Quantification of Cavitation in Mechanical Heart Valve Patients

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Mechanical heart valves (MHV) are used to replace native valves in patients with various heart valve diseases. However, the patients remain at risk of blood cell damage, thromboembolic events and material failure of the MHV. A phenomenon known as cavitation has been identified as a likely cause of a series of MHV failures and has been shown in vitro to occur near MHVs. It is thought that cavitation damages blood components, leading to both clot formation and possibly cerebral embolization in MHV patients. A non-invasive in-vivo technique to quantify the level of cavitation present in MHVs would be useful to help cardiologists determine the amount of anticoagulant medication to prescribe for their patients. Recent work has shown some promise towards achieving this goal of cavitation quantification by signal processing of acoustic measurements of heart sounds. In this paper, two different algorithms for cavitation quantification are investigated for robustness and usability. The first algorithm calculates the root mean squared value of the (acoustic) pressure signal after it has been high-pass filtered to separate the cavitation component from the rest of the signal. The second algorithm separates the deterministic energy from the random (non-deterministic) energy in the acoustic signal. These algorithms are investigated for the purposes of determining robustness, usability and implementation issues that need to be addressed in order to ensure accuracy and utility of this approach in a hospital setting.