Patient-Specific CFD in the Left Atrium. Atrial Fibrillation VS Sinus Rhythm STUDENT: Savier Yogita Sharda ADVISOR: Juan Carlos del Álamo

Background

- Sinus rhythm (SR) is the normal, coordinated electrical rhythm of the heart
- Atrial fibrillation (AF) is a common arrhythmia and key risk factor for stroke.
- AF disrupts atrial contraction, causing irregular left atrial (LA) flow and promoting blood stasis.

There is a lack of data comparing AF and SR in the same patient, which is crucial for understanding the physiological changes that occur during arrhythmia.

To identify rhythm-specific flow features linked to Goal: thrombogenesis and risk of stroke in humans.

Introduction

Left Atrial Pumping Mechanism: Electromechanical Perspective



Blood Stasis

Protein accumulation

Contractility

Blood velocity

SA node impulses propagate Bachmann's bundle to activate the left atrium P-wave on ECG represents depolarization atrial triggers myocardial contraction In AF, chaotic electrical activity P-wave disrupts coordinated contraction

Risk Stratification in Atrial fibrillation



Inflammation 1

VIRCHOW'

TRIAD

Hypercoagulability

von Willebrand factor

- Prothrombin fragment 1+2 1 Fibrinogen 1
- CHA₂DS₂-VASc has limited predictive power 35% of patients with scores ≤1 show LA thrombi
- Traditional scoring overlooks atrial substrate factors: fibrosis, endothelial dysfunction, hypocontractility
- CFD provides superior risk assessment through 3D flow visualization and key parameters: residence time, wall shear stress, blood residual ratio
- Combined CFD-biomarker significantly approach discrimination

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- signatures driving thrombogenesis enabling data-driven stroke risk modeling.
- Using CFD, we demonstrated that during AF, blood exhibits increased residence time within the LAA, potentially promoting thrombogenesis.

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