

Acoustic-based monitoring of the aortic valve opening in patients implanted with a third-generation left ventricular assist device: feasibility analysis

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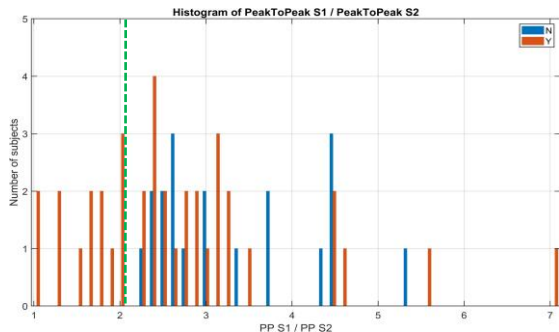
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The assessment of the aortic valve (AV) opening in patients implanted with a left ventricular assist device (LVAD) is relevant, since persistent AV closure has been associated with valve degeneration, aortic insufficiency, and thrombosis. At present, AV status is assessed by echocardiography. Deriving AV-related information from phonocardiography (PCG) could support the development of home-monitoring strategies. This study investigates the feasibility of identifying AV opening in patients implanted with a HeartMate 3 (HM3) LVAD through acoustic signal analysis, despite pump interference.

PCG recordings were acquired during patients' follow-up using a wearable multi-sensor array, developed at Politecnico di Torino, that integrates 58 microphones and three ECG electrodes. A total of 57 recordings were analyzed, including 38 associated with AV opening (Y) and 19 with persistent AV closure (N). After ECG-based beat segmentation, acoustic recordings were filtered to preserve heart sounds and attenuate LVAD noise, and signals with SNR higher than 8 dB were considered.

Two significant S2-based features were extracted: peak-to-peak amplitudes of S2 and the ratio between the peak-to-peak amplitudes of S1 and S2. Histogram-based analysis suggested that S2 peak-to-peak amplitude above 0.8 mV and S1/S2 ratio below 2.2 were more frequently associated with AV opening, and 29 of 38/57 recordings in which the AV was functioning satisfied both thresholds.

These findings suggest that AV opening in HM3 patients is reflected by the acoustic signal and support the feasibility of PCG as a complementary tool for LVAD follow-up and domiciliary monitoring.



Histogram of S1/S2 peak-to-peak ratio.