

## COMPUTATIONAL FRAMEWORK FOR STUDYING MYOCARDIAL BRIDGING

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### 1. Introduction

Myocardial bridging (MB) is a congenital anomaly where a segment of coronary artery is encased by overlying myocardium. Although traditionally considered benign, recent studies have linked MB with myocardial ischemia, arrhythmias, and sudden cardiac death [1]. These complications result from (i) systolic compression of the MB and (ii) abnormal distributions of endothelial wall shear stress (WSS). The aim of this study is to develop a personalized computational approach for the morphological and hemodynamic characterization of MB by integrating clinical imaging with computational fluid dynamics (CFD) methods.

### 2. Materials and Methods

The study's workflow is shown in Fig 1. Specifically, dynamic Computed Tomography (CT) images acquired over five phases (from 40% to 80%) of the cardiac cycle were segmented to reconstruct patient-specific MB geometries at each cardiac phase. To replicate the model's dynamics, each segmented geometry was meshed and processed using a Coherent Point Drift (CPD) registration algorithm. [2]. CFD simulations were performed by imposing allometrically scaled velocity data at the inflow boundary and pressure data at the outflow boundaries [3]. A *Moving Boundary* condition was applied at the wall to replicate coronary wall motion along the cardiac cycle. Two cardiac cycles were simulated to damp the initial transient, modelling blood as an incompressible non-Newtonian fluid. Morphological analysis involved measurements of vessel cross-sectional area, curvature, and torsion [4], while the hemodynamic analysis was performed in terms of WSS, a hallmark of flow disturbances [5].

### 3. Results

As expected, the MB segment is characterized by a remarkable lumen reduction (30% of physiological value, Figure 1, panel C). This lumen reduction persists across all analysed cardiac phases, with no diastolic recovery. The location of the MB reflects in the WSS magnitude luminal maps, which show locally elevated, non-physiological values at the arterial segment encased by the myocardium (Figure 1, panel D).

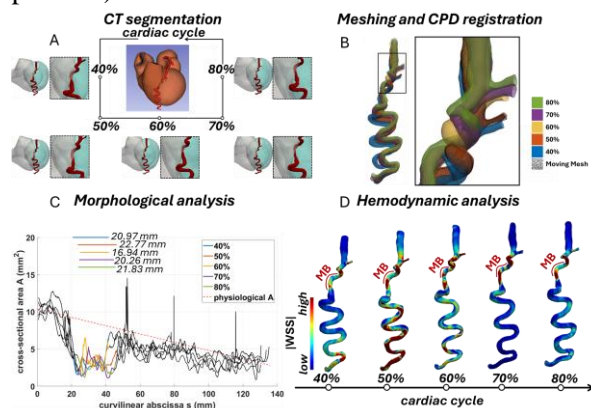


Figure 1. Workflow of the study.

### 4. Discussion and Conclusions

This study, which we are expanding to include 10 cases, presents a computational framework for the morphological and hemodynamic analysis of MB subjects using personalized *Moving Boundary* CFD models. This approach could help identify at-risk patients who may benefit from closer monitoring or medical management.

### 5. References

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