Detection of aortic stenosis using built-in microphones of commercially available smartphones

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Funding Acknowledgements: None.

Background: According to recent data, asymptomatic patients with severe aortic stenosis benefit from early treatment. Hence, widely applicable methods to identify patients with severe aortic stenosis in an asymptomatic state may be desirable in the future. While the diagnosis of aortic stenosis is currently based on echocardiography, population-wide use is not feasible due to resource constraints. With recent technological advances in built-in microphones of commercially available smartphones, digital auscultation may provide a viable alternative.

Methods: As part of this study, a smartphone application to perform digital auscultation was developed. To ensure high-quality recordings real-time signal analysis is implemented. The 8 kHz sampling rate of the signal encompasses all typical frequencies of cardiac auscultation while keeping resource usage minimal. To prevent frequency leakage the signal is attenuated using a Blackman-Harris window. After applying Fast Fourier Transformation to the windowed signal, frequencies around 100 Hz and 250 Hz are amplified to match the frequency response of traditional stethoscopes. The resulting signal amplitudes are then visualized. The application provides functionality for storing metadata about each patient in addition to the raw audio recordings.

To verify the feasibility of using the described application to detect severe aortic stenosis, this study aims to enroll 50 persons with no valvular heart disease and 50 persons with severe aortic stenosis. Initial audio recordings by the smartphone application and of a digital stethoscope are compared by visualizing the frequency spectrum using the Mel Frequency Cepstral Coefficients.

Results: The peaks of the first and second heart sound at around 50 Hz are both clearly identifiable, as is the crescendo-decrescendo murmur typically associated with aortic stenosis in the frequency range of 100-600 Hz (Figure 1). This is true for both smartphone and stethoscope recordings, even though the built-in microphone of smartphones results in a lower signal-to-noise ratio. Nevertheless, the quality of the signal is robust enough to clearly indicate the presence of aortic stenoses.

Conclusions: The initial findings of this study indicate that a smartphone application using built-in microphones is a promising approach for identifying severe aortic stenoses. This approach has the potential to be a reliable and cost-effective screening tool for early detection. Further development of automated algorithms may enhance the tool's effectiveness and accessibility.

Figure 1