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Variability of perfusion index in selected pulse oximeter models

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Introduction

The perfusion index (*PI*) is a parameter representing the ratio between the pulsatile and non-pulsatile components in peripheral tissue and it is obtained from the plethysmographic signal using pulse oximeters. Some studies point out that the calculation of *PI* is not standardized and each pulse oximeter uses its own algorithm. Factors such as patient movement or changes in tissue perfusion further influence *PI* values. The aim of this work was to design and implement an experiment that allows comparison of *PI* variability between selected pulse oximeter models and specific scenarios that may occur in routine clinical practice.

Methods

Measurements were performed in three scenarios: rest, motion artifacts and vascular occlusion. All scenarios were completed by 42 healthy volunteers. Before starting each measurement, randomization of the deployment of specific pulse oximeters was performed: the Intec A310 (Frankfurt am Oder, Germany), the Contec CMS-50 Pro (Qinhuangdao, China), the Masimo Radical-7 (Masimo Corporation, Irvine, CA, USA) on specific fingers of the right hand: ring, middle, and index fingers. *PI* values were read every 20 s for 2 min in the first two scenarios, followed by swapping the pulse oximeters between fingers and repeating the process until each device measured 6 values on each finger. In the third scenario, values were read every 10 seconds for 1 minute, followed by a 4-minute rest phase, after which the process was repeated twice more.

Results

The study was conducted on healthy participants at the Faculty of Biomedical Engineering in Kladno, Czech Republic, in the Laboratory of Special Equipment for ICU during February and October 2024. All 42 participants completed all three scenarios of the experimental assessment.

The change in perfusion index over time in first scenario is shown in Figure 1. The mean PI values were 7.07 % for Intec A310, 5.80 % for Contec CMS-50 Pro, and 6.80 % for Masimo Radical-7.

The change in perfusion index over time in second scenario is shown in Figure 2. The mean PI values were 6.49 % for Intec A310, 5.51 % for Contec CMS-50 Pro, and 5.80 %. for Masimo Radical-7.

The change in perfusion index over time in final scenario is shown in Figure 3. The mean PI values were 3.64 % for Intec A310, 2.51 % for Contec CMS-50 Pro, and 2.70 % for Masimo Radical-7. Contec CMS-50 Pro and Masimo Radical-7 showed a sharp PI drop within 30 seconds, while Intec A310 declined more gradually.

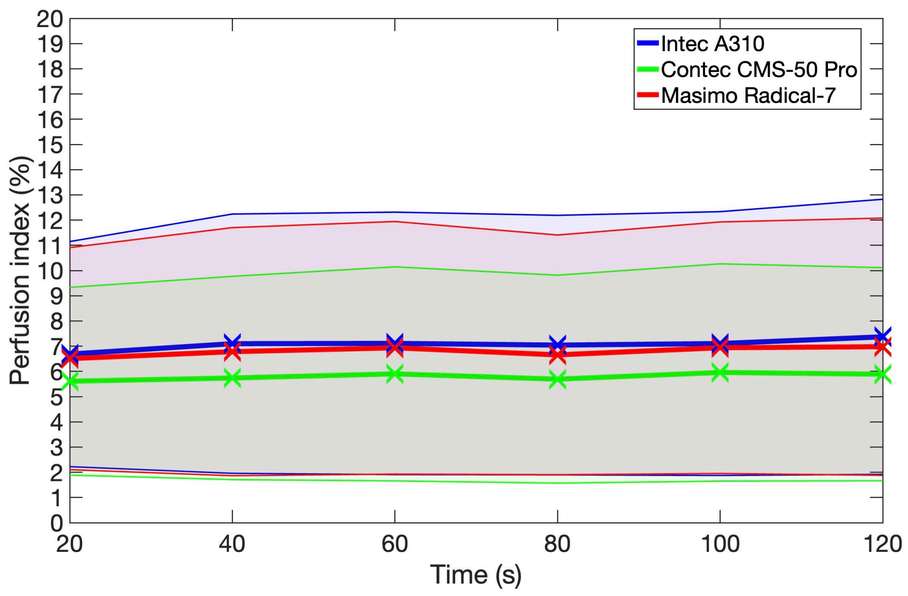

Fig. 1. *Time dependence of PI of a participant at rest*

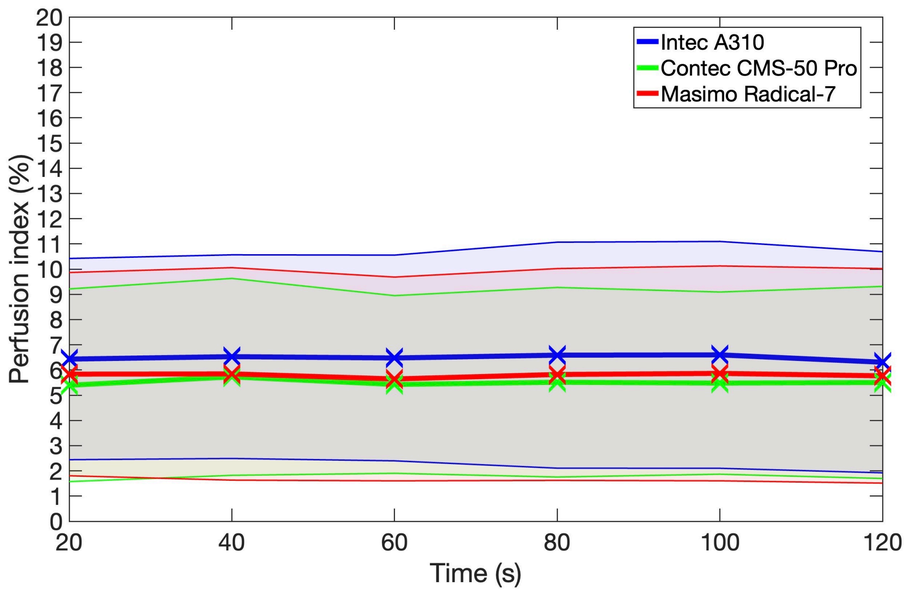

Fig. 2. *Time dependence of PI of a participant performing motion artefacts*

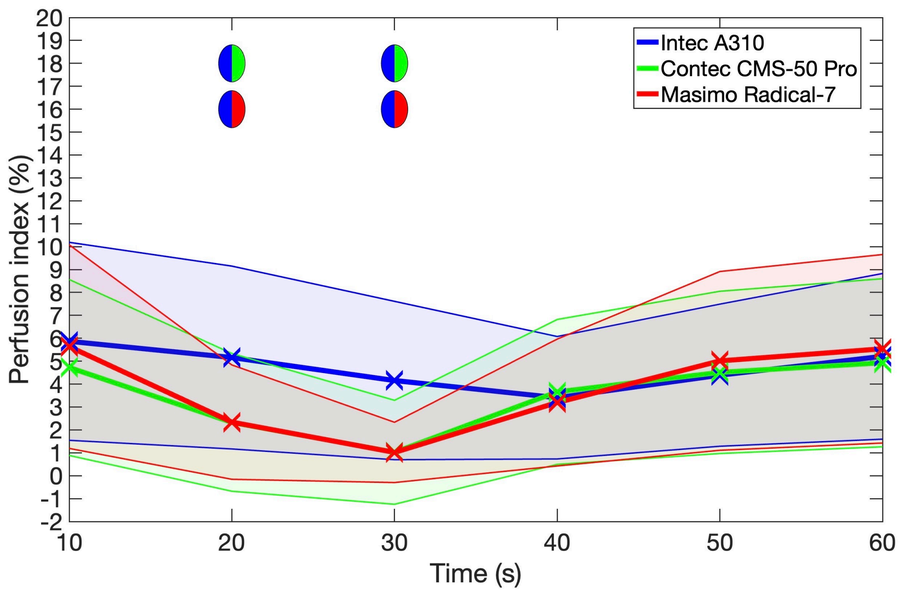

Fig. 3. *Time dependence of PI during vascular occlusion, The colors of the semicircles indicate a statistically significant difference between* pulse oximeters with the corresponding colors

Discussion

The main finding of this study is that the three tested pulse oximeters: Intec A310, Contec CMS-50 Pro, Masimo Radical-7, provided consistent and comparable perfusion index values under resting and motion conditions, with no statistically significant differences. However, in the vascular occlusion scenario, Contec CMS-50 Pro and Masimo Radical-7 showed a rapid decrease in *PI* within the first 30 seconds, whereas Intec A310 responded more gradually. This suggests differences in signal processing or averaging algorithms among the devices. Statistically significant differences were confirmed between Intec A310 and both Contec CMS-50 Pro and Masimo Radical-7 during the 20–30 second interval.

Conclusion

Under standard and mildly dynamic conditions, all three pulse oximeters appear interchangeable for *PI* measurement. However, in situations with rapid changes in peripheral perfusion, such as vascular occlusion, Contec CMS-50 Pro and Masimo Radical-7 may offer faster response, which could be clinically relevant.

Acknowledgements

I would like to thank to Ing. Šimon Walzel for help during the experiment and all the participants who dedicated their time and patience to me. This study was supported by the Grant Agency of the Czech Technical University in Prague, Grant No. SGS25/110/OHK4/2T/17