

Stroke Risk Identified By Slow Blood Flow in the Left Atrium

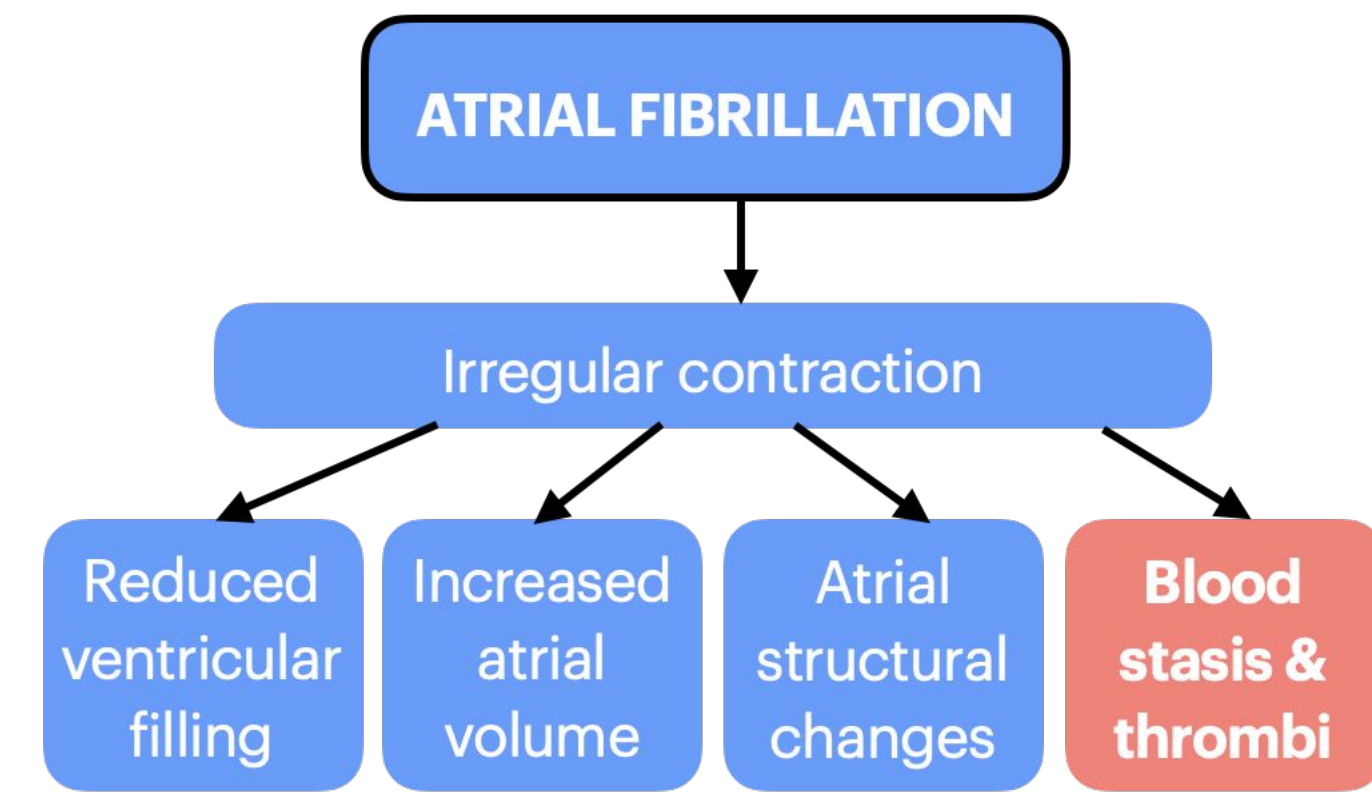
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Background



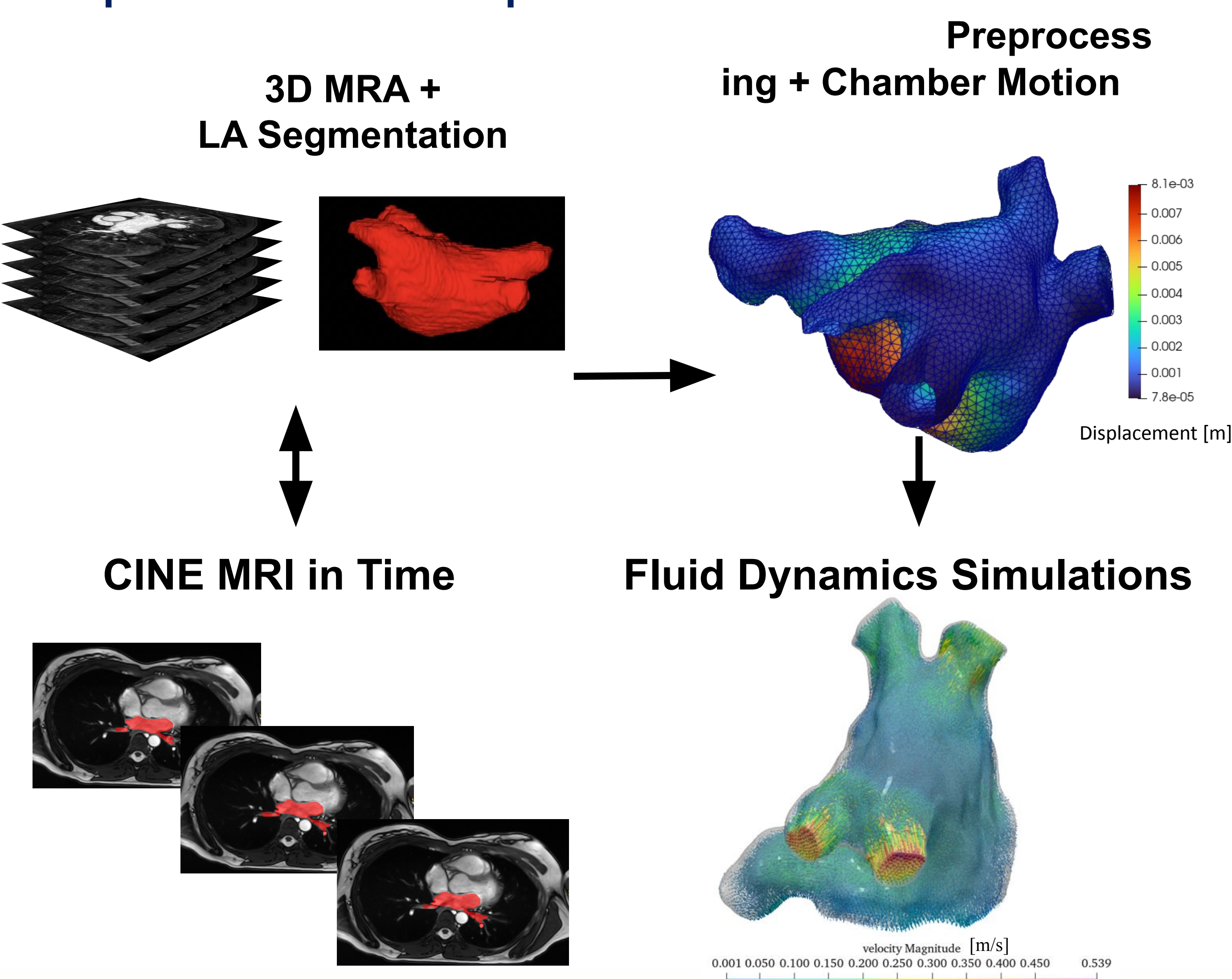
- Atrial fibrillation (AF) patients have 4-5x increased risk of stroke [1].
- Current AF stroke risk assessment, **CHA₂DS₂-VASc score**, is often inaccurate and unreliable [2,3].
- Oral Anticoagulants** with **severe side effects** such as **internal bleeding** prescribed for score > 1 to prevent thrombus formation.
- Left atrial (LA) and left atrial appendage (LAA) morphology and hemodynamics are linked with **thrombus formation** [4].
- For atrial motion, computational models commonly assume rigid walls or idealized chamber motion, without accounting for functional patient-specific data [5,6].

Objective(s)

- Characterize and distinguish **hemodynamics** of **stroke** patients from control patients using personalized fluid dynamics simulations.

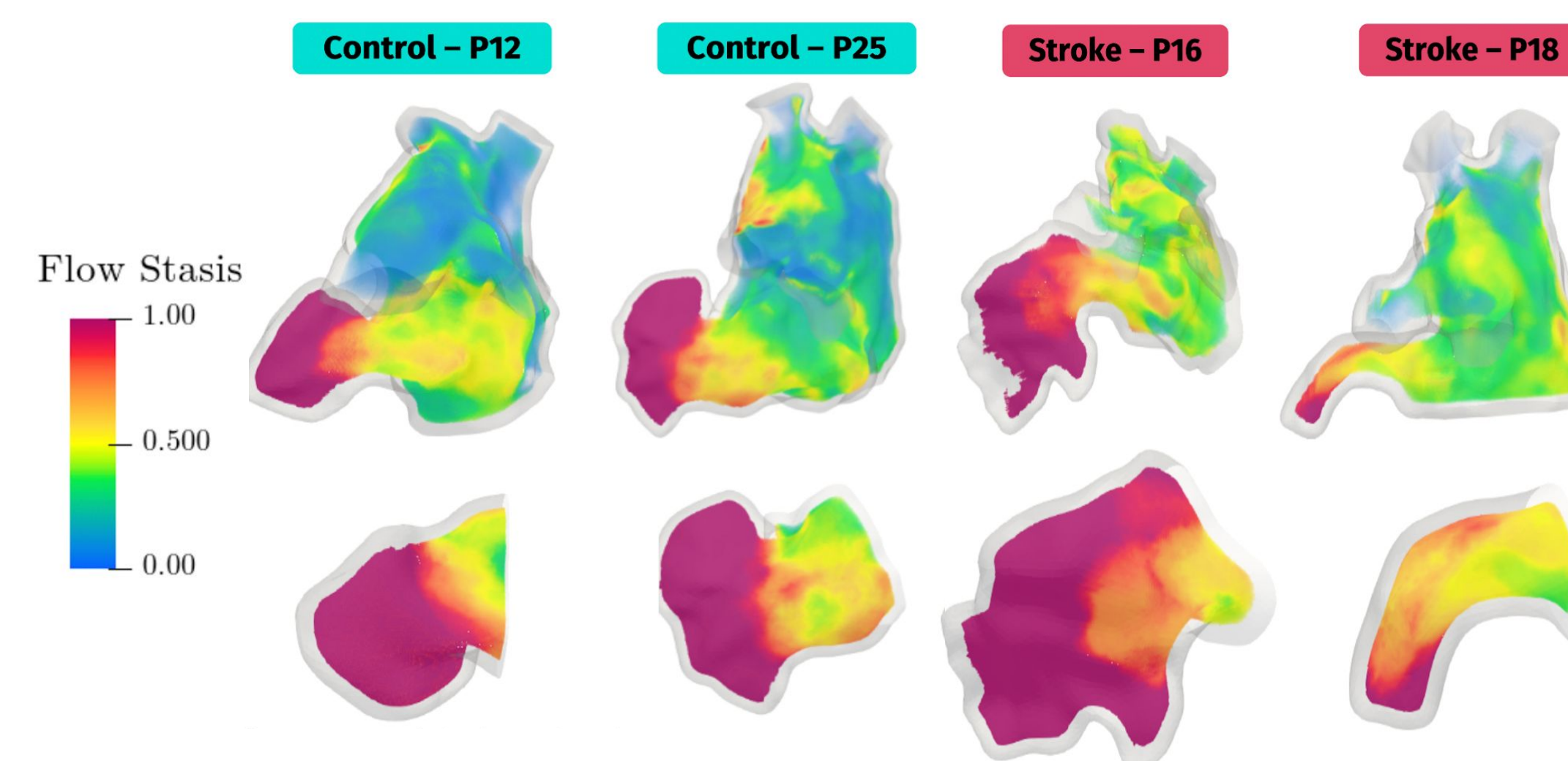
Methods

- Patient cohort:** 5 control patients, 4 stroke patients.
- Static* and *dynamic* image data interpolated to achieve personalized LA displacement:

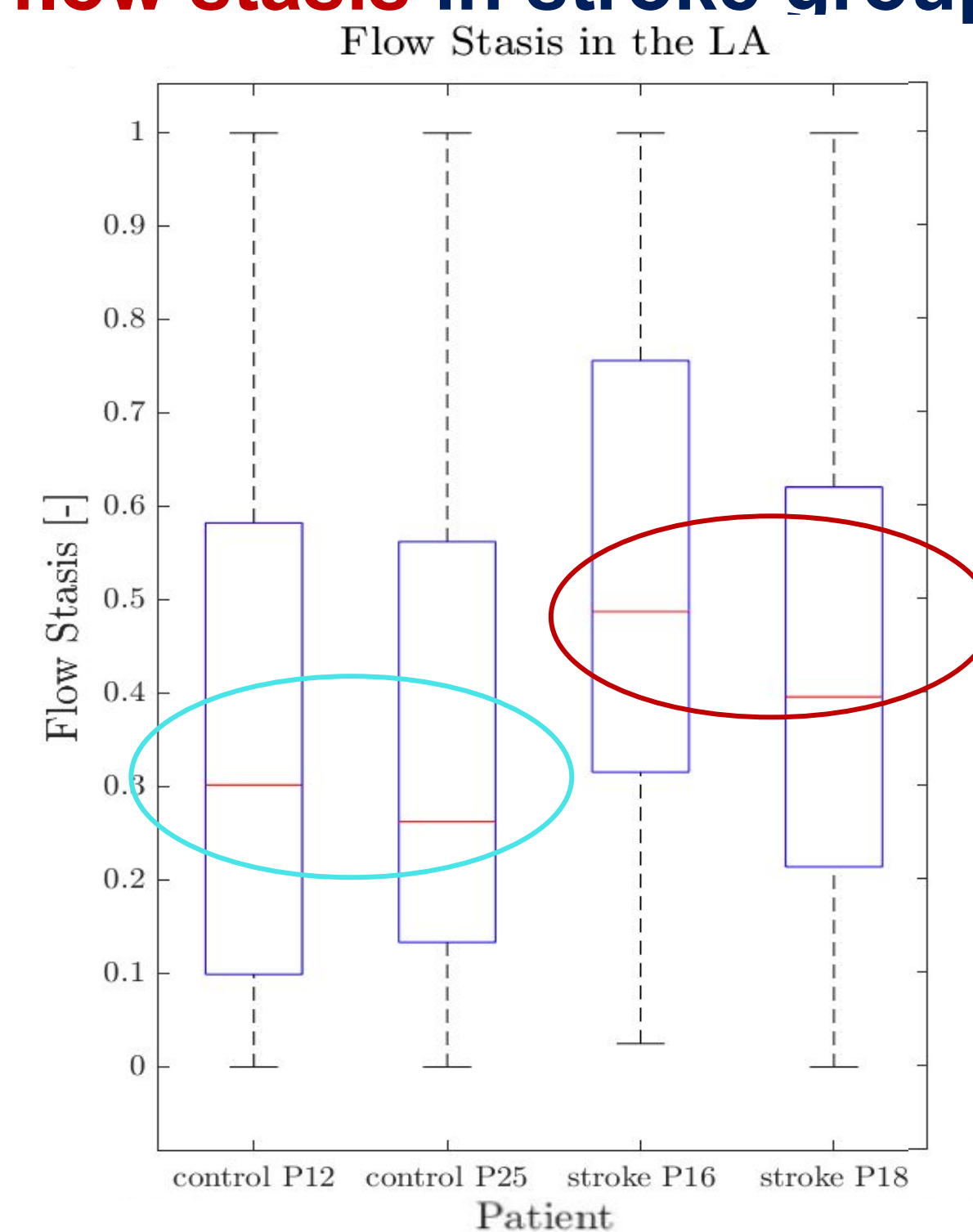


Results (shown for 2 control & 2 stroke patients)

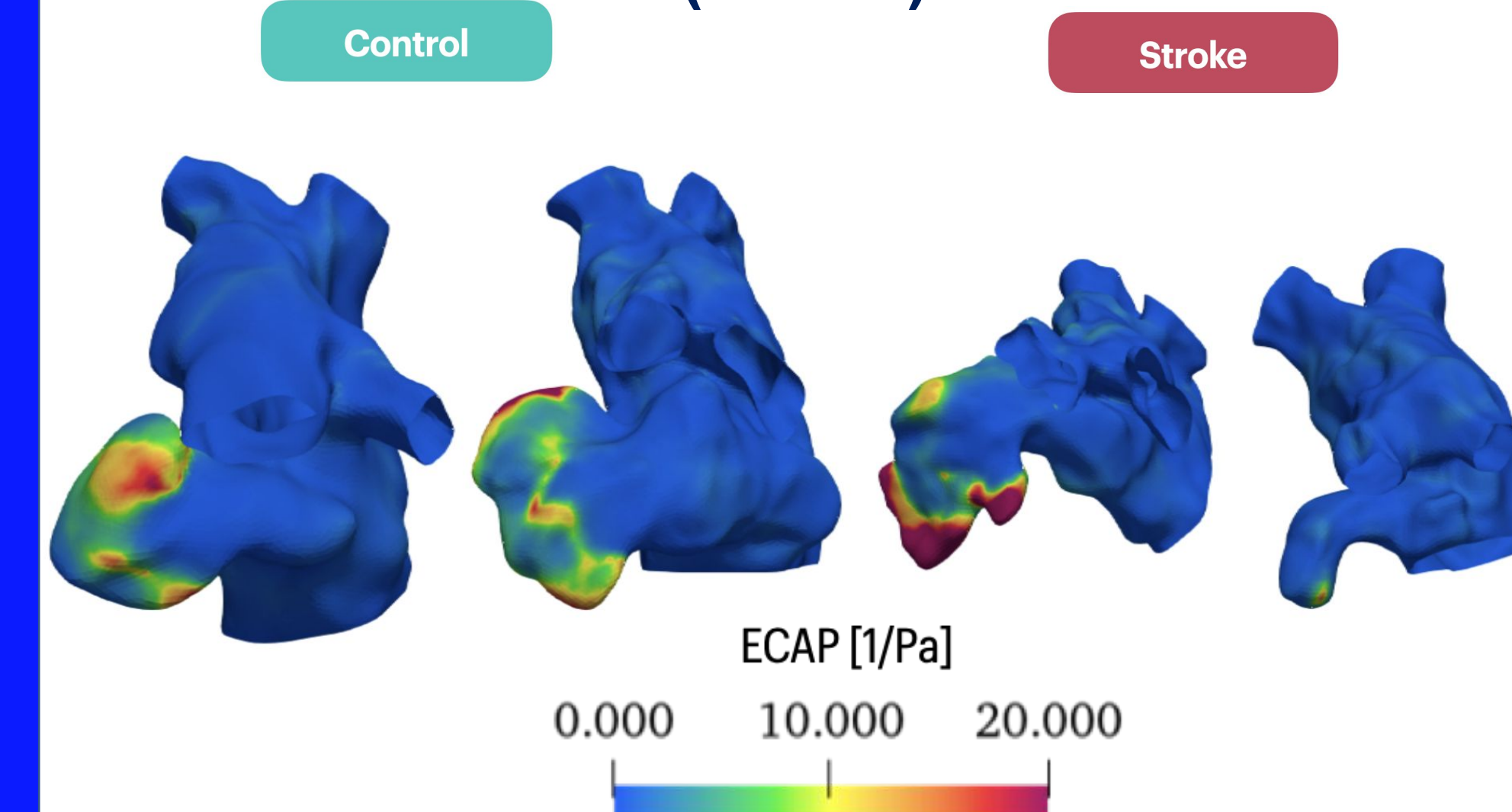
Flow Stasis



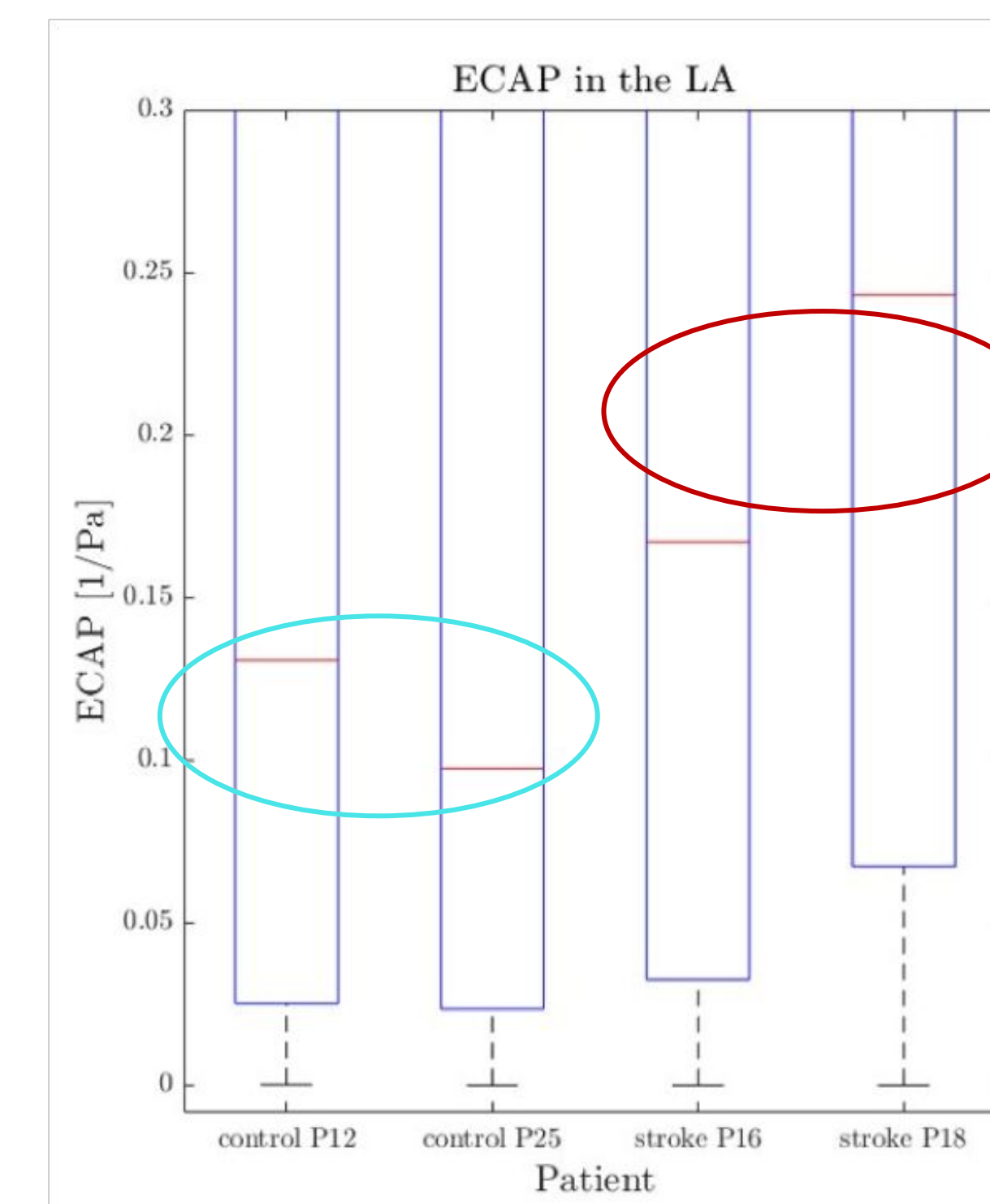
- Quantifies fraction of blood **slower** than **0.1 m/s** in LA and LAA.
- Higher flow stasis in stroke group.**



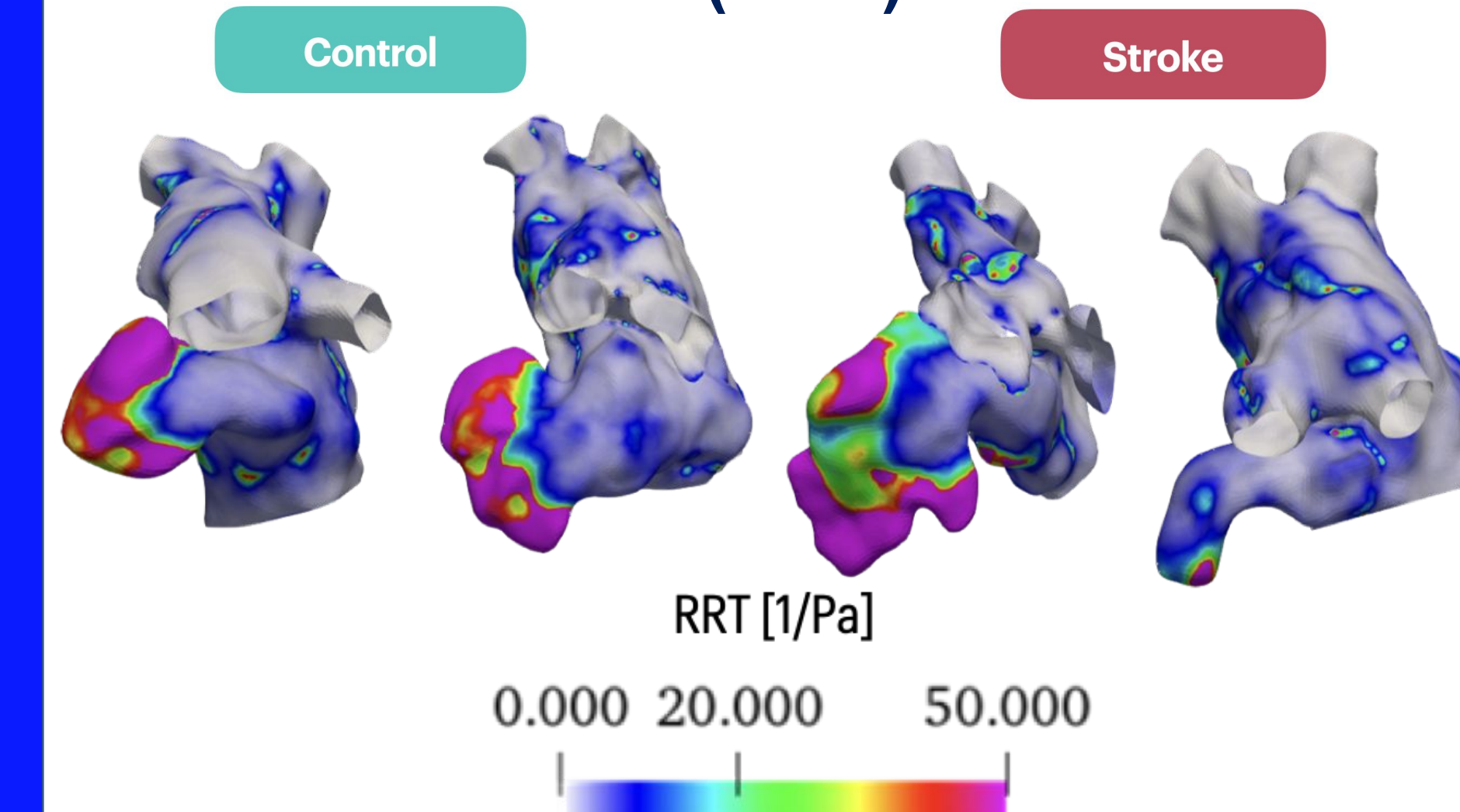
Endothelial Cell Activation Potential (ECAP)



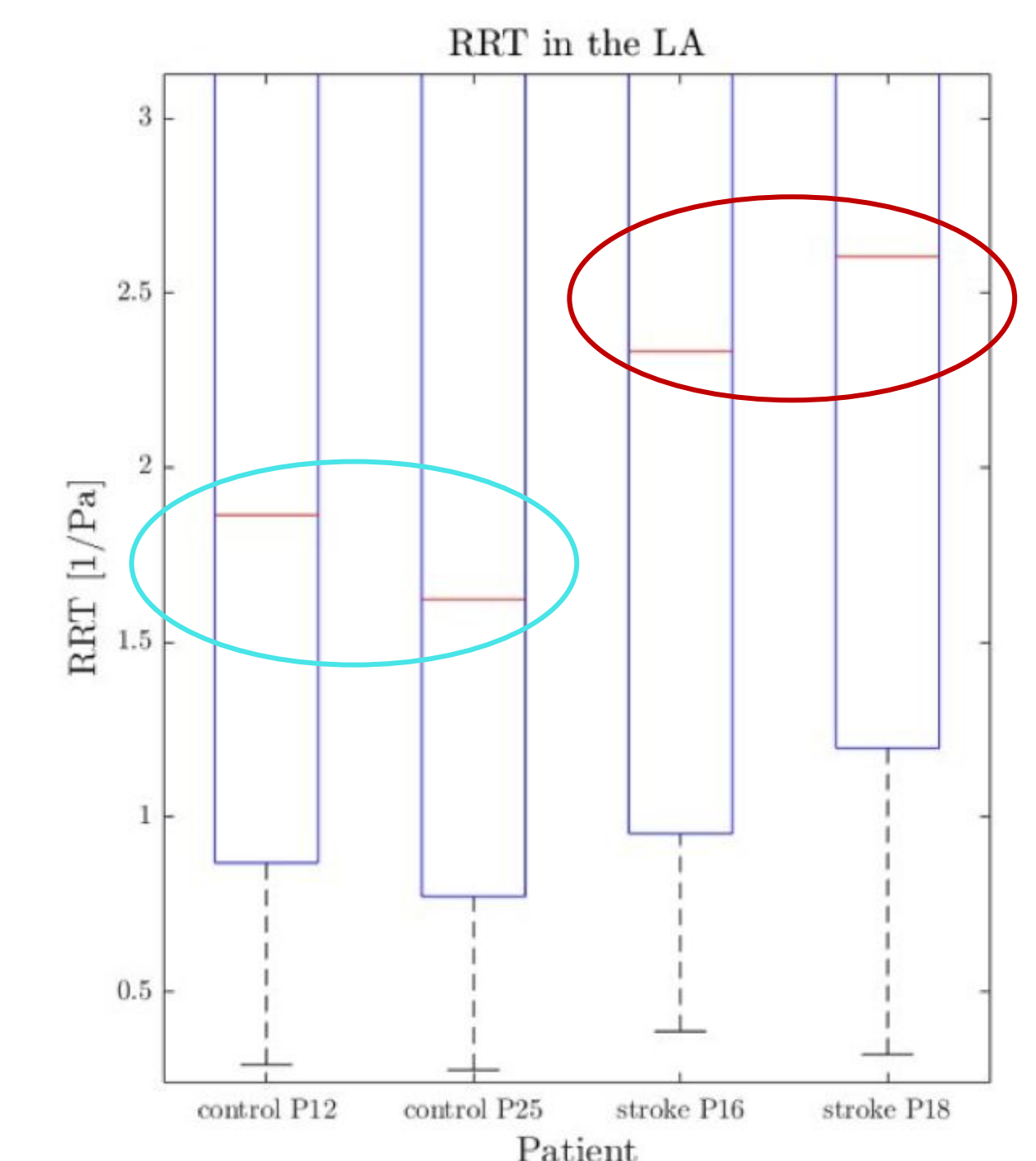
- Indicator of thrombus susceptibility
- Higher ECAP in stroke group.**



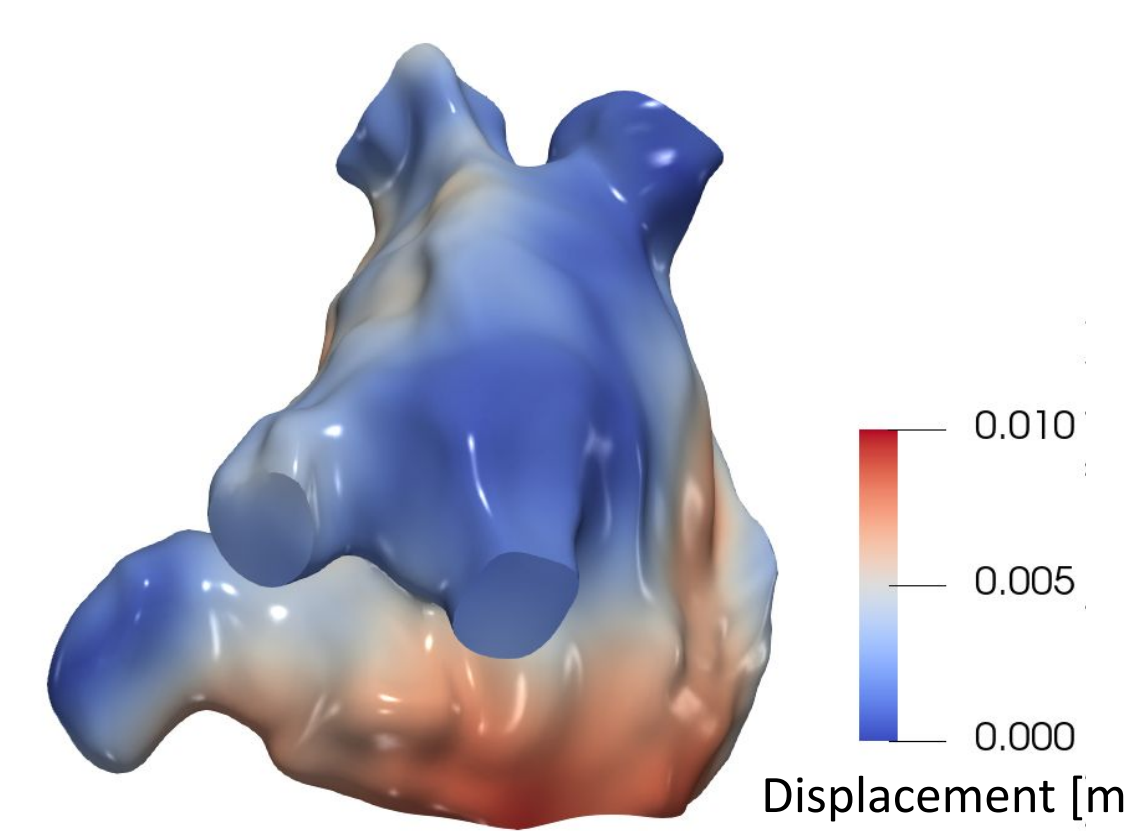
Relative Residence Time (RRT)



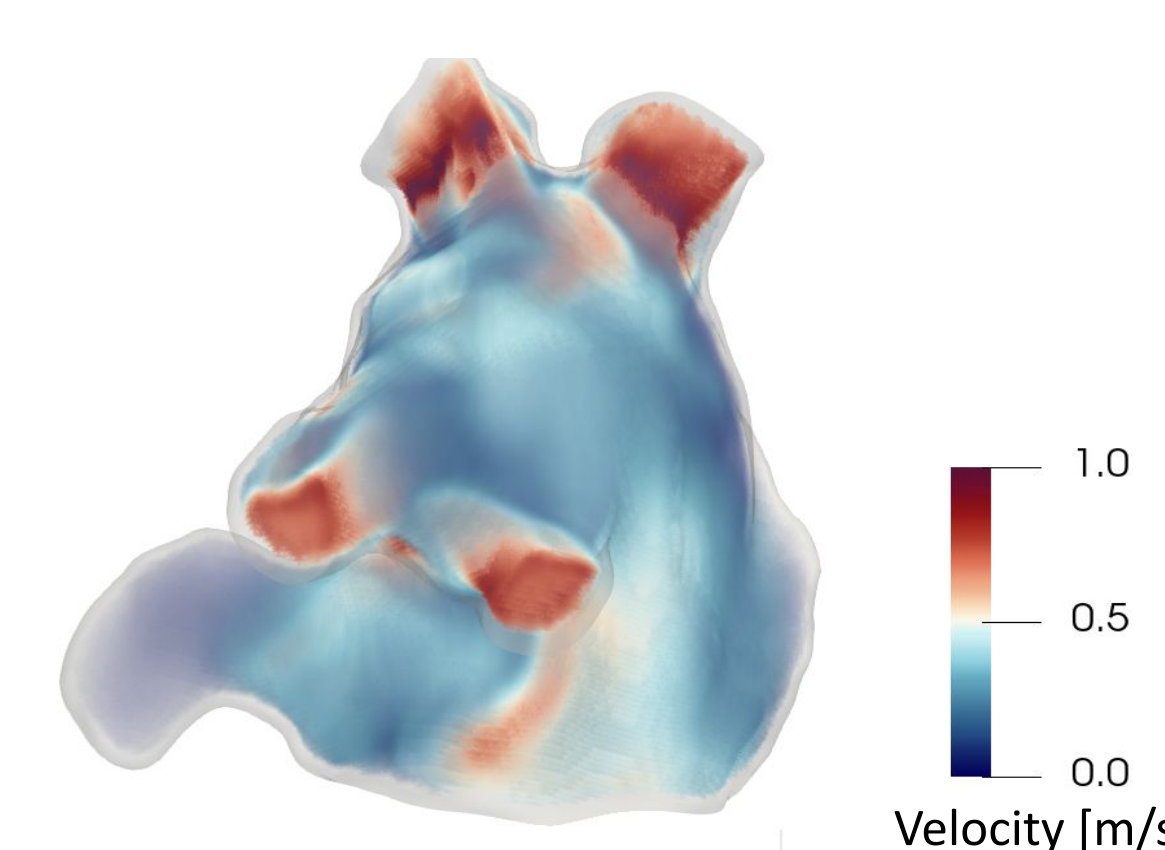
- Marker of disturbed blood flow
- Higher RRT in stroke group specifically in LAA**



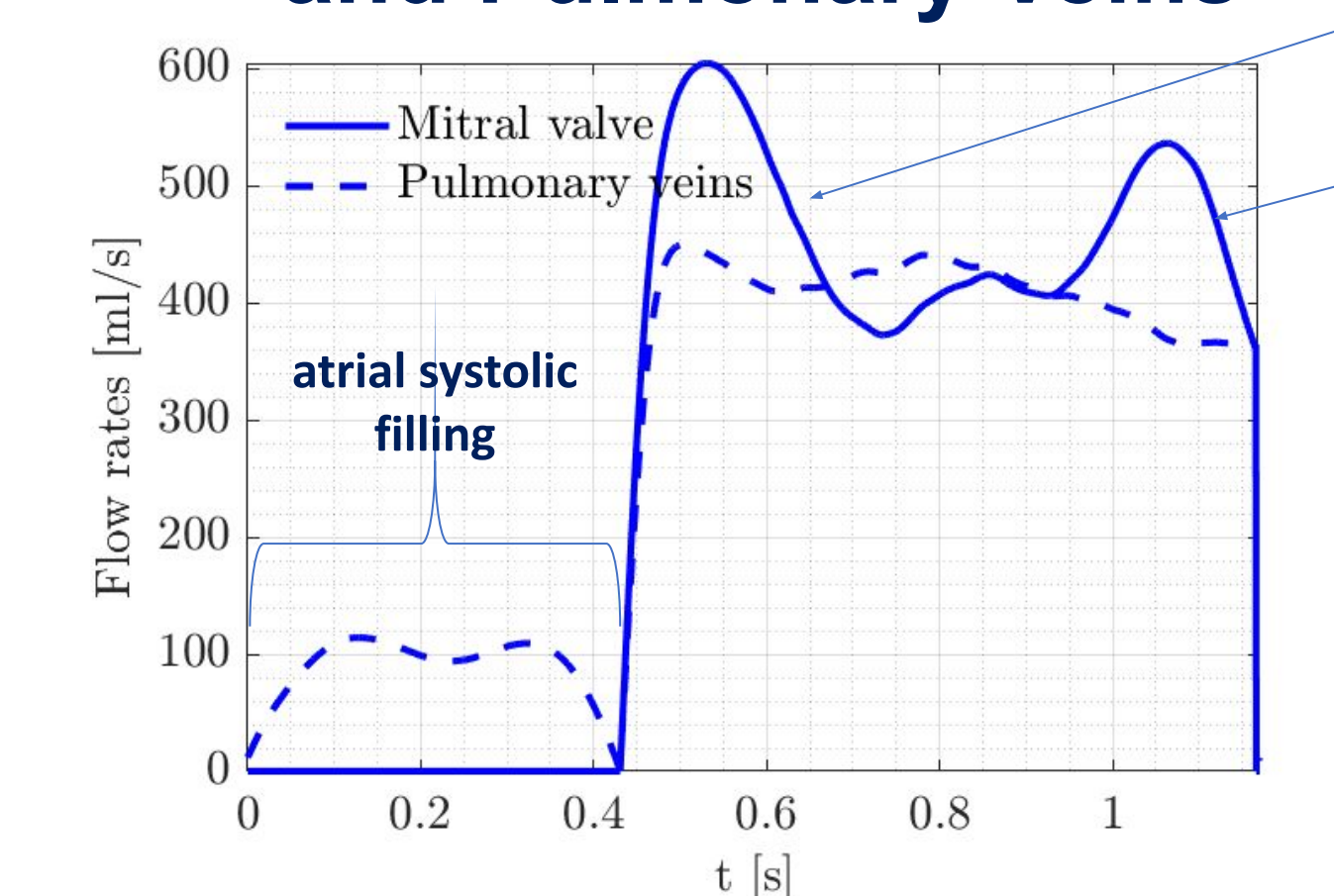
LA Displacement from CINE MRI



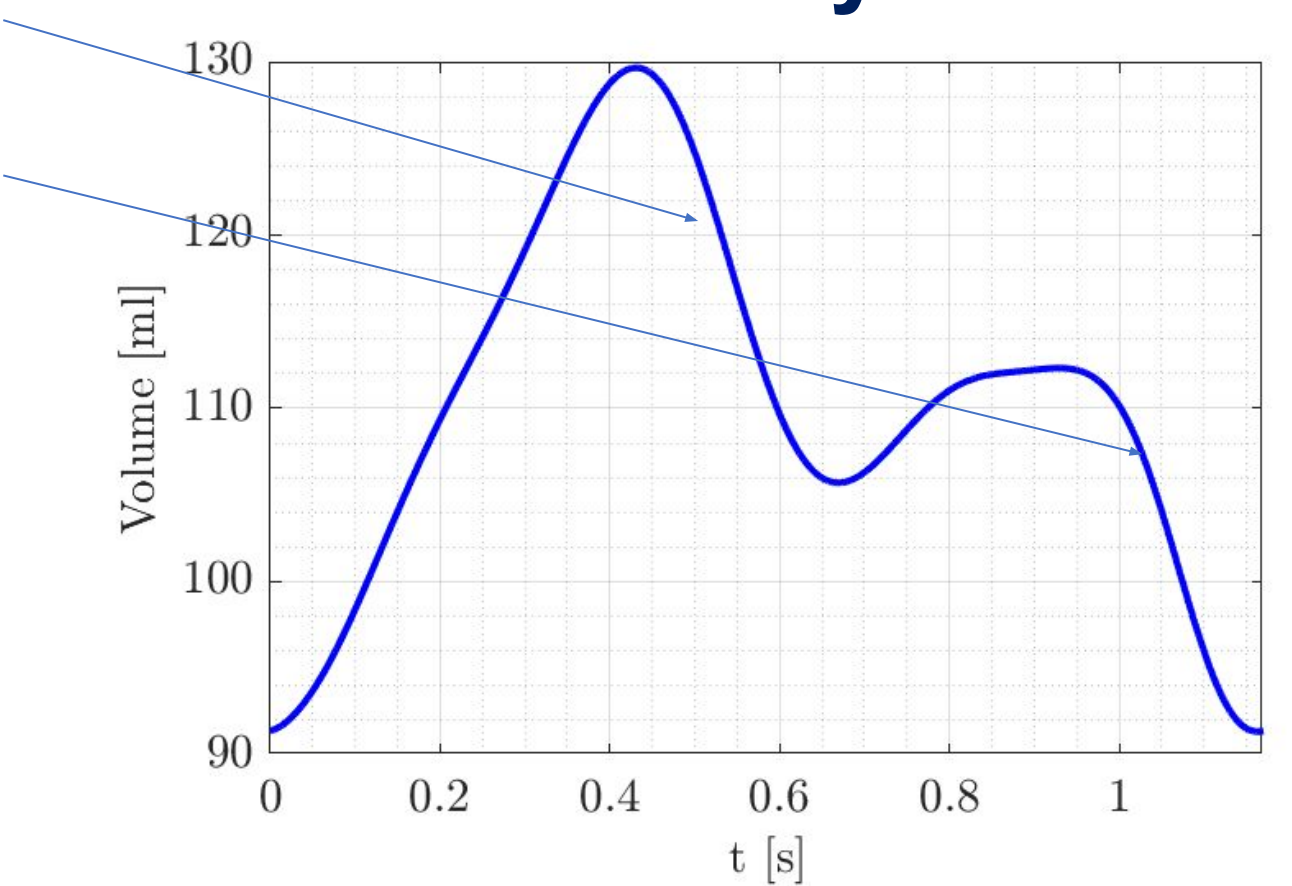
LA Blood Velocity from Simulations



Flow Rate in Mitral Valve and Pulmonary Veins



LA Volume over Cardiac Cycle



Conclusion

- Personalized fluid dynamics models with **patient-specific chamber geometries and motion** show **higher RRT, ECAP and flow stasis** values for **stroke patients**.
- Results indicate that simulations are useful for stratifying patient stroke risk, since they consider LA chamber specificities that are neglected in the CHA₂DS₂-VASc score.

References

1. January, Craig T., et al. "2014 AHA/ACC/HRS guideline for the management of patients with atrial fibrillation: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and the Heart Rhythm Society." *Journal of the American College of Cardiology* 64.21 (2014): e1-e76.
2. Chen, Lin Y., et al. "CHA₂DS₂-VASc score and stroke prediction in atrial fibrillation in whites, blacks, and hispanics." *Stroke* 50.1 (2019): 28-33.
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4. Biegling, Erik T., et al. "Statistical Shape Analysis of the Left Atrial Appendage Predicts Stroke in Atrial Fibrillation." *The International Journal of Cardiovascular Imaging*, vol. 37, no. 8, 2021, pp. 2521-2527. <https://doi.org/10.1007/s10554-021-02262-8>.
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