The Effect of Vibration Ablation Catheter on the Temperature of the Electrode under 30 gf

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1. Introduction

Radio-frequency (RF) catheter ablation is a highly effective treatment for many tachycardias. During catheter ablation, a catheter with an electrode on the tip is inserted into the heart through blood vessels and placed at the target place which causing the heart rhythm disorder. RF energy is introduced through the electrode to destroy the abnormal heart tissue. High output power is necessary for ventricle muscle; however the high power may cause complications such as thrombus because of the excessive temperature on the electrode-tissue interface. We proposed a new electrode cooling by making the catheter vibrating to increase the convective cooling from blood flow which called vibration ablation catheter. Contact force between electrode-tissue is a major factor which may affect the electrode cooling by vibration. In our previous study, the cooling effect of vibration can be maintained with increasing contact force from 2 gf to 10 gf. In this study, we investigated the effect of the high contact forces (20 and 30 gf) on electrode cooling during ablation with vibration.

2. Experimentation

Figure 1 shows a schematic diagram of the in vitro ablation system. The open channel (500 × 50 × 20 mm) was filled with 0.9% saline (room temperature). Instead of using animal heart tissue, we used PVA-H as ablated tissue [1]. A K-type thermocouple with the diameter of 0.5 mm was located at a depth 2 mm from the surface to measure the internal PVA-H temperature. The contact force between the electrode-tissues was measured by the electronic balance. The 10~30 gf were used as the normal and heavy contact. The output power was set at 8W, and the perform duration was 60s. Vibrations with amplitude of 0.5 mm and frequencies of 0, 31 Hz and 63 Hz were used in each contact force.

3. Results and Discussion

Figure 2 shows the electrode temperature at 60 s under flow velocities with vibrations. The temperature at 60 s is the highest temperature during the perform time. Except the ablation under 30 gf with 0 Hz vibration, no significant change with increasing contact force can be seen. The result of no difference suggests that the electrode cooling by vibration could be maintained under the increasing contact force from 10 gf to 30 gf. The electrode cooling by vibration is because the vibrations increase the convective cooling from blood flow. Under high contact force, the vibration may still disturb the flow around the catheter and increase the convective cooling. The significantly high temperature under 30 gf with 0 Hz is caused by the melted PVA surrounding electrode (the melting point of PVA-H is about 70°C). More experiments with the heavier contact force are necessary for the future study.

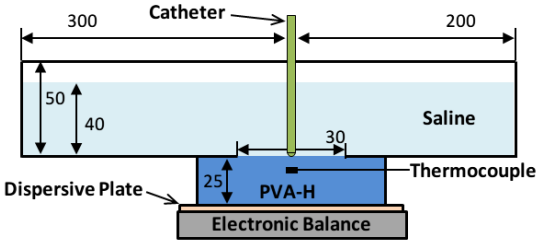

Fig. 1 Schematic diagram of the in vitro ablation system.

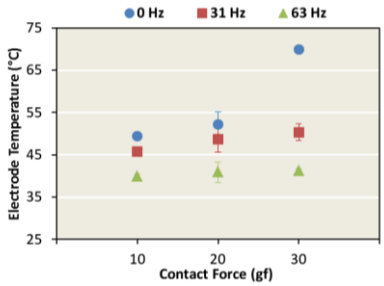

Fig. 2 Electrode tip temperatures at 60 s.

References:

[1] K. Yu, et al., Proceedings of ASME, "PIV ANALYSIS OF THE FLOW PATTERN AROUND AN ABLATION CATHETER TO OBSERVE THE FLOW EFFECT ON THE ELECTRODE.," IMECE2013-62791.