Evaluation of principal strain-lines in the left ventricle: a computational model

Ivan Colorado-Cervantes[1], Paolo Piras[2], Vittorio Sansalone[1], Luciano Teresi[2]
[1] *Université Paris Est, Crèteil, France*
[2] *Università Roma Tre, Roma, Italy*

Abstract

Principal strains in a point of a material body measure the maximum and minimum deformations that can be attained at this point and can be measured by a post-processing analysis of the movement of the tissue. In [1] was suggested that principal strain lines (PSL) can highlight relevant information about the fibre architecture of the myocardium, the hypothesis propose that during systolic phase strains will mainly be suffered by the contraction of the muscle fibres, then systolic PSL may identify fibre direction within the heart wall.

Using a patient-specific left ventricle geometry, retrieved from the post-treatment of 3D speckle tracking echocardiography (3DSTE), we develop a computational model to simulate contraction mechanics of the chamber and evaluate PSL along the systolic phase. The outcomes of our simulation show similitude with the results of [2, 3] where it was seen that in endocardial surface the PSL's are oriented in a circumferential manner, suggesting that this may be the result of a stiffening effect of the circumferential material lines when high pressures are attained. With this model we expect to better understand the PSL patterns which may help to give a perception of the global state of the left ventricle.

References

[1] G. Pedrizzetti, E. Kraigher-Krainer, A. De Luca, G. Caracciolo, J.O. Mangual, A.Shah, L. Toncelli, F. Domenichini, G. Tonti, G. Galanti, P.P. Sengupta, J. Narula, S. Solomon. Functional Strain-line Pattern in the Human Left Ventricle. *Phys. Rev.Lett.*, 109(4):048103, 2012.

[2] S. Gabriele, P. Nardinocchi, V. Varano, Evaluation of the strain-line patterns in a human left ventricle: a simulation study, *Computer Methods in Biomechanics and Biomedical Engineering*, 18(7):790–798, 2015.

[3] Evangelista, A and Gabriele, S and Nardinocchi, P and Piras, P and Puddu, PE and Teresi, L and Torromeo, C and Varano, V, Non-invasive assessment of functional strain lines in the real human left ventricle via speckle tracking echocardiography, *Journal of biomechanics*, 48(3):465–471, 2015.