When Good Valves Go Bad: The Durability Challenge of Porcine Bioprosthetics

By: Shanell Hill

University of Washington Tacoma – Biomedical Science

Mentor: Dr. Tawanda Chivese, TBIOMD429

INTRODUCTION

Heart valve disease affects more than 74 million people worldwide and frequently requires valve replacement tc restore normal cardiac function. (Chen et al., 2024). Porcine aortic valve bioprosthetics are widely used due their favorable hemodynamics and reduced need for lifelong anticoagulation. However, structural valve degeneration remains a major limitation, driving the development of tissue-engineered heart valves as a potential long-term solution.

OBJECTIVES

- **Review the advantages of porcine aortic valve bioprosthetics.**
- **Identify major limitations affecting long-term use.**
- **Explore emerging bioengineered technologies aimed a improving valve performance.**

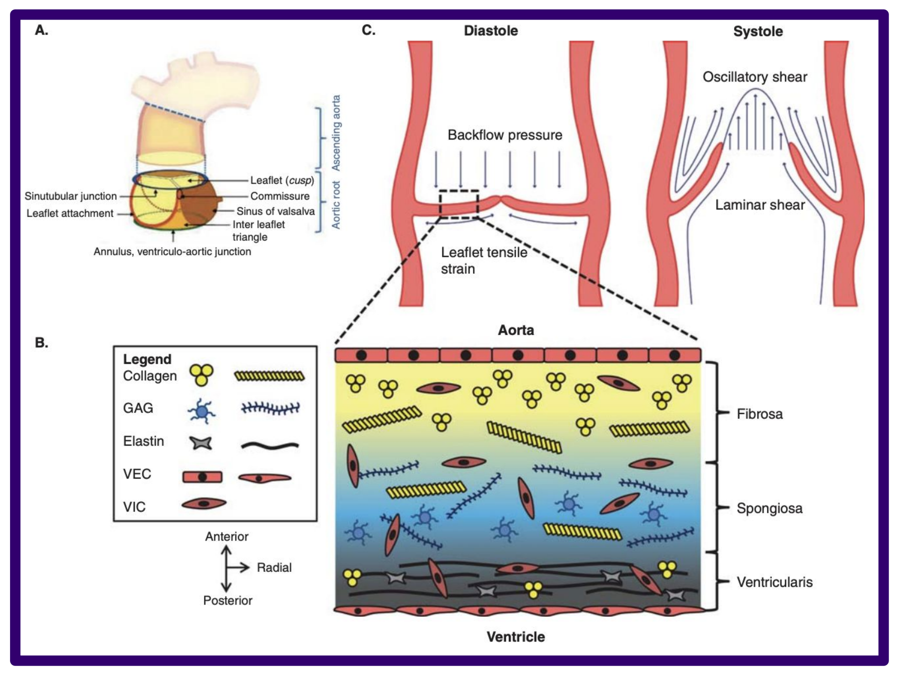

Fig 1. Functional anatomy and composition of aortic root (Cheung at al., 2015).

METHODS

- Conducted a literature review of over 30 peer-reviewed articles on porcine aortic bioprosthetic valves, xenotransplantation, and tissue-engineered heart valves using the PubMed database.
- Articles used were evaluated for findings related to clinical performance, durability, structural valve degeneration, and emerging bioengineered valve technologies.
- Key themes were synthesized to assess the current limitations of porcine bioprosthetic valves and the future potential of tissue-engineered alternatives.

RESULTS

- **Review the advantages of porcine aortic valve bioprosthetics.**

Porcine Bioprosthetic Valves	Bioengineered Valves
Established clinical use	Emerging technology
No lifelong anticoagulation	Potentially regenerative
Good hemodynamics	Designed for remodeling and repair
Structural degeneration over time	Goal of improved durability

- **Identify major limitations affecting long-term use.**

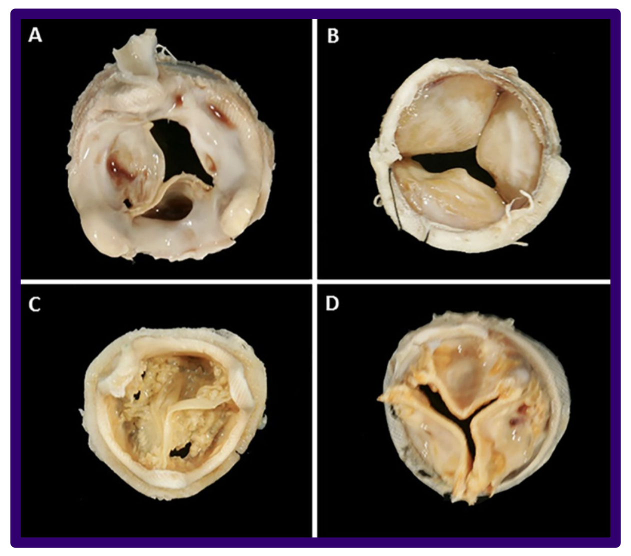

Fig 2. Examples of structural valve degeneration in bioprosthetic heart valves, including fibrosis, thrombus formation, calcification, and leaflet tearing observed at explant. (Sellers et al., 2019).

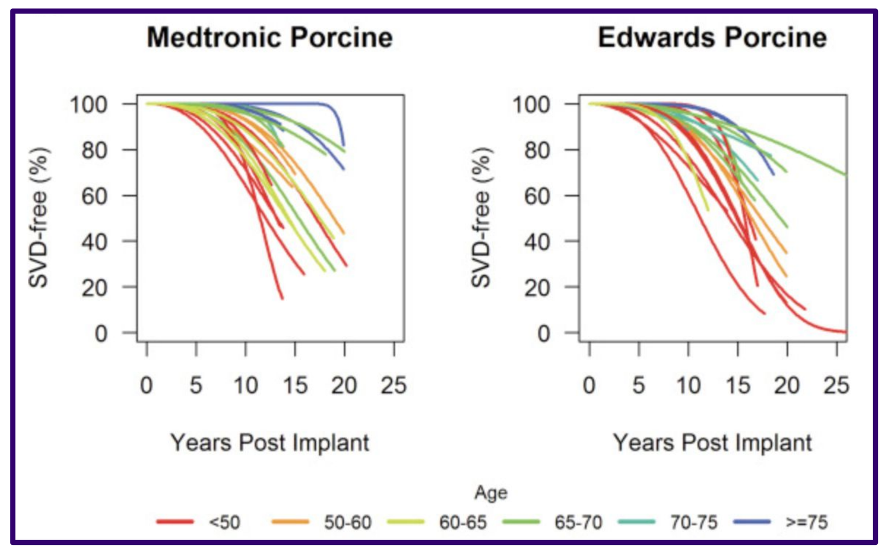

Fig 3. Weibull curves showing structural valve deterioration (SVD) in bioprosthetic aortic valves. Valve durability is strongly influenced by patient age, with lower rates of SVD observed in older patients (Wang et al, 2017).

- **Explore emerging bioengineered technologies aimed at improving valve performance.**

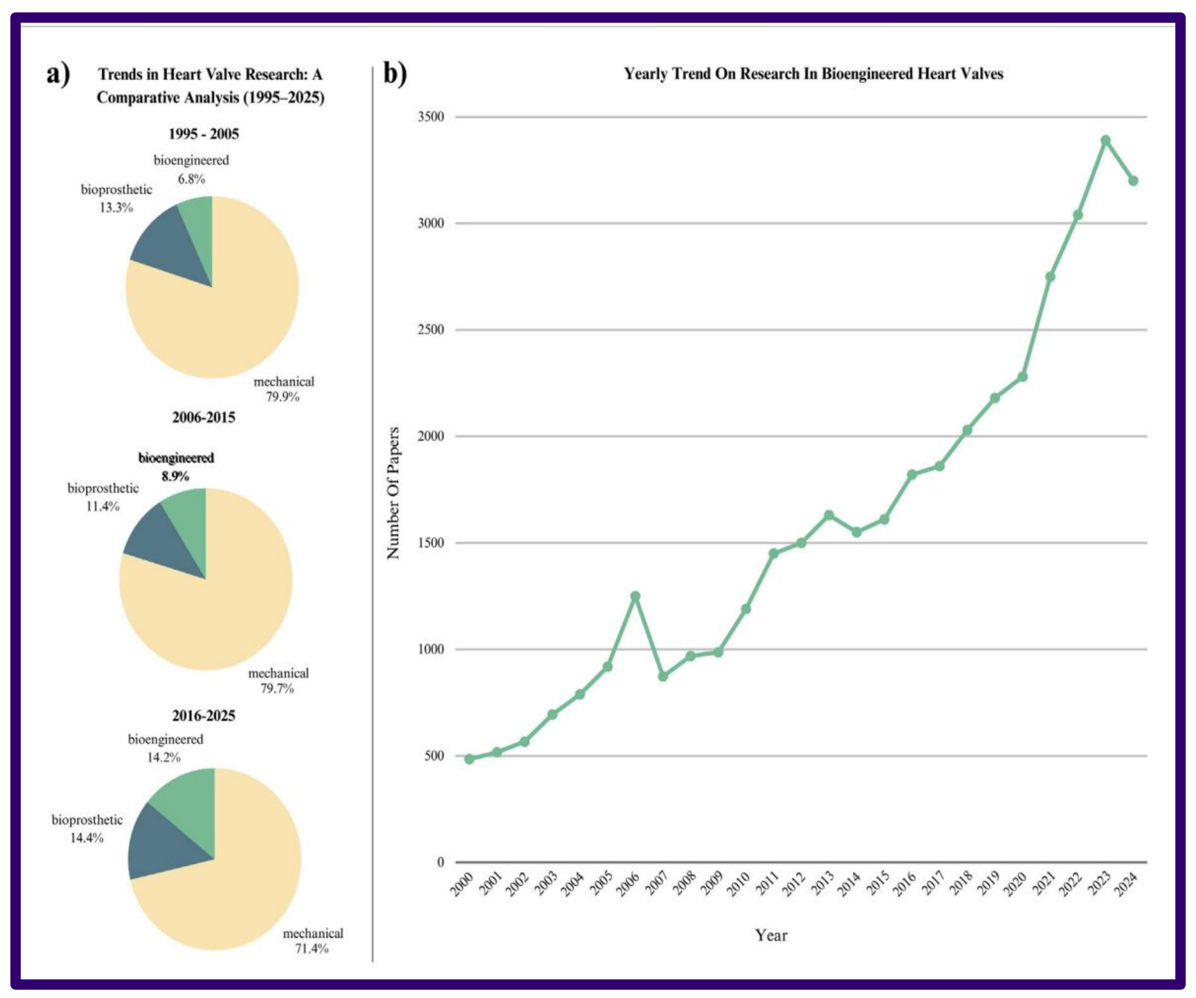

Fig 4. Comparative trends in heart valve research from 1995 to 2025 (Saeed & Khan, 2026).

FUTURE DIRECTIONS

- **Structural valve deterioration remains a major limitation**, increasing the need for alternative long-term solutions.
- **Tissue-engineered heart valves show promise** as future alternatives to current mechanical and bioprosthetic valves, though replicating the native tri-layered valve structure remains a challenge (Jana et al., 2015).
- **Research is increasingly shifting toward bioengineered valves** to improve durability, biocompatibility, and long-term patient outcomes (Fig. 4).

CONCLUSION

Porcine aortic bioprosthetic valves remain clinically valuable, but durability limitations persist. As tissue-engineered heart valves continue to advance, may ultimately surpass current porcine valve technologies.

★ KEY TAKEAWAYS ★

- **Porcine valves mimic native valve function.**
- **Durability is limited by structural degeneration.**
- **Bioengineered valves represent a promising next step.**

ACKNOWLEDGMENTS

Special thanks to Dr. Chivese for his mentorship, guidance, and support throughout this project.

REFERENCES