thrombus.eu

Electrode Comparison for Impedance-Based Venous Occlusion Plethysmography

Sami Maja (sami.maja@tuni.fi)
Sensor Technology and Biomeasurements Group, Faculty of Medicine and Health Technology, Tampere University, 33720 Tampere, Finland

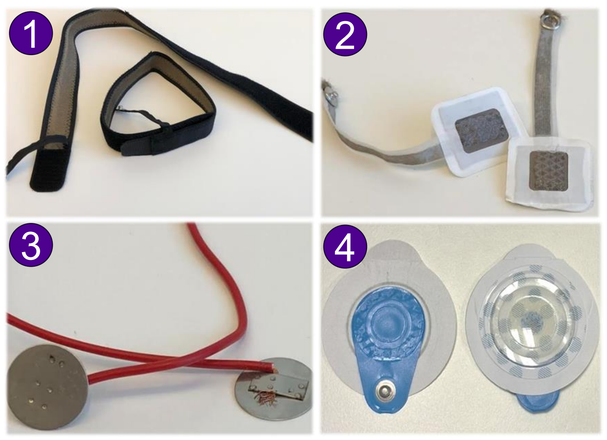
Introduction

- Deep vein thrombosis (DVT) and its fatal complication, pulmonary embolism, constitute the third most common cardiovascular disease after myocardial infarction and stroke.
- Although contrast venography and ultrasonography are gold standards in clinical practice, they are impractical for continuous monitoring.
- Therefore, new methods for continuous DVT monitoring are needed to enable effective early detection, particularly in high-risk patients.
- Impedance-based venous occlusion plethysmography (VOP) provides a simple and non-invasive option, but conventional disposable gel electrodes are unsuitable for long-term monitoring.
- Novel textile-based electrodes provide an alternative, enabling seamless integration into wearable and facilitating translation to point-of-care monitoring.

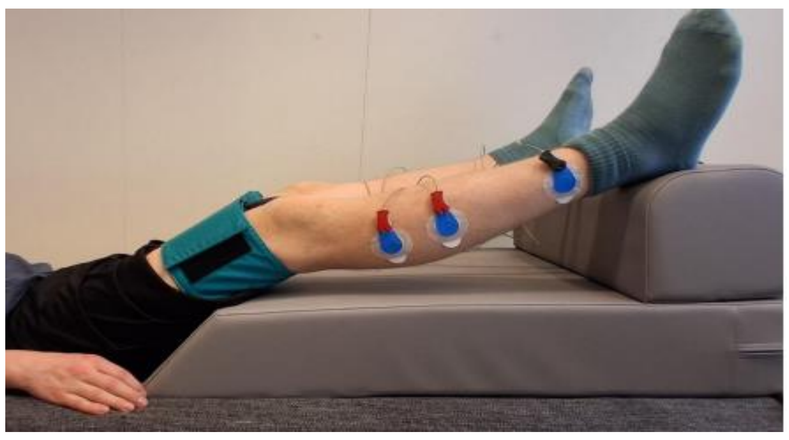
Materials & Methods

Three in vivo experiments with 10 healthy volunteers:

1) Signal-to-noise ratio (SNR) using template matching
2) Electrode stabilization over 30-minute period
3) VOP measurement

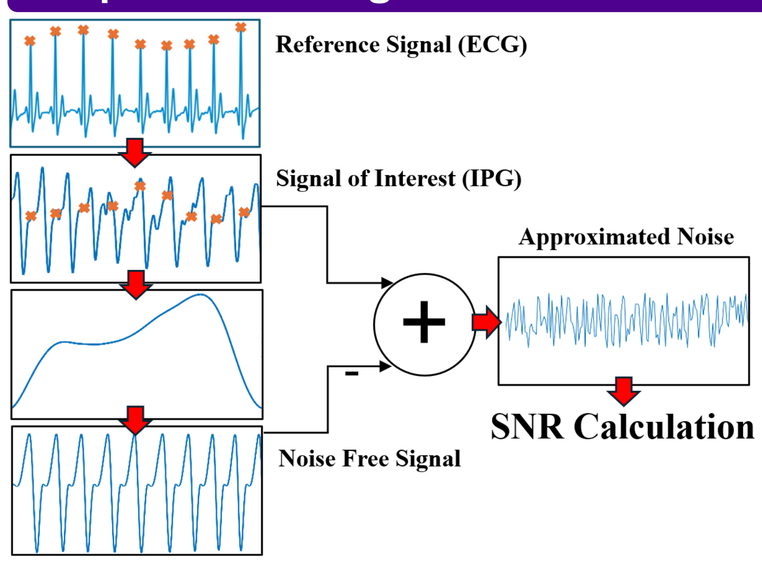


Evaluated electrodes: 1) Textile band 2) Textile spot 3) Metal plate 4) Disposable Ag/AgCl gel electrodes



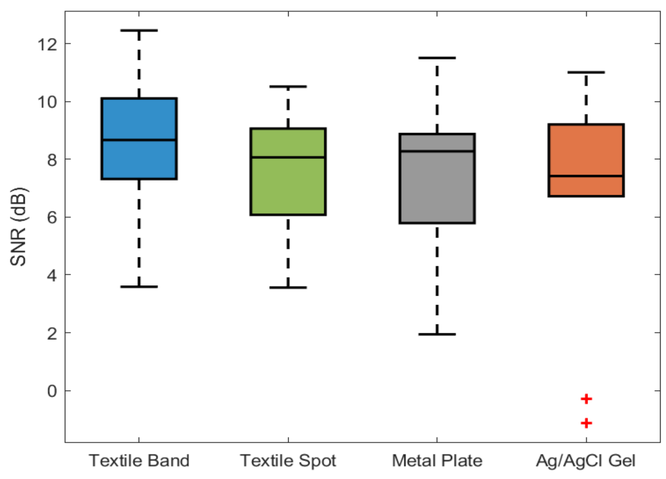
VOP setup: Impedance plethysmography was used at the calf to measure blood volume changes induced by thigh cuff inflation and deflation.

Template Matching

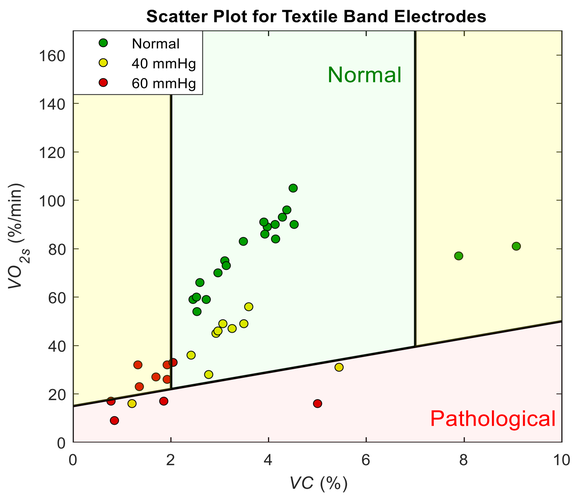


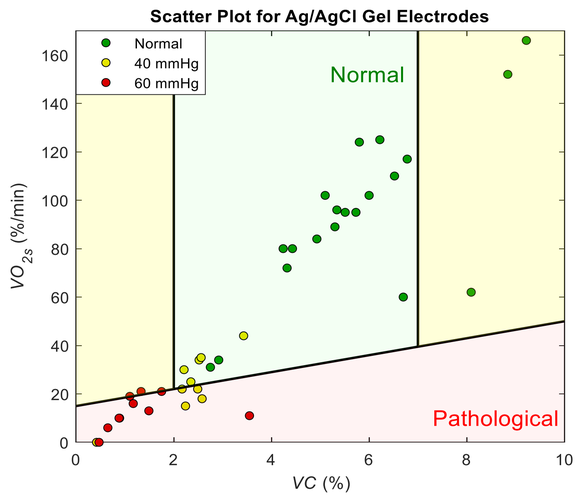
SNR calculation from impedance plethysmography (IPG) signal using template matching.

Results

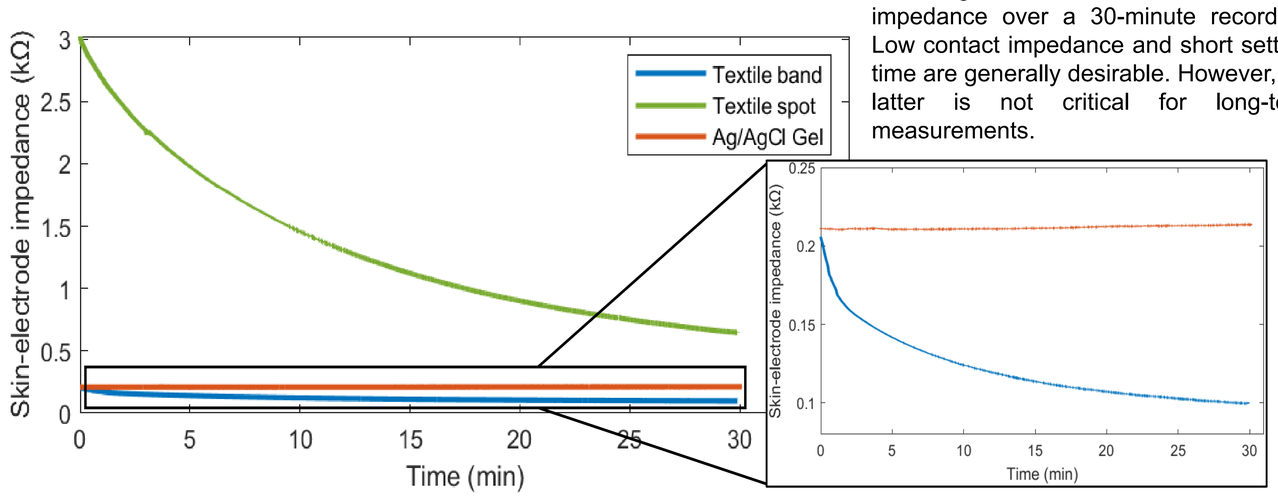


SNRs for each electrode type. No statistically significant differences were found ($p > 0.05$). Values deviating from the median more than 1.5 times the interquartile range, have been marked with red sign.





Scatter plots for textile band and Ag/AgCl gel electrodes: the sensitivity was 40% for band and 72% for gel electrodes, with specificity at 100% for both. Samples that fell into yellow areas were ignored.



The magnitude of skin-electrode contact impedance over a 30-minute recording. Low contact impedance and short settling time are generally desirable. However, the latter is not critical for long-term measurements.

Conclusions

- Textile band electrodes are feasible for measuring VOP signals
- With further optimization and adjustment, they could provide a comfortable alternative to conventional disposable gel electrodes.
- They enable easy integration into wearables and transition to continuous monitoring.

Scan for Full Thesis!

Acknowledgements

This work is funded under the Horizon Europe Innovation Action ThrombUS+ (Grant Agreement No. 101137227), co-funded by the European Union.

Horizon Innovation Action | Agreement No. 101137227
HORIZON-HLTH-2023-TOOL-05-05
Co-funded by the European Union