Modeling the instantaneous pressure-volume relationship in the left ventricle

A. Lucas[1], P. Steendijk[2], J.W. Lankhaar[2], P. Kolh[1], T. Desaive[1], P.C. Dauby[1]

[1] Cardiovascular Research Center, University of Liège, Liège, Belgium
[2] Institute for Cardiovascular Research, VU University Medical Center, Amsterdam, The Netherlands

Introduction

Pressure-volume loops are a common modeling tool of the cardiovascular system. They are very useful because they characterize the global function of the cardiac pump and can also be analyzed by considering the various phases of the cardiac cycle and marking each point of a cycle with the corresponding time. When several loops are considered, the points corresponding to the same time *t* in each loop can be joined to define a curve named **isochrone.** In this work, we are interested in models of the **instantaneous pressure-volume relationship**, i.e. isochrone models. More precisely, we concentrate on the 6 models considered by Lankhaar *et al.* [1] and we propose a critical analysis of the work of these authors and suggest some improvement of their procedure.

Methods

Initially, Lankhaar *et al.*

1. Estimate the parameters characterizing six different isochrones models from experimental data measured in five sheep
2. Simulate each experimental loop with these parameters

To test the procedure developed in [1], we

1. Estimate the model parameters from the simulated loops
2. Compare the parameters estimated from the simulated loops and from the experimental loops

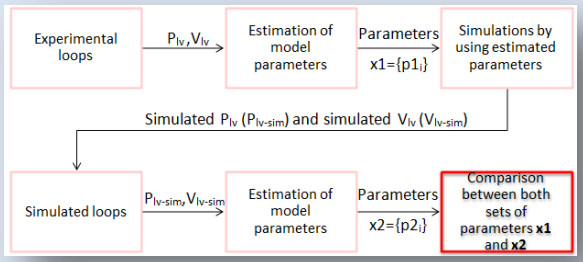

Fig. 1 : Test done to verify the consistency of the procedure.

→ **Consistent procedure** if both sets of parameters are equal
→ **Inconsistent procedure** if both sets of parameters are different

Results

Our tests have shown inconsistencies for some of the six models. The causes are:

- the use of the ESPVR defined as an isophase, and not as an isochrone, to estimate some parameters
- the lack of uniformity in the definition of some parameters between the programs of parameters estimation and those for loops simulation

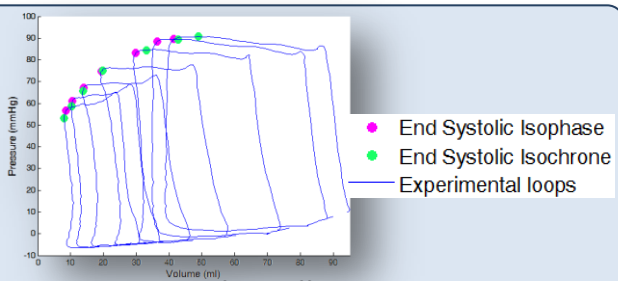

Fig. 2. : Illustration of the difference between the ESPVR defined as an isophase and as an isochrone.

Conclusions

The ESPVR commonly defined as an isophase is not adapted in isochrone models. We think it is better to define an end-systolic isochrone, namely the closest isochrone to the ESPVR. Furthermore, we redefine the identification of important landmarks in P-V loops, paying attention to the uniformity.

References

[1] Lankhaar J.W. et al. *Annals of Biomedical Engineering,* Volume 37, Number 9, 1710-1726, 2009.
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Contacts

alucas@ulg.ac.be and pc.dauby@ulg.ac.be