Mapping the Impact of Breast Tissue on Wearable Phonocardiography

Nirmani Rathnayake, Andrew McDonald, Maximilian Nussbaumer, Anurag Agarwal

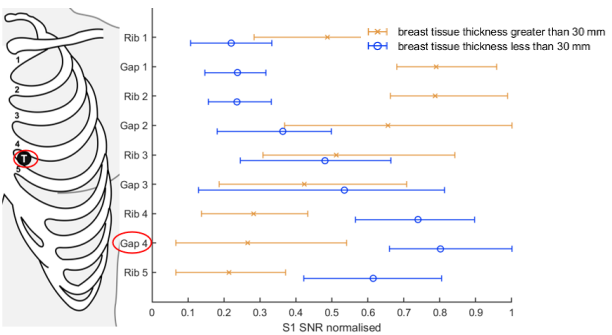
University of Cambridge, Cambridge, United Kingdom

Background: Many cardiovascular diseases progress over time, necessitating regular monitoring. Wearable phonocardiogram (PCG) devices can revolutionise healthcare accessibility, particularly for women, who are under-monitored for many reasons including underrepresentation in clinical trials. Home monitoring with wearable PCG sensors can significantly improve women's health outcomes. The optimal sites for these sensors are currently assumed to be the same for all individuals. However, anatomical variations, especially in females with more breast tissue near the tricuspid valve site, could dampen heart sounds. Investigating heart sound propagation across breast tissue can reveal better auscultation sites, aiding in the home monitoring of women.

Methods: In this study, we compared the signal-to-noise ratio (SNR) of the S1 heart sound of 12 healthy males and 20 healthy females using accelerometers to record PCG signals. Recordings were taken at 9 locations along the left sternal border, at the first five ribs and the first four intercostal spaces. Female breast tissue thickness was estimated using torso circumference measurements.

Results: In males, the SNR of the S1 heart sound was highest at the tricuspid valve site. This is expected since this valve contributes to the production of the S1 sound. However, the position of the best SNR was very variable in women, with low SNR correlating with locations with more breast tissue. SNR in females with less breast tissue followed the same pattern as that of males.

Conclusion: This study suggests that auscultation locations are affected by breast tissue distribution and indicates the need to consider anatomical differences in wearable design and placement, particularly in monitoring females.



Normalised SNR of females with different breast tissue thicknesses. Gap 4 circled is the location of the tricuspid valve site.