# What is the in vivo axial strain of a porcine coronary artery?

# WHAT IS THE IN VIVO AXIAL STRAIN OF A PORCINE CORONARY ARTERY?

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## Introduction

Knowledge of mechanical properties of living arteries is important to understand vascular function during health and disease. An effective way to study the behavior of living tissue is organ culture.
In arterial culture the artery should be loaded at in vivo levels to maintain the artery's viability. The in vivo axial strain of coronary arteries, however, is unknown. Therefore, the aim of this study is to determine the physiological axial strain of the porcine left anterior descending coronary artery (LAD). Based on Weizsäcker (1983) and Schulze-Bauer (2003) it was hypothesized that: *The in vivo axial strain of an artery is the strain at which the axial force ($F_{ax}$) is relatively insensitive to changes in pressure (P).* This "physiological" strain (fig.1, right, red line) was determined in an organ culture model. To test the hypothesis an isolated beating heart experiment, in which a porcine heart is loaded physiologically, was performed. Due to the pumping of the heart, a cyclic axial strain is induced to the coronaries.

## Material and methods

The **culture model experiment** protocol:

- A segment of a porcine LAD was excised.
- The length was measured of (fig. 1):
  - The segment still fixed to the heart ($l_{heart}$)
  - The segment at its ex vivo length ($l_{ev}$)
- The segment was loaded with a pulsatile pressure in the culture model
- The segment length was increased until the $F_{ax}$ change during a P cycle was minimized ($l_{phys}$)

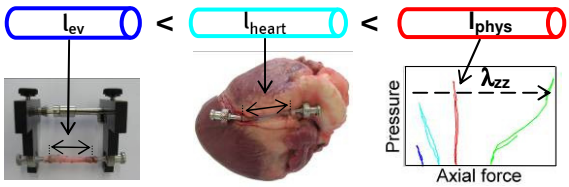


*Figure 1: Definition of different segment lengths.*

**Isolated porcine heart experiment**

The in vivo axial strain was measured on an isolated beating porcine heart model (PhysioHeart, HemoLab). Markers were positioned in parallel to the LAD. By high speed camera recording of the markers during a heart beat, the ex vivo strain amplitude was measured. At the end the marked segment was dissected to determine $l_{heart}$ and $l_{ev}$.

## Results

- There was a small spread in the determined axial strains, i.e. $\lambda_{heart}$ and $\lambda_{phys}$, in the culture model experiment (n=12, fig.2a).
- The following axial strains have been determined in the isolated beating heart experiment (preliminary results → n=1, fig. 2b):
  - $\lambda_{heart}$ =1.2
  - $\lambda_{phys,min}$ =1.3
  - $\lambda_{phys,max}$ =1.38
- The "physiological" stretch derived from the culture model experiment equals the maximum stretch of an artery during a heart beat.

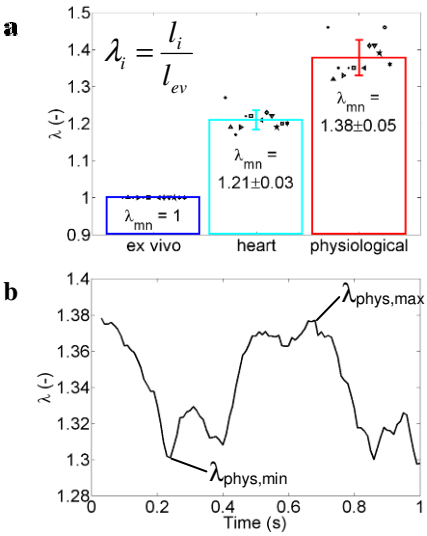


*Figure 2a) Axial stretches derived from the culture model experiment; b) Stretch of segment during a heartbeat in the isolated porcine heart experiment.*

## Conclusion

The average "physiological" stretch of the porcine LAD is found to be 1.38, which is equal to the maximum stretch during a heartbeat in the isolated heart experiment. More isolated heart experiments need to be conducted to be conclusive on whether the in vivo axial strain is indeed the strain at which the axial force is relatively insensitive to changes in pressure.

## References

Weizsäcker *et al*, J. Biomech., 16:703-715, 1983
Schulze-Bauer *et al*, J. Biomech. Eng., 125:395-406, 2003