Non-invasive optical estimation of local venous oxygen saturations

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Breathing causes variations in blood volume in the peripheral vascular bed, which are evident as respiratory-induced intensity variations (RIIV) on recorded photoplethysmography (PPG) signals during spontaneous and mechanical ventilation [1]. It has been suggested that suitable signal analysis of PPG signals in the respiratory frequency range can produce estimations of local venous oxygen saturation ($SxvO_2$) [2,3]. Although saturations lower than those of arterial blood have been obtained from PPG analysis of oesophageal [2] and peripheral [4] measurements, these have not been validated by comparison with co-oximetry of venous blood. The aim of this study was to record PPG waveform effects and derived venous saturations during exaggerated inspiratory and expiratory airway pressures in volunteers.

Twelve healthy volunteers performed unforced breathing for one minute, followed by two minutes of forced breathing through a narrow tube. Airway pressure monitored from the mouthpiece was displayed in real time on a computer screen so that the volunteers could aim for recommended rate, rhythm and airway pressure values. At the end of the recording period, venous blood, sampled from the dorsum of the hand, was analysed in a co-oximeter (Radiometer ABL80). PPG-derived venous saturations were estimated using Fourier analysis of PPG signals in the respiratory frequency range.

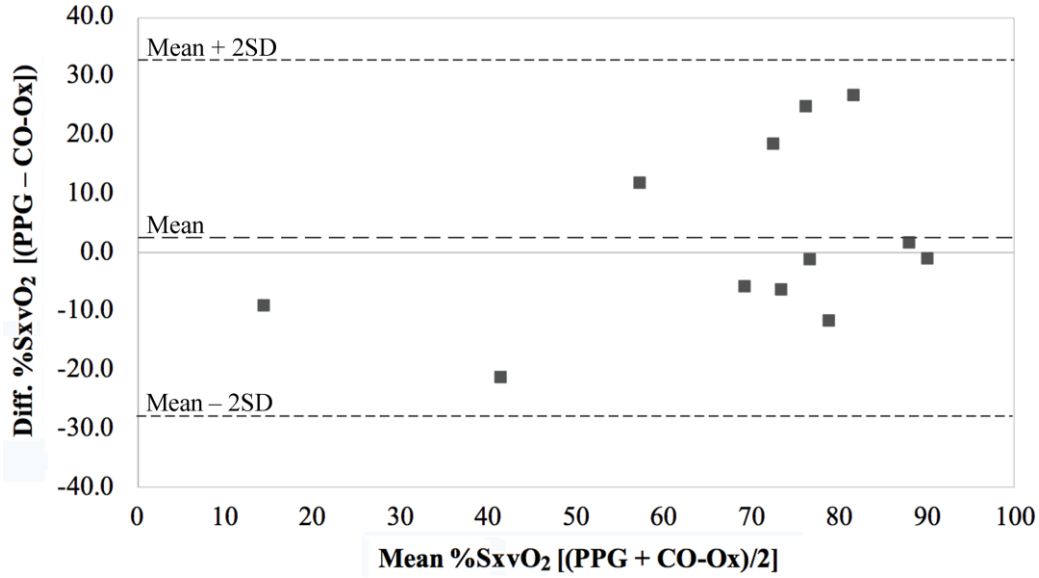

Figure 1. Bland Altman Plot comparing PPG-derived and co-oximetry (co-ox) results

The preliminary data (Figure 1) showed good correlation between PPG-derived $SxvO_2$ and blood co-oximetry values (r = 0.805, mean difference = +2.3, n = 12). These results justify further studies in volunteers and mechanically ventilated patients.

References: 1. Shelley KH, Anesth Analg. 2007 Dec;105(6 Suppl):S31-6; 2. Walton ZD, Kyriacou PA, Silverman DG, Shelley KH, J Clin Monit Comput. 2010 Aug;24(4): 295-303, 3. J. P. Phillips, P. A. Kyriacou, D. P. Jones, *Curr Op Anesth*, vol. 21, pp.779–783, 2008. 4. Thiele RH et al Anesth Analg 2011;112;1353-7.