Study of the induction and characteristics of ventricular fibrillation in an experimental model of metabolic syndrome

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Introduction: Metabolic syndrome (MetS) has become a major public health concern due to its increased prevalence, which portends a greater risk of cardiovascular disease such as heart failure and sudden cardiac death (SCD). Indeed, it has been shown that obese and diabetic patients have a higher incidence of arrhythmias that are non-related to ischaemic events, suggesting a pro-arrhythmic structural and/or electrical remodeling, but the underlying mechanisms are not completely understood.

Purpose: To investigate VF induction and the cardiac electrical remodeling produced in an experimental model of diet-induced MetS by means of the study of the characteristics of ventricular fibrillation (VF).

Methods: Male NZW rabbits were randomly assigned to a control (n=12) or a MetS group (n=13), fed during 28 weeks with high-fat (10% hydrogenated coconut oil and 5% lard), high-sucrose (15% dissolved in water) diet. After 28 weeks, their hearts were isolated and perfused in a Langendorff system and epicardial optical mapping was performed using two synchronized EMCCD cameras focused on the left (LV) and right (RV) ventricles (field of view= 128 x 128 pixels; sampling frequency: 330 frames/second). We used the electromechanical uncoupler blebbistatin (7.5 µM) and the potentiometric dye di-4-ANBDQPO. VF was induced by pacing at increasing frequency (intensity= 3 x diastolic threshold) and, once triggered, 10 s recordings were made each minute, during 6 minutes (without interrupting perfusion). We registered VF induction (beats per minute, bpm) and then we analyzed time- and frequency-domain characteristics of VF by means of VV intervals, dominant frequency (DF) and their coefficient of variation (CV). A mixed model ANOVA an unpaired t-test were used for statistical analysis (p<0.05).

Results: Time-domain analysis showed that VV interval duration decreased in the RV of MetS animals, whereas we did not find differences in the LV between control and MetS group (Figure: temporal evolution, A and mean VV, B). Similarly, we found an increase of DF in the RV of MetS animals, while DF remained unchanged in the LV (Figure: temporal evolution, C and mean DF, D). When comparisons were made within groups between RV and LV, we found modifications in VV interval and DF in control animals but not in MetS animals. We did not find changes in CV of VV and CV of DF. Regarding VF induction, no differences were observed between control and MetS groups (474±196 versus 482±53 bpm).

Conclusion: High-fat and high-sucrose diet administration during 28 weeks produced, in isolated heart, a decrease of VV interval duration and an increase in DF of VF in the RV of MetS animals, showing a higher frequency of activation during VF. The differences between LV and RV observed in control groups (VV and DF) disappeared in MetS animals. Both groups showed similar VF inducibility under our experimental conditions.
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