# Development of a Decellularized Extracellular Matrix from Porcine Aorta for Heart Valve Applications in the Ross Procedure

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## INTRODUCTION

Cardiovascular diseases are the leading cause of adult mortality worldwide, according to the World Health Organization [1]. An important surgical approach for treating diseased aortic valves is the **Ross procedure**, in which the affected aortic valve is replaced with an autograft from the patient's own pulmonary valve (Fig.1).

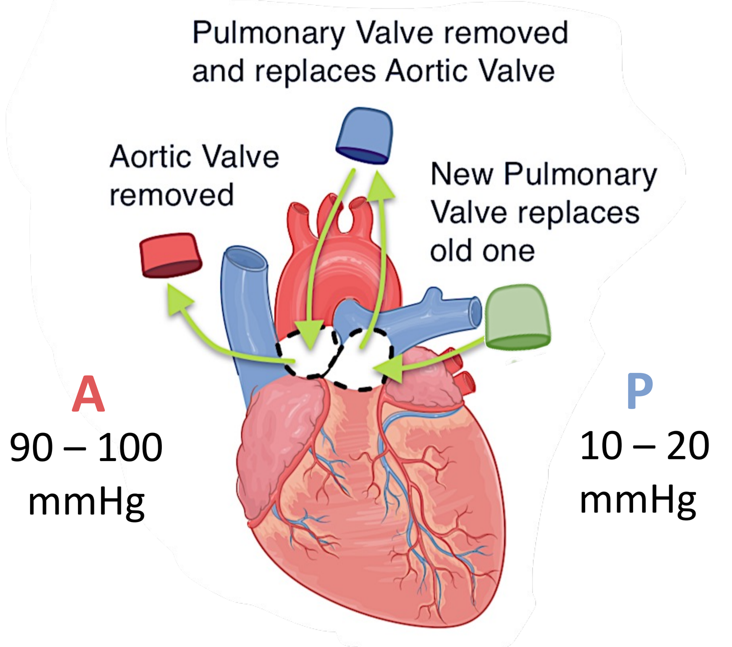



*Fig. 1: The Ross Procedure.*

Limitations:

Pulmonary valve in aortic conditions → Increase of the blood pressure → Wall dilatation → Valve leakage and reoperation

## PROPOSED SOLUTION AND METHODS

We aim to develop a **bio-mechano-compatible external support** around the autograft made of polycaprolactone (PCL) and elastin enhanced with **decellularized extracellular matrix (dECM).**

Mechanically compatible: to sustain high blood pressures and avoid stress shielding.

Biologically compatible: to promote favorable biological integration and tissue remodeling.

Decellularization removes immunogenic cellular material, minimizing inflammation and rejection risk, while preserving key ECM components that guide cellular behavior [2].

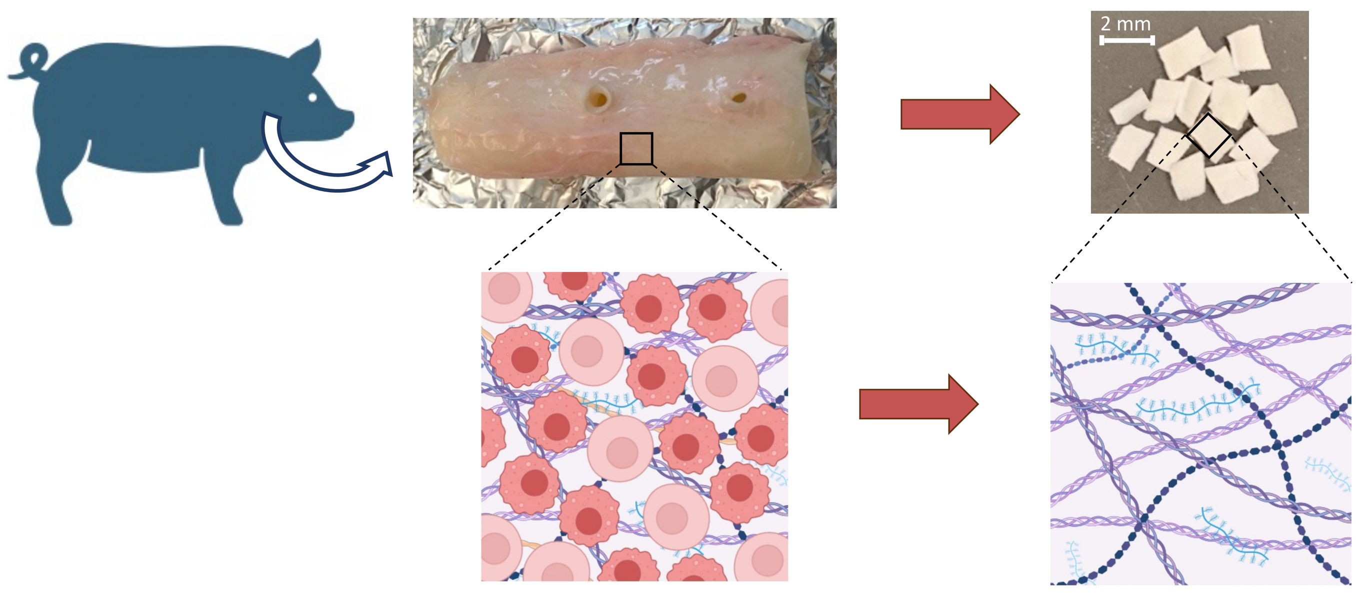



*Fig. 2: Native tissue.* *Fig. 3: Decellularized tissue.*

**Decellularization of the porcine aortic tissue** was performed using a detergent and enzymatic-based protocol combined with supercritical $CO_2$ ($scCO_2$). Additional steps of sonication, agitation, washing and freeze-thaw were performed to enhance decellularization efficiency.

## RESULTS

SEM micrographs

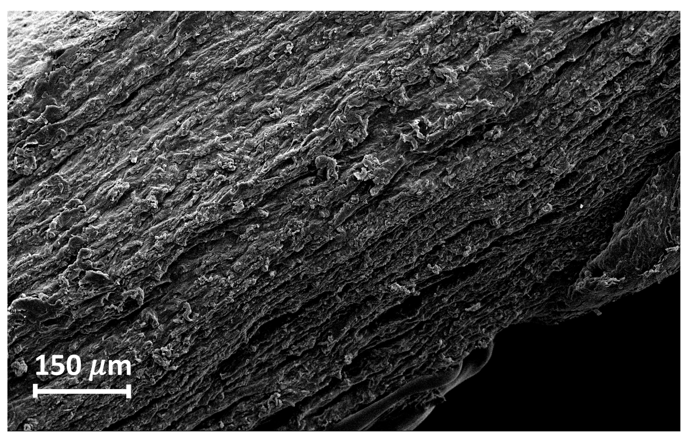
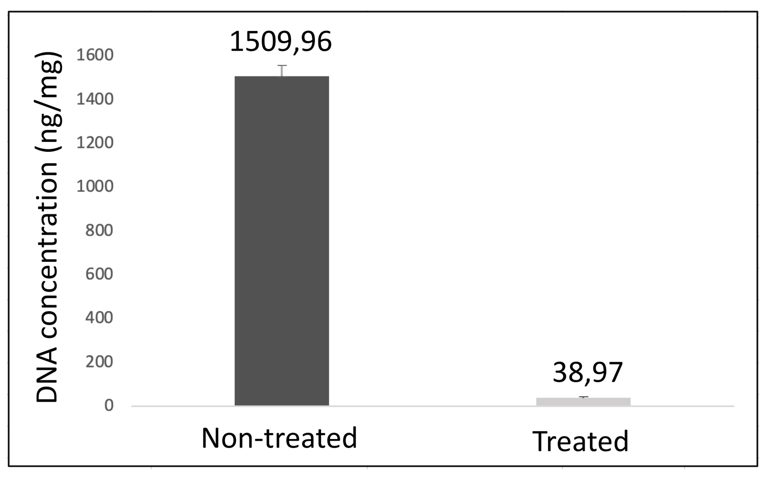



*Fig. 4: Native aorta.*

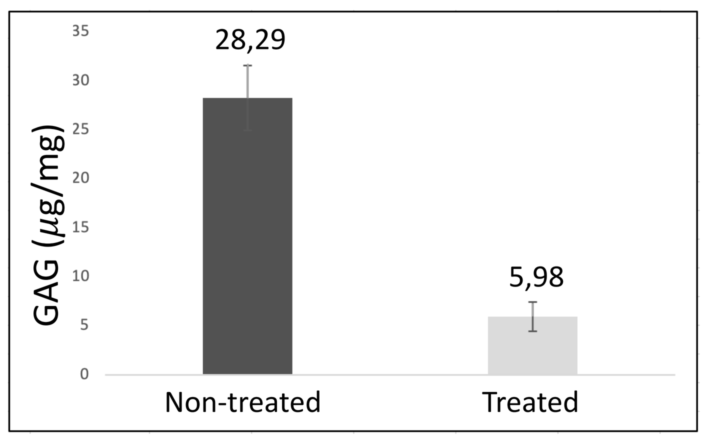

*Fig. 5: Decellularized aorta.*



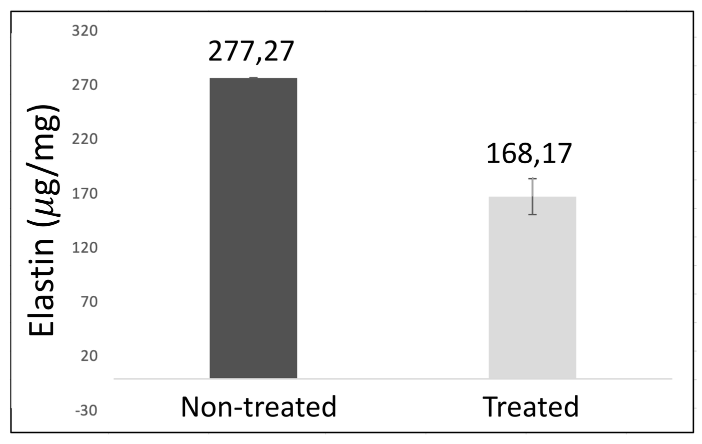

*Graph. 1: DNA content.*

Graphic 1 shows a ~97% reduction in DNA content following decellularization, with the treated tissue reaching the accepted threshold of <50 ng/mg of DNA content [3], indicating **effective removal of immunogenic components**.

ECM components

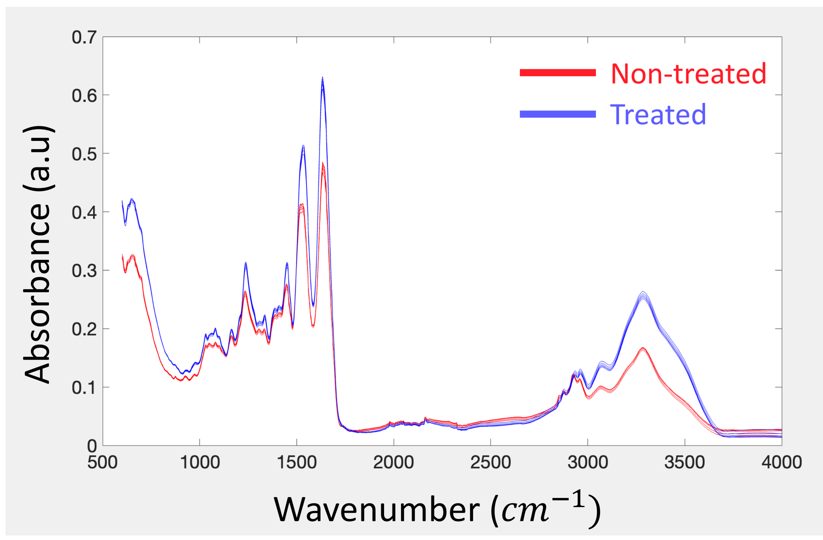



*Graph. 2: GAG's content.*




*Graph. 3: Elastin content.*

Even after the decellularization process, key **ECM components** such as glycosaminoglycans (GAG's) and elastina were mantained (Graphic 2 and 3), supporting the biological potential of the dECM to contribute effectively to tissue integration in the Ross procedure.




*Graph. 4: GAG's content.*

Fourier-transform infrared spectroscopy (FTIR) analysis (Graph. 4), revealed conserved spectral patterns, indicating the **preservation of native biochemical features** and no evidence of contamination during the decellularization process.

## FUTURE WORK

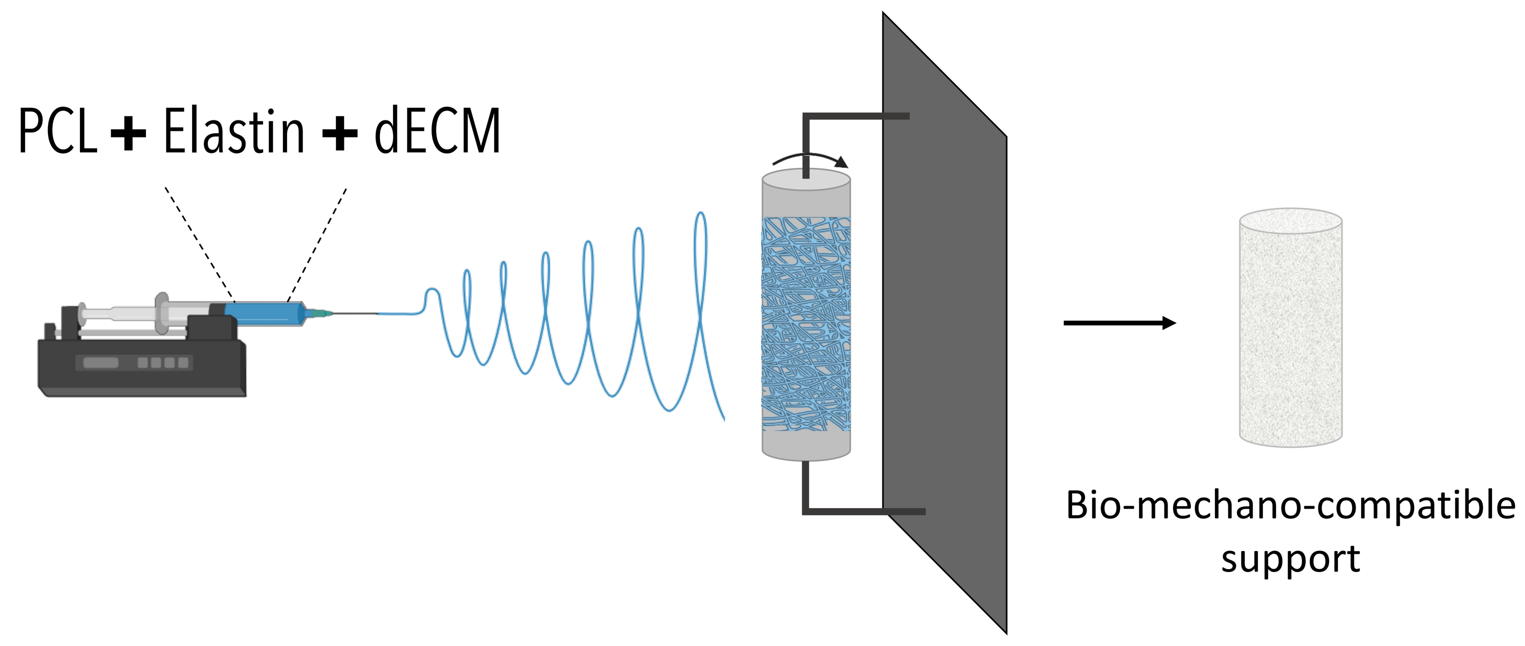



*Fig. 6: Electrospinning process.*

Aorta dECM powder will be combined with polycaprolactone (PCL) and elastin, then **electrospun** into a tubular scaffold designed to be an external support that aims to improve current Ross procedure outcomes. As a **bio-mechano-compatible structure**, it gradually transfers mechanical load to the regenerating valve, while the dECM provides essential biochemical cues for long-term repair and adaptation.

## REFERENCES & ACKNOWLEDGEMENTS

1. Parmaksiz, M., Dogan, A., Odabas, S., Elçin, A. E., & Elçin, Y. M. (2016). Clinical applications of decellularized extracellular matrices for tissue engineering and regenerative medicine. Biomedical Materials, 11(2), 022003.
2. Zhang, X., Chen, X., Hong, H., Hu, R., Liu, J., & Liu, C. (2022). Decellularized extracellular matrix scaffolds: Recent trends and emerging strategies in tissue engineering. Bioactive Materials, 10, 15–31.
3. Philips, C., Terrie, L., Muylle, E., & Thorrez, L. (2024). Determination of DNA content as quality control in decellularized tissues: challenges and pitfalls. *Regenerative Biomaterials*, *11*, rbae123.

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