Patient-specific atrial fibrillation simulation prediction depend on rhythm used for calibration

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Background:
Personalised therapies using patient-specific models of atrial fibrillation (AF) can enhance treatment outcomes. These models are constructed from patient's imaging data, incorporating AF effects. Electroanatomic data collected during an ablation procedure can be used to calibrate patient-specific activation and repolarisation properties, which affect fibrillation properties and therapy outcomes. However, it is unknown how calibration data rhythm, pacing location, and choice of calibration technique affects prediction. We aim to compare AF properties and predicted therapy responses for patient-specific models calibrated using electroanatomic mapping data collected at different pacing rates.

Methods:
Initially, six patients underwent electroanatomic mapping during catheter ablation therapy, pacing from a catheter in the coronary sinus at cycle lengths of 250ms, 400ms and 600ms (Fig A). Conduction velocity (CV) was calculated for each map using a wavefront fitting method and a gradient-based method (Fig B). Anatomical models with labelled pulmonary veins and fibres were constructed using an automated pipeline. Tissue conductivities were calibrated to each of the different CV maps to generate a series of possible models. AF was simulated in each model using CARP simulator, and phase singularity (PS) density maps were calculated. Pulmonary vein isolation (PVI) was applied to each model after 5 seconds of AF.

Results:
Mean CV was lower for pacing at 250ms than for 600ms (0.78m/s and 1.00 m/s respectively), demonstrating the effects of restitution. AF wavefront patterns differed depending on pacing rate, with no correlation between PS density maps (mean correlation 0.14) (Fig C). Number of PS varied between models depending on calibrated cycle length (average difference of 2.01 PS/s). AF was sustained post-PVI in all cases tested (Fig D).

Conclusion:
AF properties depend on the pacing rate used for model calibration. Our future work will calibrate patient-specific restitution properties and compare AF model patterns and predicted therapy outcomes to clinical recordings.