Kyriacou, P. A., Shafqat, K. & Pal, S. K. (2007). Investigation of the effect of peripheral perfusion on photoplethysmography and blood oxygen saturation during blood pressure cuff-induced hypoperfusion. British Journal of Anaesthesia, 98(2), 293P-294P. doi: 10.1093/bja/ael319

Investigation of the effect of peripheral perfusion on photoplethysmography and blood oxygen saturation during blood pressure cuff-induced hypoperfusion.

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Photoplethysmography (PPG) is a non-invasive electro-optical technique widely used in the monitoring of the pulsations associated with changes in blood volume in a peripheral vascular bed [1]. The technique is based on the absorption properties of vascular tissue when it is transilluminated by light. The PPG signal component is synchronous with the heart rate, which is assumed to be related to the arterial blood volume pulse [2]. Photoplethysmography is also used in the estimation of arterial oxygen saturation (SpO_2) by pulse oximetry. Pulse oximeters estimate SpO_2 non-invasively by shining light at two different wavelengths, red and near infrared, through vascular tissue. Hence, the technique of pulse oximetry relies on the presence of adequate peripheral arterial pulsations, which are detected as PPG signals. When peripheral perfusion is poor, pulse oximeter readings become unreliable or cease altogether. However, there are only a few reports that investigate the effect of the PPG on the accuracy of pulse oximeters during hypoperfusion. In this pilot study we investigated the PPG signal and its effect on pulse oximetry under controlled vasoconstriction. A reflectance finger PPG/SpO_2 probe and a data acquisition system have been developed [3]. Fourteen healthy male volunteers, mean age, ± SD (28 ± 5.2) participated in this study. The cuff of a sphygmomanometer was placed on the left arm at the level of the brachial artery. Hypoperfusion was induced by gradually occluding the brachial artery using the sphygmomanometer atincrements of 10 mmHg (10-15 seconds intervals) and gradually released in a similar manner. PPG signals and SpO_2 values were recorded from the custom made probe which was placed on the index finger. PPG signals with high signal-to-noise ratios were obtained from all induced pressures prior to full brachial occlusion. A Kruskal-Wallis One Way Analysis of Variance (ANOVA) on ranks showed that there are statistically significant differences ($p<0.05$) between the PPGs in the low pressures (0 to 80 mmHg) than those in the upper pressures (90 to 150 mmHg). Blood oxygen saturation values were also recorded simultaneously from a commercial finger pulse oximeter place on the same hand. Both pulse oximeters showed gradual decrease of saturations during induced hypoperfusion which demonstrate the direct relation between blood volumes (PPG amplitudes), arterial vessel stenosis and blood oxygen saturation. The custom made pulse oximeter was found to be more sensitive to SpO_2 changes than the commercial pulse oximeter especially at high occluding pressures (Fig 1). Signal averaging might be one of the reasons that affected the slow response of the commercial pulse oximeter.

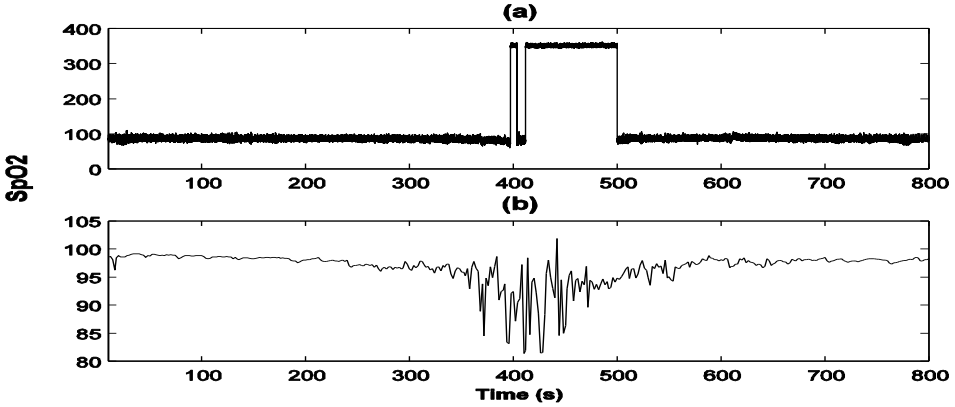

Figure 1: Blood oxygen saturation traces during hypoperfusion. (a) and (b) represent SpO2 traces from the commercial and custom made pulse oximeter respectively.

References:

1) Challoner A V J 1979, Academic Press, New York, chap. 6 125-151. 2)Roberts V C 1982 Trans Inst M C 4 101-6. 3)Kyriacou P A, Physiological Measurement 2006; (27): R1-R35.