NONINVASIVE ASSESSMENT OF VENTRICULAR-ARTERIAL COUPLING: FROM THEORY TO APPLICATIONS

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Ventricular-arterial coupling (VAC) is considered as the cornerstone of the synergic interplay between the pumping action of the heart and the impedance of the arterial network that enables the blood circulation through the cardiovascular system. The VAC is typically quantified via the ratio between the effective arterial elastance ($\boldsymbol{E_a}$) and the left ventricular (LV) end-systolic elastance ($\boldsymbol{E_{es}}$) (VAC ratio =$\boldsymbol{E_a}$/$\boldsymbol{E_{es}}$). The gold standard technique for estimating the VAC ratio is left ventricular catheterization, by which pressure-volume (P-V) loops can be generated and $\boldsymbol{E_a}$ and $\boldsymbol{E_{es}}$ are estimated. However, LV catheterization is highly invasive and has a limited applicability in clinical practice. Currently, the VAC ratio is estimated by a volumetric ratio calculated from echocardiographic measurements based on a single-beat method. However, this method suffers from oversimplification, does not inform on $\boldsymbol{E_a}$ and $\boldsymbol{E_{es}}$ separately, and can only be done periodically due to logistic issues (cost, need for specialized equipment and training). Therefore, the main goal of this study is to propose a non-invasive VAC assessment by quantitative measurements of both cardiac and arterial functions that are easy to collect, thereby increasing its clinical impact. By means of a mechanism-driven closed-loop model of the cardiovascular system [1], we have identified three noninvasive signals whose features are expected to change in a differently depending on whether the VAC changes because of alterations to $\boldsymbol{E_a}$ or $\boldsymbol{E_{es}}$. The three signals are: electrocardiogram (ECG), seismocardiogram (SCG) and ballistocardiogram (BCG). The potential of this technique based on synchronous ECG-SCG-BCG acquisition for noninvasive VAC monitoring and interpretation is currently being evaluated on animal and human subjects [2].

REFERENCES

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