Title	**Experimental Modelling of Mitral Regurgitation**
Location	Laboratory of Applied Biomechanics, Marseille
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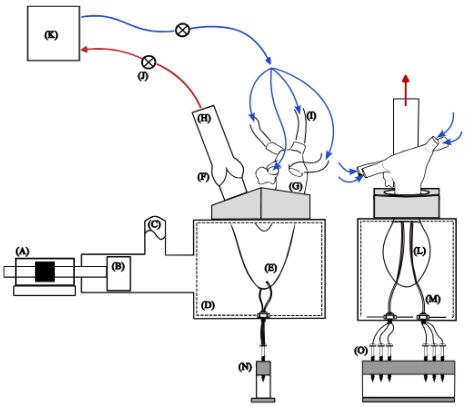
Keywords	Mitral valve, mitral regurgitation, experimental setup

Context of the internship

Mitral regurgitation (MR) is a condition in which the mitral valve fails to close properly, allowing blood to flow backward from the left ventricle into the atrium during heart contraction (systole). In France, >50,000 hospital admissions occur yearly for MR (Messika-Zeitoun et al., 2020). It consists of a leakage of the bi-leaflet mitral valve mainly due to a strained chordae or rupture. It highly depends on the mitral valve apparatus and may lead to prolapse. It is diagnosed by transoesophageal echography and classified into severity according with the size of the regurgitant orifice and the velocity time integral through the orifice. First intention is repair of the mitral valve. When repair is not possible or after a degenerative initial repair, mitral valve replacement can be performed using a bioprosthesis or a mechanical valve prosthesis. Mitral valve replacements represent more than 40,000 operations per year in the United States (Yoon et al., 2017) and mitral regurgitation, the leading cause of surgical repair, has a worldwide prevalence of 1.7%.



In-vitro experimental set up from (Teimouri et al., 2025)

Interplay between chordae tension during the cardiac cycle, strains of the mitral valve leaflets and contraction of the left ventricle is complex.
In-vitro tests on a dedicated experimental bench reproducing a pulsating flow for different conditions of flow rates and pressures upstream and downstream of the prosthesis is required for mitral valve prostheses (ISO 5840-3 standard). It has been shown to be the right tool to investigate mitral valve device (Teimouri et al., 2025) and could also help in the understanding of the mechanism of mitral valve regurgitation. Indeed, strains on leaflet has been measured in-vitro (Stanová et al., 2019) and mitral valve leaflet characteristics has been previously described (ref).

In-vitro experimental bench will also enable ultrasound measurements, digital image correlation and particle image velocimetry measurements. Numerical simulation could then reproduce the mechanism of mitral valve leaflet without using fluid-structure interaction simulation but rather imposing the motion of the structure within a realistic in-vivo left ventricle flow pattern. Characterization of the native valve apparatus could also help in understanding the interaction between left atrium flow and function and mitral valve regurgitation mechanism.

This internship will focus on the development of in-vitro fluid bench enabling the simulation of the physiological mitral valve flow as well as the mechanical characterization of juvenile porcine mitral valve leaflets.

Objectives

Associated with the laboratory team working on the modelling of biological fluids in the human body and their interaction with the structure, you will be in charge of developing the mitral regurgitation experimental bench. The study will include mechanical characterization of the mitral valve leaflets.

Expected results

Expected results are threefold:

- Literature review and test of numerical simulation of the MR
- Design and manufacturing of an experimental bench for the investigation of mitral regurgitation
- Characterization of mechanical properties of the mitral valve leaflets

References

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Starting date of the internship (Duration)	October 2025 (6 months)