a novel interpretation of the pathogenetic mechanism of vasovagal syncope, shifting the target to the peripheral effectors of the autonomic system by the activity of baroreflexes [9,17,30,32] or by an humoral vasodilating mechanism like for example, the increase of secretion of adrenalin instead of noradrenalin [42-44], beta endorphin [36,37] or adenosine [45].

REFERENCES