In silico assessment of a multihole electrode design for High Power Short Duration ablation

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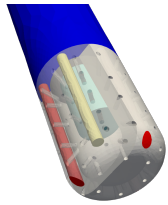
Aims: High Power Short Duration (HPSD) ablation is an emerging approach to the radiofrequency catheter ablation for the treatment of cardiac arrhythmias. New catheter technologies have been introduced aiming at improving the efficacy and safety of HPSD. Our previous in-silico assessment considered 6-holes electrodes, which were proven to not provide adequate cooling of the blood during the ablation. In this work, we aim to explore in silico the impact of a better electrode cooling system on the HPSD procedure.



The 66-hole electrode design with thermocouples (yellow) and mini electrodes (red).

Methods: We used our previously validated computational model, which is based on an in-vitro experimental setup. The model uses a fluid-thermal-electromechanical framework for the simulation of the ablation process. A new electrode design is considered that consists of 66 irrigation pores, 3 thermocouples and 3 mini electrodes based on state-of-the-art catheters used for HPSD. Ablations are simulated on a virtual human cardiac tissue, with combinations of (70W, 8s), (80W, 6s) and (90W, 4s) for power and duration and different contact force between 5g-20g.

Results: The results show a better cooling on the ablation site, with fewer complications due to charring formation. A slightly larger lesion size is obtained when compared to the previous 6-hole electrodes, due to the low irrigation rate of this design. In terms of steam pops, a safety margin comparable to the 6-hole electrodes is obtained, possibly indicating that temperature control plays an important role for the prevention of this complication.

Conclusion: The multihole electrode design is well suited for HPSD ablations due to its effective cooling of the blood. From the steam pop perspective, this design doesn't really outperform common 6-hole electrodes.