Atrial Fibrillation (AF) - Pathophysiology and Mechanisms

Insights into electrophysiological mechanisms of atrial fibrillation propagation using simultaneous bi-atrial mapping

Pope M.[1]; Kuklik P.[2]; Banerjee A.[3]; Briosa E Gala A.[1]; Leo M.[1]; Mahmoudi M.[4]; Paisey J.[5]; Betts TIMOTH[1]

[1]John Radcliffe Hospital, Oxford, United Kingdom of Great Britain & Northern Ireland
[2]Asklepios Clinic St. Georg, Cardiology, Hamburg, Germany
[3]University of Oxford, Oxford, United Kingdom of Great Britain & Northern Ireland
[4]University of Southampton, Human Development and Health, Southampton, United Kingdom of Great Britain & Northern Ireland
[5]University Hospital Southampton NHS Foundation Trust, Cardiology, Southampton, United Kingdom of Great Britain & Northern Ireland

Introduction: Early evidence of pulmonary vein triggers initiating AF has led to focus on the left atrium (LA). Little work has been done to characterise the role of the right atrium (RA) in AF maintenance.

Purpose: To characterise the relative roles of the LA and RA in maintenance of atrial fibrillation and explore mechanisms of AF propagation.

Methods: Simultaneous bi-atrial mapping was carried out in patients undergoing first time catheter ablation using 2 linked non-contact charge density mapping systems to obtain 30-second recordings during AF. The predominant channel of communication between chambers was identified and the time difference across this channel measured (see figure). The proportion of signals earlier in each chamber was calculated and a dominant chamber identified if preceding the opposite chamber for ≥60% of the recording. AF was characterised in each chamber according to frequency of specific propagation patterns (localised rotational activation (LRA) and focal firing (FF)). The difference in AF characteristics in the LA and RA according to acute procedural outcome (termination with ablation vs. DCCV) was measured using 2-way ANOVA and predictors of AF termination identified using binomial logistic regression.

Results: Twenty-one patients were included (16 persistent AF, 5 paroxysmal AF, 11 in sinus rhythm at baseline) with 41 maps obtained prior to ablation. A dominant chamber was identified in 11 maps (in 9 patients). Of these, 5 maps (in 4 patients) were LA dominant, and 6 maps (in 5 patients) were RA dominant. The remainder showed balanced interatrial propagation. For patients with persistent AF, in the RA, those needing DCCV had more LRA than those with termination with ablation (79 activations, (95% CI 65-93) vs. 51 (30-71); p = 0.025). There was no difference in the LA in the two groups (77 vs 59, p = 0.541). There were fewer FFs in the RA vs LA in patients needing DCCV (123 (106-140) vs. 155 (137-172), p = 0.012)(see panel F). No differences in distribution of LIA were observed. The frequency of LRA (p = 0.003) and FF (p = 0.004) in the RA, and RA AFCL (p = 0.041), were predictors of acute procedural outcome.

Conclusions: Our novel approach of simultaneous bi-atrial mapping revealed that mechanisms responsible for AF maintenance were evenly distributed between atria whilst acute AF termination with left atrial ablation was dependent on the contribution of right atrial substrate. Strategies incorporating right atrial mechanisms may result in improved outcomes from AF ablation.

Abstract Figure.

Mean phase coherence (MPC) is calculated for every vertex on the anatomy and every vertex on the surface of the opposite chamber (A-B). The maximum MPC value is assigned to each vertex with the purple region denoting the area with maximal value. Local activation times (LAT) are assigned using phase analysis (C) and the time shift between local activations at the point of highest MPC calculated (D). A histogram of time shifts between chambers is plotted (E). F: Table of LRA and FF frequency between chambers in patients needing DCCV and those in whom ablation terminated AF (mean and 95% confidence interval). (AP, antero-posterior; DCCV, Direct current cardioversion; FF, Focal firing; LA, left atrium; LAT, Local activation time; LRA, Localised rotational activation; PA, postero-anterior; RA, right atrium)