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Assessment the change on rhythm cardiac produces by the metabolic syndrome in rats: using non-linear methods

Albarado-Ibañez Alondra1, 3, Hiriart Marcia 2, Frank Hoeflich Alejandro1 , Torres-Jácome Julián

1 Centro de ciencias de la complejidad UNAM, cd de México, México, alondra.albarado@correo.buap.mx 2 Instituto de Fisiología Celular UNAM, cd de México, México, mhiriart@ifc.unam.mx 3 Instituto de Fisiología BUAP, Puebla, México, julian.torres@correo.buap.mx

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Abstract

In the mammals of heart rate depend on the production and conduction action potential cardiac with origin in pacemaker and any electrical changes could be produced sudden arrhythmias in the heart. The current evidence suggests that the rats with metabolic syndrome presented changes in the sino atrial node. However, is not relates the alteration produces by metabolic syndrome and rhythm cardiac such as the changes only related to vascular injury. In this study shows the existence of this relationship. We induced metabolic syndrome in young Wistar rats administering 20% sucrose in the drinking water. Ten and twenty eight weeks later, the rats were anesthetized and the electrocardiogram recorded, disclosed the heart rate decline from 237 bpm in control at 198 bpm in metabolic syndrome. The conventional microelectrodes technics showed that the production, morphology and propagated of action potential in sino atrial node was inadequate. The time series of RR and action potential intervals these data showed a decreased ability to regulate hear rate

1 Introduction

The emerging disease that produces side effects which increase health expenditure, for this reason are important for the industrialized countries. The metabolic syndrome (MeS) is an ill disease has been described as a cluster of several factors, abdominal obesity, hyperglycemia, dyslipidemia and elevated pressure [1]. The progression of MeS from Diabetes mellitus type 2 depend on behavior lifestyle and genetic predisposition [2]. The MeS increases the risk for development cardiovascular disease and type 2 diabetes the signs. The cardiovascular disease is the first cause of dead in world, according to the World Health Organization [3]. The MeS produced fluctuations in RR intervals and changes in the rhythm cardiac increasing lethal arrhythmias, for this reason we should explore new ways for analyze the changes by MeS [4].

On the other hand, the heart rate variability (HRV) analysis it is using to assess cardiac function in patients with several pathologic conditions, however in these studies do not relationships HRV and rhythm cardiac with changes in MeS, this considerably improved the prognostic and diagnostic of MeS as well as the side effects. In this work proposed to analyze the changes in HRV produced MeS, as a method to predict future chronic injuries, before of diabetes or lethal arrhythmias [5].

2 Methods

2.1 Model of metabolic syndrome

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Young adult Wistar rat males (250-280 g) they were kept in a 12 h light/dark, fed with standard rat chow composed by laboratory rodent diet 5001 with 28.5% protein, 13.5 fat and 58% carbohydrates [4]. *Ad libitum* tap water was provided to control group or 20% (w/v) of sucrose solution treated group, for 24 weeks. After the treatment, animals were anesthetized with an intraperitoneal sodium pentobarbital injection (40 mg/kg). We obtained heart, blood, peripancreatic and epididymal fat samples. All methods used in this study were previously approved by the Internal Council and the Animal Care Committee of the Instituto de Fisiologia Celular, Universidad Nacional Autónoma de México. Animal care was performed according to the "International Guiding Principles for Biomedical Research Involving Animals" Council for International Organization of Medical science 2010. After treatment we took the following measure: body weight, abdominal circumference abdominal and body length.

2.2 Heart rhythm

To check for heart rhythm abnormalities, at the rats were performed the electrocardiogram (ECG). The rats anesthetized with sodium pentobarbital (63 mg Kg^{-1}, IP) and bipolar ECGs were recorded using subcutaneous needle electrodes and following ECG lead I configuration. Data was stored in a personal computer and analyzed off-line using Clamp Fit (Molecular Devices). All rats were continuously monitored to guarantee right ventilation and temperature. We obtained the heart and made the dissection of SA node and using the microelectrodes conventional technician recorded action potential (AP).

2.3 Heart rate variability

The electrocardiogram was recorded rat controls and with SM. RR intervals were measured of the recorded and performed in the interval time series RR of the ECG. The electrical activity of sino atrial node recorded and measured the time interval between consecutive action potentials (APi). The intervals of RR and APi were using for the time series plot. The heart rate variability was measured with SD1, SD2 and index Poincaré SD1/SD2.

$$SD_1 = \sqrt{\left(\frac{1}{n-1}\right)\sum_{i=1}^{n}\left(\sqrt{\left(\frac{RR_i - RR_{i+1}}{2}\right)^2} - \overline{\sqrt{\left(\frac{RR_i - RR_{i+1}}{2}\right)^2}}\right)^2}$$

$$SD_2 = \sqrt{\left(\frac{1}{n-1}\right)\sum_{i=1}^{n}\left(\sqrt{2\left(\frac{2\overline{RR_i} - RR_i - RR_{i+1}}{2}\right)^2} - \overline{\sqrt{2\left(\frac{2\overline{RR_i} - RR_i - RR_{i+1}}{2}\right)^2}}\right)^2}$$

3 Results

The animals with MeS the spectral power density analysis of RR intervals time series display an increased and the lower frequency compared control see figure 1. Also, the MeS decreased heart rate variability such as SD1 7 ± 0.4 and 16 ± 1 and SD2 28 ± 0.3 and 69 ± 1 control animals with MeS respectively, both standard deviations has increased of 2 times your value. The MeS produced sinusal bradichardya then if necessary examined that electrical activity of SAN. The recording the intrinsic heart rate was measured in the isolated preparation of SA node (used the four activities electrical). The spontaneous cycle length of sinoatrial node was 350 ± 120 ms (n=15) in control and 571 ± 60 ms (n=15) in animals with MeS. Aside from decreased in frequency in SA node, the rate variability was SD1=70, SD2=144 in control and SD1=172, SD2=376 in rats with Mes. In both cases the index were similar in control was 0.45 and the MeS was 0.48.The spectral power density analysis of AP intervals time series showed an increased with MeS at the lower frequency compared control see figure 2.

4 Conclusion

The atrial fibrillation and sinus node dysfuntion are clinical arrhythmias, both have relationship in common [6]. Our data demonstrated that the MeS produced arrhythmias in model animal such as decreased the heart rate but increased the intrinsic heart rate variability. In addition these data are a correlation with the changes was also observed in sino atrial node, the preceding point decreased ability to regulate hear rate for pacemaker increased potentially deadly heart rhyhm.

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Figures

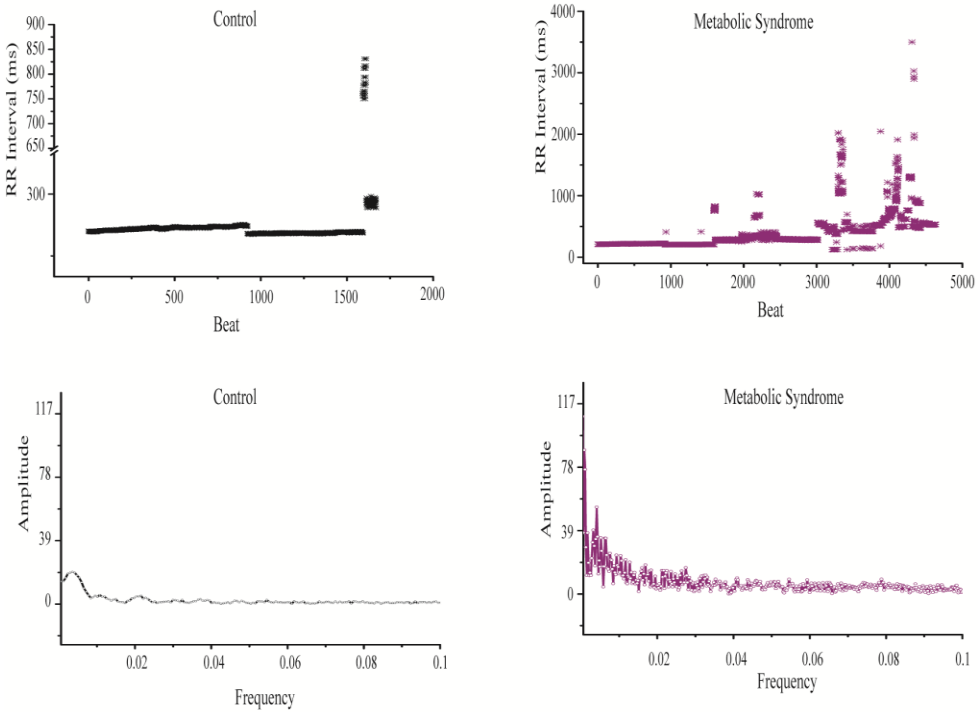

Figure 1. Fast Fourier Transform of RR intervals time series. Increase the lower frequency and RR interval (RRi) for MeS see left panel purple square. Upright panel see control empty square.

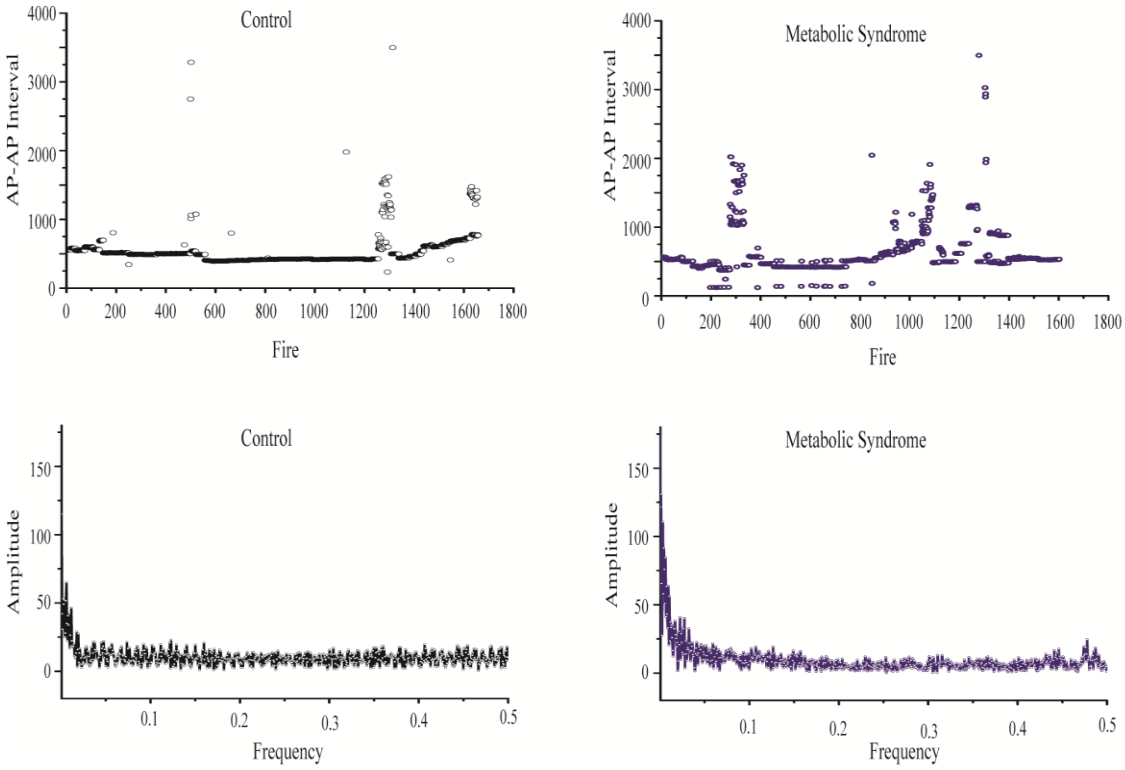

Figure 2. Fast Fourier Transform of AP intervals time series. Increase the lower frequency for MeS blue circle and action potential interval (APi) see left panel. Upright panel see control dark circle.

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