Porcine valves in cardiovascular surgery and tissue compatibility

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Introduction. The tissue compatibility of human hearts with pig valves can be explained through a concept known as xenotransplantation (Carrier et al 2022), which is the transplant of cells, tissues, or organs between species (Lu et al 2020). In this short paper we will present several factors that contribute to tissue compatibility in the case of pig valves being used in human hearts.

Similarities in structure and function. Despite being from different species, pig heart valves and human heart valves share similarities in their structure and function (Kavarana et al 2022). Both consist of connective tissue, primarily composed of collagen and elastin fibers, which provide strength and flexibility. The functionality of pig valves in regulating blood flow is comparable to that of human valves (Figure 1).

Figure 1. The donor/porcine aortic valve is prepared and kept in ice-cold solution until ready for transplantation (Kwon et al 2021, available under Public License at https://doi.org/10.1186/s13019-021-01743-0).

Immunological considerations. One of the main challenges in xenotransplantation is the potential for immune rejection, where the recipient's immune system recognizes the transplanted tissue as foreign and mounts an immune response against it (Sykes & Sachs 2022). Pig valves used in humans are typically treated to reduce the risk of rejection. Techniques such as decellularization, where the cellular components of the pig valve are removed, can help minimize immune responses (Sykes & Sachs 2022).

Cross-species compatibility. Pigs are often used as a source for xenotransplantation due to their physiological and anatomical similarities to humans. While there are still differences between pig and human tissues, such as variations in certain proteins and carbohydrates, pig tissues are generally well-tolerated by the human body compared to tissues from more distantly related species (Cooper 2012).

Advancements in transplantation science. Advances in medical technology and transplantation science have improved the success rates of xenotransplantation procedures. Researchers are still working to improve tissue compatibility and lower the likelihood of rejection; one such technique is genetic engineering, which modifies pig tissues to make them more compatible with human recipients (Wu et al 2023).

Clinical experience and monitoring. Over the years, there have been clinical trials and case studies involving the use of pig valves in human patients. These experiences have provided valuable insights into the long-term outcomes, risks, and benefits of xenotransplantation. Close monitoring of recipients allows healthcare professionals to detect and address any potential complications that may arise (Welsh & Evans 1999).

Conclusions. The tissue compatibility of pig valves with human hearts can be attributed to structural similarities, immunological considerations, cross-species compatibility, advancements in transplantation science, and clinical experience. While challenges remain, the use of pig valves in human cardiac surgery represents a significant advancement in medical technology and offers hope for patients in need of heart valve replacement.

Conflict of interest. The author declares that there is no conflict of interest.

References

Carrier A. N., Verma A., Mohiuddin M., Pascual M., Muller Y. D., Longchamp A., Bhati C., Buhler L. H., Maluf D. G., Meier R. P. H., 2022 Xenotransplantation: a new era. Frontiers in Immunology 13:900594. doi: 10.3389/fimmu.2022.900594

Cooper D. K., 2012 A brief history of cross-species organ transplantation. Bayl Univ Med Cent Proc 25(1):49–57.

Kavarana S., Kwon J. H., Zilinskas K., Kang L., Turek J. W., Mohiuddin M. M., Rajab T. K., 2022 Recent advances in porcine cardiac xenotransplantation: from aortic valve replacement to heart transplantation. Expert Review of Cardiovascular Therapy 20(8):597-608.

Kwon J. H., Hill M., Gerry B., Kubalak S. W., Mohiuddin M., Kavarana M. N., Rajab T. K., 2021 Surgical techniques for aortic valve xenotransplantation. Journal of Cardiothoracic Surgery 16:358. Available under Public License. doi: 10.1186/s13019-021-01743-0.

Lu T., Yang B., Wang R., Qin C., 2020 Xenotransplantation: current status in preclinical research. Frontiers in Immunology 10:504994. doi: 10.3389/fimmu.2019.03060

Sykes M., Sachs D. H., 2022 Progress in xenotransplantation: overcoming immune barriers. Nature Reviews Nephrology 18(12):745-761.

Welsh I., Evans R. J., 1999 Xenotransplantation, risk, regulation and surveillance: social and technological dimensions of change. New Genetics and Society 18(2-3):197-217.

Wu H., Lian M., Lai L., 2023 Multiple gene modifications of pigs for overcoming obstacles of xenotransplantation. National Science Open 2(5):20230030. doi: 10.1360/nso/20230030.

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