

Design of a new device for heart valve repair testing

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Introduction

Aortic valve-sparing root replacement (AVSRR) is a surgical intervention for treating aortic root pathology and aortic regurgitation. There is currently a lack of instrument to assess the valve competence during the surgery. The aim of this work is to improve and validate a valve leakage device (VL-device) developed at the ARTORG Center. The VL-device measures the leakage of the aortic valve under a progressive pressure, mimicking the physiological pressure of the aortic root.

Materials and Methods

Multiple measurements were conducted on three prosthetic valves (mechanical bileaflet, mechanical monoleaflet and bioprosthetic) to evaluate and improve the VL-device. Then an ex-vivo porcine aortic heart valve was tested to validate the device. The leakage was quantified with the VL-device on the competent native valve with pressure going up to a maximum of 129.9 mmHg. The valve was then damaged by incising a leaflet to mimic an incompetent valve. The leakage was again determined and compared to the native valve.

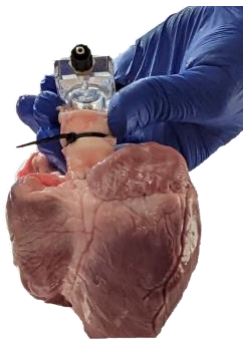


Fig. 1 Experimental test on an ex-vivo porcine heart.

The permeability of the graft used in AVSRR was experimentally determined to be included in the calculation for future measurements on patients. A smartphone application was also developed with a Python module called Kivy to display the results directly on a mobile device.

Results

A median leakage of 23.1 and 98.5 ml/min was measured at a pressure of 40 and 70 mmHg on the

competent native valve. On the damaged valve a median leakage of 114.2 and 362.2 ml/min was measured. A permeability of 2.55 ± 0.02 ml/cm²/min was observed on a Dacron graft at 70 mmHg. The smartphone application developed was able to show live data during the measurement. But the leakage calculation must be further developed.

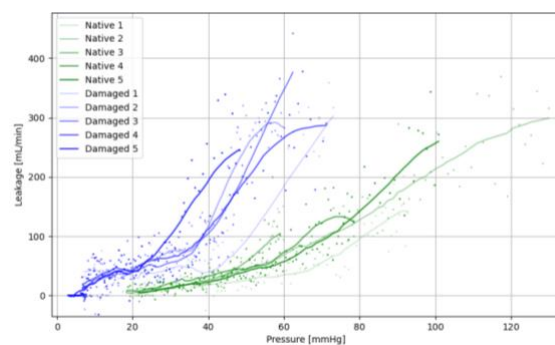


Fig. 2 Leakage of a pig aortic valve with a competent native valve in green and damaged valve in blue.

Discussion

These results show that the VL-device developed is able to give satisfactory leakage measurements. It enables rapid measurements (20-30 seconds) and is easy to use. The current state of the prototype is ready to be tested on humans. The graft's high permeability could present numerous challenges in its application to humans, including the potential difficulty of achieving adequate pressure levels.

References

Arabkhani B et al. Aortic valve visualization and pressurization device: a novel device for intraoperative evaluation of aortic valve repair procedures. *European Journal of Cardio-Thoracic Surgery*. 2023;64(5): ezad291.

Acknowledgements

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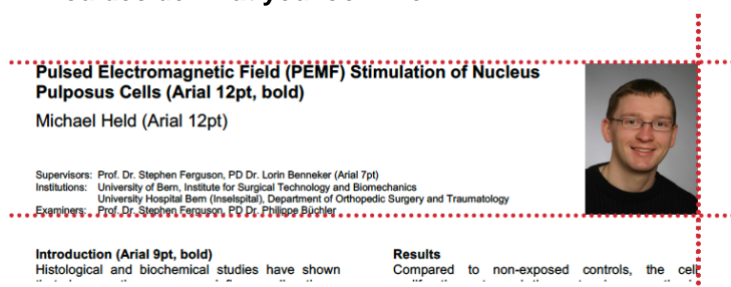
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