SPEAKING FROM THE HEART: A MATHEMATICAL POINT OF VIEW

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30 SECOND SUMMARY

Computational models provide insight on heart valve mechanics

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Unknowns on the influence of dimensional changes in valve mechanics

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Creation of mathematical model describing shape of mitral valve

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Study of different valve shapes and impact on function

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Aid clinicians in patient risk stratification

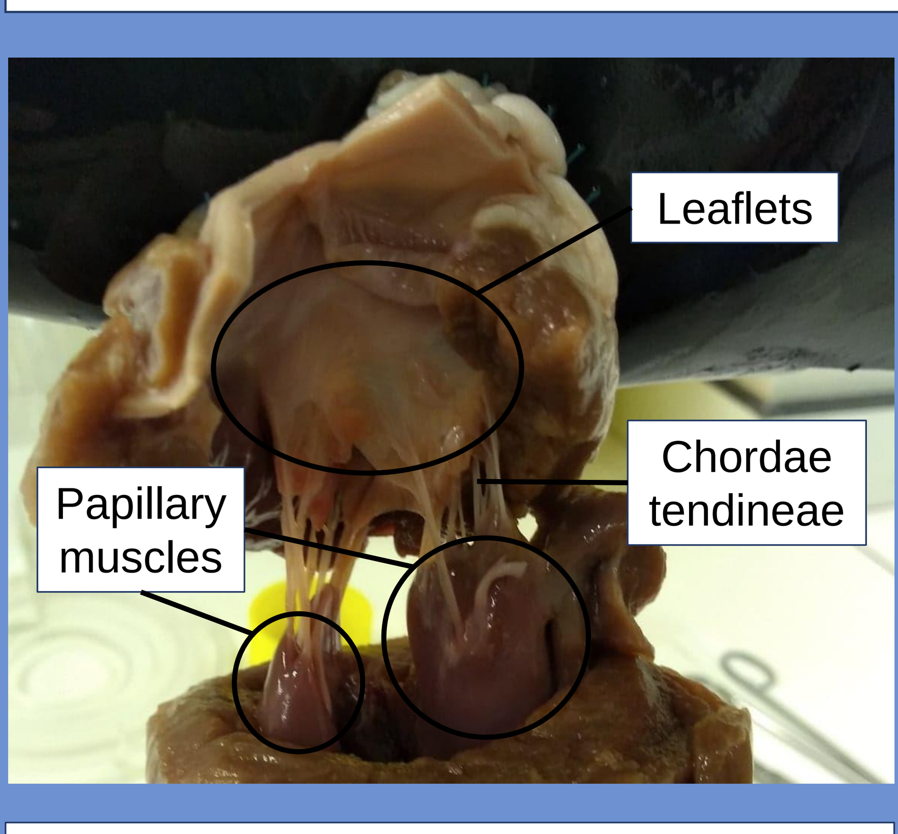

Fig. 1. MV complete structure, obtained from an excised pig heart, with main components highlighted.

1. BACKGROUND AND AIMS

- **Mitral heart valve** (MV) function relies on its mechanical properties and structural integrity. A compromise in these leads to dysfunctions that can **endanger** a person's life
- Computational models provide further insight on valve mechanics and their **accuracy** is sensible to valve geometry
- Current mathematical models representing MV structure are based on **assumptions** and **differ** from realistic valves
- Here, we built a **mathematical model** for the MV based on **realistic** dimensions and correlations and we study the **impact** of varying relevant valve dimensions in its function

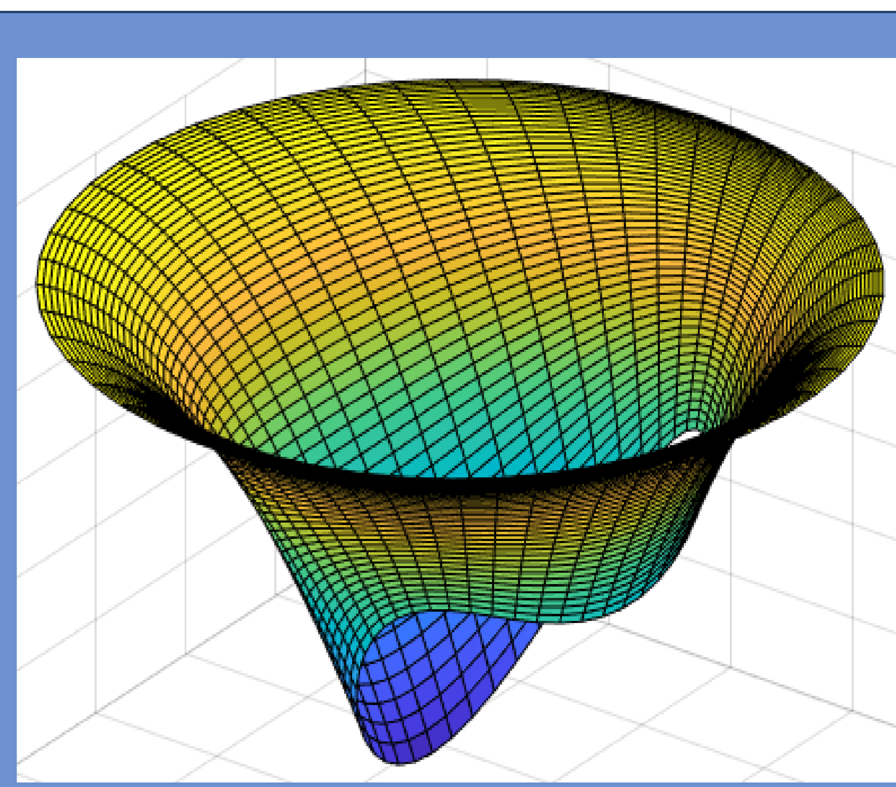

Fig. 2. Highly simplified mathematical model of mitral valve leaflets [1].

2. METHODOLOGY

Revision of MV shape and identification of relevant landmarks, dimensions and correlations

- Literature review concerning MV dimensions available for healthy and diseased cases, as well as valve shapes obtained by medical images and designed in computational works
- Computational manipulation of porcine MV leaflets to match a **human valve** shape and **dimensions** from the literature (Fig. 3)

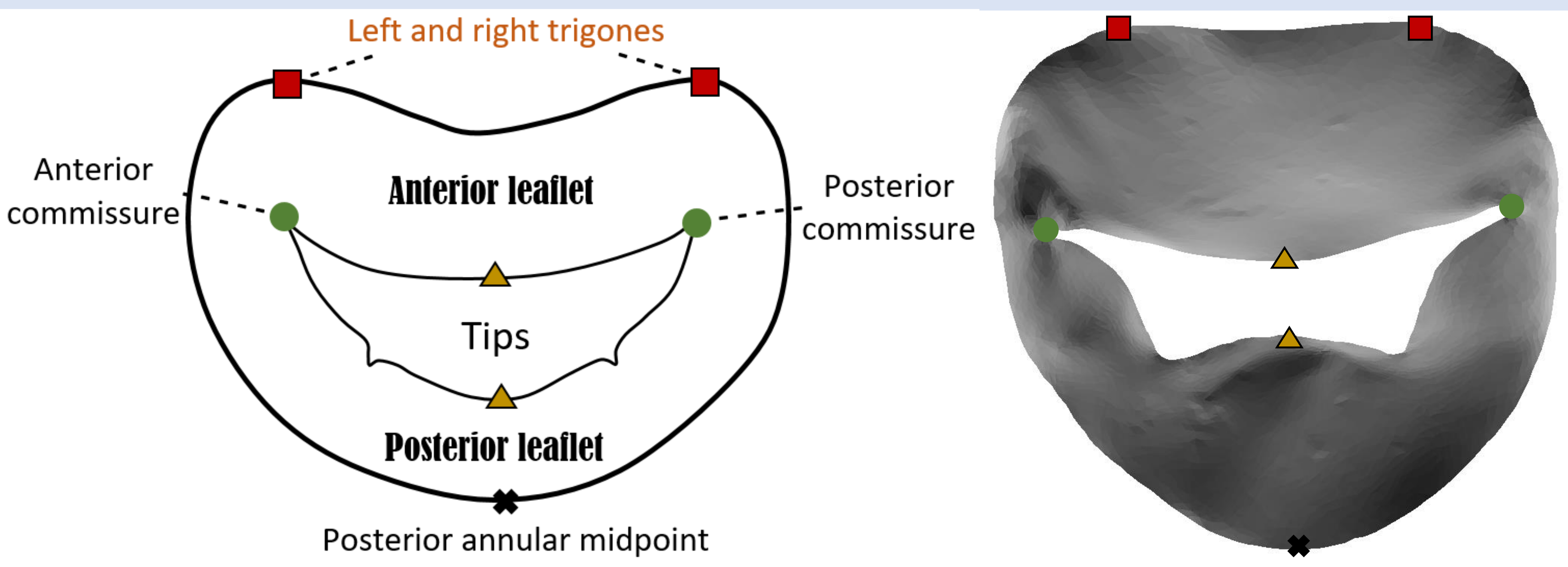

Fig. 3. Schematic of important MV landmarks to incorporate on mathematical model (left) and computational model for the leaflets defined accordingly (right), with the same landmarks.

Development of a mathematical model incorporating all aspects of the MV structure

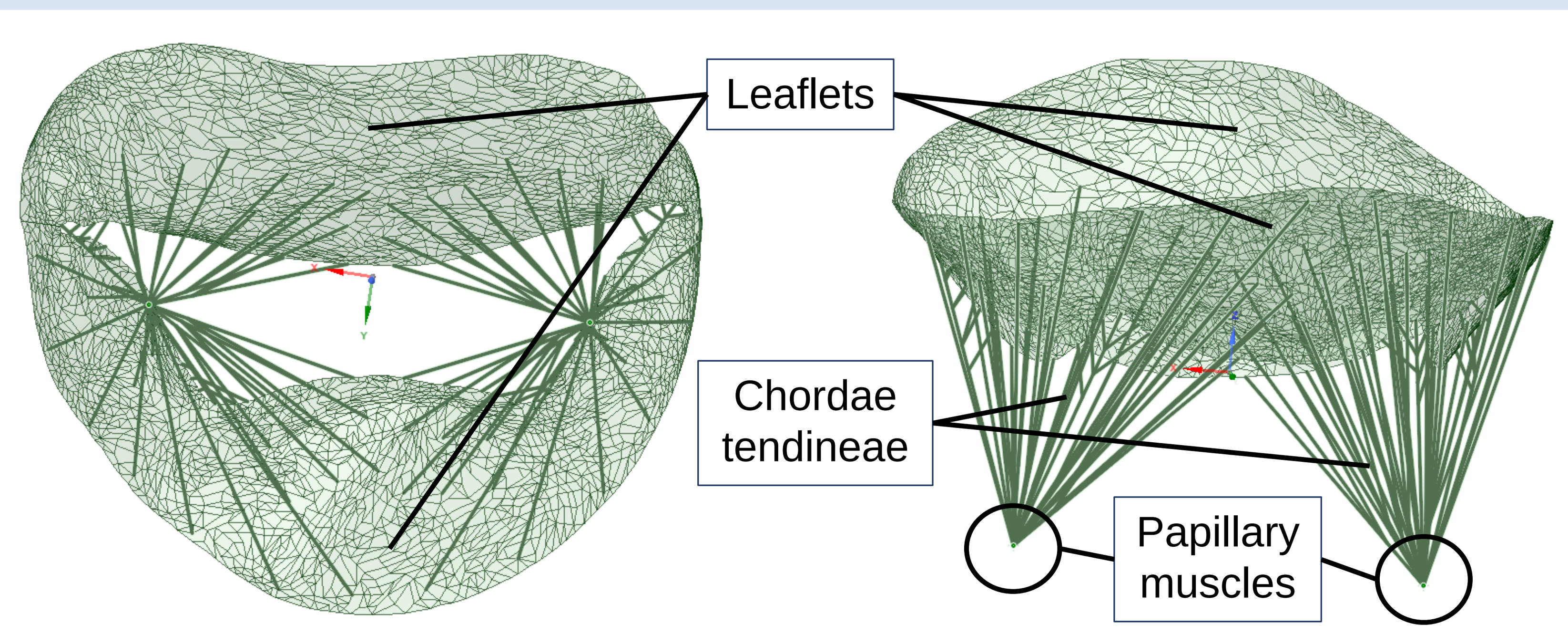

Fig. 4. Complete MV computational model with all main components represented.

Creation of computational simulations to represent valve function using different model configurations

- Generation of a range of MV shapes and assessment of valve mechanics using computational parameters such as Von Mises stress and deformation

3. COMPUTATIONAL RESULTS

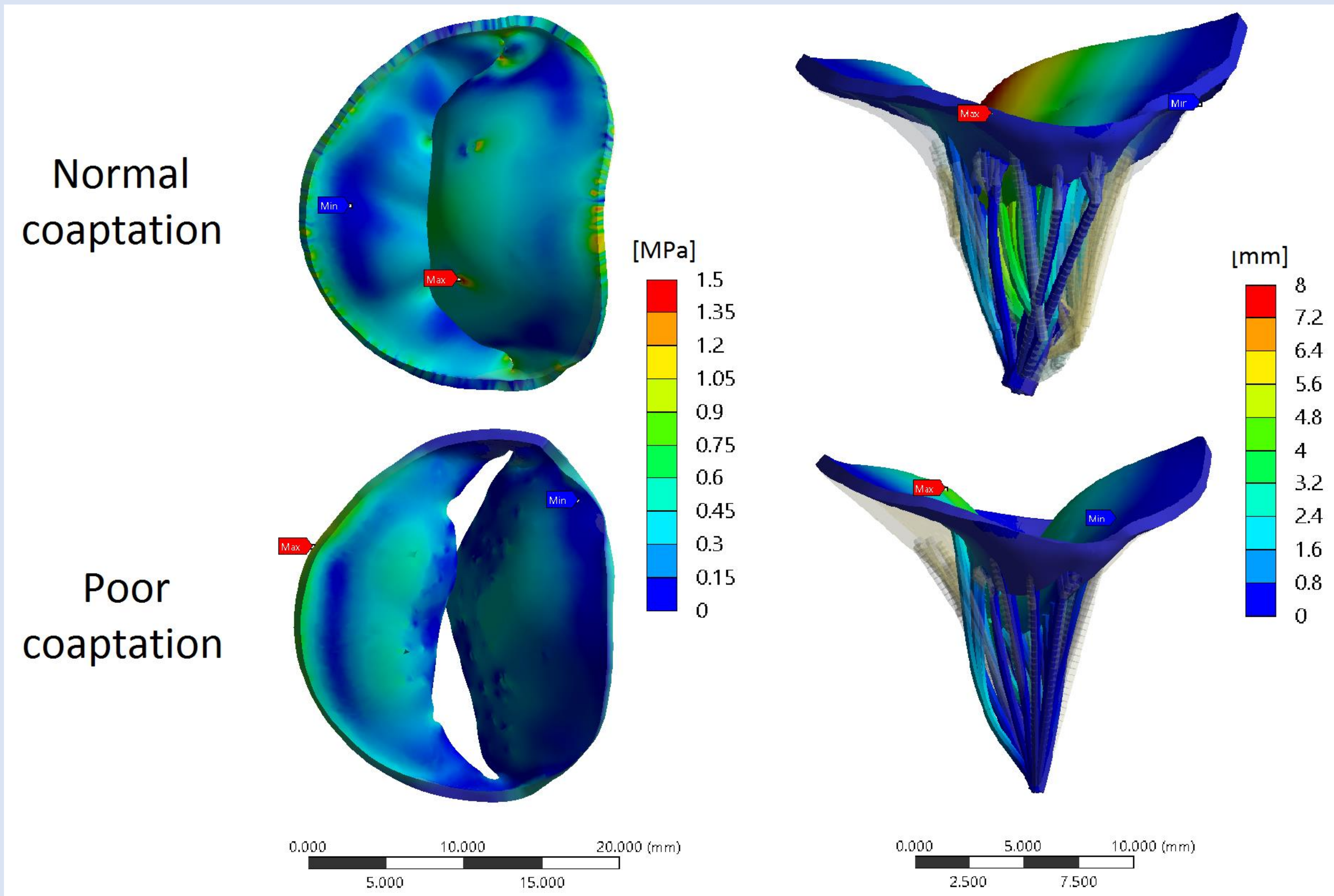

Fig. 5. Computational results: Stress distributions [Mpa] on the left and total deformation [mm] on the right.

- Our mathematical MV model simulates **accurate physiological function**, with normal coaptation (closing) associated parameters resembling those of the literature
- Different valve **geometrical changes** are associated with different cases of function
- **Diseased** valve configurations (poor coaptation and leaflet billowing) are associated with greater valve tissue stress at the posterior leaflet, exhibiting greater damaging

4. DISCUSSION

- Our model provides with **adjustable geometric detail**, useful to study customized cases of the MV shape
- This framework can indicate which shape configurations are associated with **unfavourable performance**, helping clinicians understand which patients are at greater risk of disease onset and progression

5. WHAT'S NEXT?

- Incorporation of more information on the mathematical model
- Assessment of other dimensional changes in MV function

6. REFERENCES

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