Mathematical Modelling of the Thermal Impact of Balloon Occlusion of the Coronary Sinus during Mitral Isthmus Radiofrequency Ablation

Ana González-Suárez[1]*, Andre d'Avila[2], Juan J. Pérez[3], Vivek Y. Reddy[4], Oscar Camara[1] and Enrique Berjano[3]

[1]BCN-MedTech, Department of Information and Communication Technologies, Universitat Pompeu Fabra, Barcelona, Spain. *E-mail: ana.gonzalez@upf.edu
[2]Hospital SOS Cardio, Florianopolis – SC, Brazil
[3]BioMIT, Department of Electronic Engineering, Universitat Politècnica de València, Valencia, Spain
[4]Helmsley Electrophysiology Center, Mount Sinai School of Medicine, New York, NY, USA

ABSTRACT

Purpose: Although previous experimental data have suggested that temporary occlusion of the coronary sinus (CS) can facilitate the creation of transmural lesions across the atrial wall (AW) during mitral isthmus radiofrequency (RF) ablation [1], there has not yet been an engineering study on the thermal effect of the blood flow inside the epicardial vessels and its stoppage by an occlusion balloon.

Methods: A mathematical model was built and computer simulations were conducted to study the effect of stopping the blood flow in the CS by two methods: 1) by setting blood velocity in the CS to zero, which mimics a distal occlusion; and 2) by including a balloon filled with air in the model just below the ablation site, which mimics a proximal occlusion.

Results: For short ablations (15 s), lesion sizes were smaller with proximal occlusion than with and without distal occlusion, regardless of the AW-CS distance (from 0.5 mm to 3.4 mm). For longer ablations (60 s), the internal CS blood flow (case without occlusion) considerably reduced lesion size, while stoppage combined with the presence of a balloon (proximal occlusion) produced the largest lesions. The balloon length (from 10 to 40 mm) was an irrelevant parameter when proximal occlusion was modeled.

Conclusions: Our findings suggest that using an air-filled balloon to occlude the coronary sinus facilitates mitral isthmus ablation for long ablations (60 s). In contrast, proximal occlusion could impede transmural lesions in the case of short ablations (15 s).

REFERENCES

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