

Left Atrium Hemodynamic in Atrial Fibrillation and Normal subjects

Alessandro Masci¹, Matteo Falanga¹, Antonio Chiaravalloti², Fabio Ansaloni², Corrado Tomasi², Cristiana Corsi¹

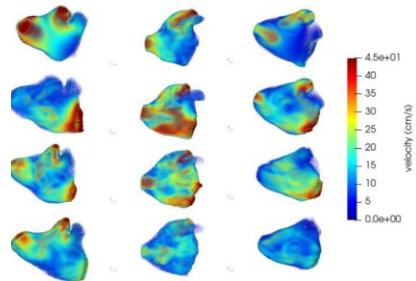
¹ DEI, University of Bologna, Campus of Cesena, Bologna, Italy

² Santa Maria delle Croci Hospital, AUSL della Romagna, Ravenna, Italy

Introduction. A computational fluid-dynamics (CFD) model previously developed with the aim of evaluating cardioembolic risk in patient affected by atrial fibrillation was used for the characterization of the left atrium (LA) hemodynamic and the stratification of the cardioembolic risk in normal subjects (NL), patients affected by paroxysmal atrial fibrillation (PAR-AF) and patients affected by persistent atrial fibrillation (PER-AF).

Methods. 3D patient-specific anatomical and motion models were derived from ECG-gated coronary artery CTs acquired with retrospective protocol. These models represented the computational domain for CFD simulation in which inflow initial conditions were derived from PW Doppler at the mitral valve and at the pulmonary veins. Velocity field and vortex structures both within the LA and left atrial appendage (LAA) were assessed in 10 NL, 5 PAR-AF and 4 PER-AF. Blood stasis was evaluated by populating the LAA with 500 particles and counting the number of particles still present after five cardiac cycles.

Results. Velocities inside the LA and LAA had different amplitude and distribution in the 3 groups (peak velocity – NL: $50\div 60\text{cm/s}$, PAR-AF: $40\div 50\text{cm/s}$, PER-AF: $15\div 25\text{cm/s}$) (see Figure). The mean velocity was also decreasing from PAR-AF to PERS-AF (mean velocity – PAR-AF: $25\div 35\text{cm/s}$, PER-AF: $8\div 20\text{cm/s}$) at the ostium of the LAA and inside the LAA in which the wash-out effect was strongly reduced. A higher number of vortex structures was observed in NL with respect to the AF patients, thus favouring a better washout of the atrial chamber and the LAA. The fluid particle analysis in the LAA confirmed these results (NL: 5 ± 2 , PAR-AF: 18 ± 3 , PER-AF: 41 ± 10). **Conclusions.** The developed approach quantifies differences in LA hemodynamic in AF and NL subjects, also allowing a stratification of the disease progression in terms of changes in the blood velocity, organization of blood flow and quantification of blood stasis.



Velocity fields in 3 representative subjects (NL, PAR-AF and PER-AF in the 1st, 2nd and 3rd column respectively), in four phases of the cardiac cycle (1st row: beginning of ventricular systole, 2nd row: beginning of ventricular diastole, 3rd row: atrial systole and 4th row: end of the ventricular systole)