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Photoplethysmographic signals from human splanchnic organs using a new fibre-optic sensor

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Background and purpose

Splanchnic organs are particularly vulnerable to hypoperfusion, and if undetected may contribute to the development of multiple organ failure [1]. Currently, there remains a need for a simple, accurate, continuous method of monitoring splanchnic perfusion pre-operatively, operatively and post-operatively [2]. As a preliminary to developing such a sensor, a new handheld photoplethysmographic (PPG) fibre-optic sensor and processing system were developed [2]. Such a sensor would allow the intraoperative assessment of splanchnic perfusion, as well as providing an evaluation of the fibre optics as a means for acquiring photopletysmographic signals.

Method

Ethics Committee approval was obtained to study patients undergoing elective laparotomy. At an appropriate time during the procedure, the splanchnic PPG sensor was inserted into a sterile medical ultrasound cover. The sensor was then placed on the surface of each accessible organ by the surgeon (Figure 1). An identical fibre-optic sensor was also placed on the periphery (finger or toe) of each patient to facilitate comparison of the acquired PPG signals from both sites. All signals were monitored and acquired for approximately two minutes on each site. Blood oxygen saturation from a commercial finger pulse oximeter (GE Healthcare) was also simultaneously monitored and recorded.

Fig. 1. Fibre-optic splanchnic PPG probe being held on the small bowel by the surgeon during open laparotomy

Results

PPG signals of good quality were obtained from all accessible splanchnic sites (bowel, liver, stomach) from six patients during open laparotomy. Figure 2 shows typical ac red and infrared signals from the small bowel.

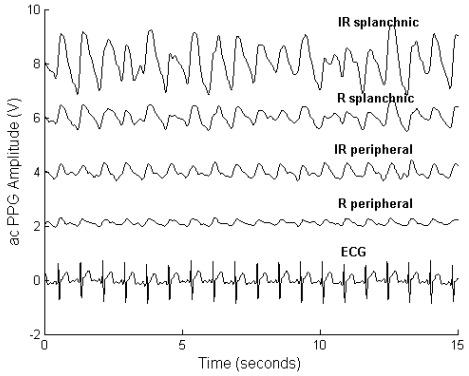

Fig. 2. Simultaneous ac infrared (IR) and red (R) splanchnic PPG signals from the small bowel and periphery

Figure 3 depicts preliminary SpO_2 results from the custom made splanchnic and peripheral fibre optic sensors and the commercial pulse oximetrer. Overall there is good agreement between all pulse oximeters.

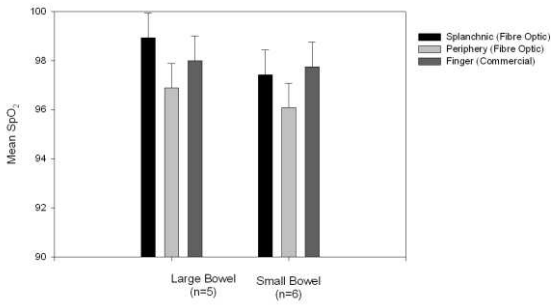

Fig. 3. Mean SpO_2 values for the large bowel and small bowel compared with simultaneous peripheral SpO_2 values acquired by the fibre optic sensor and the commercial pulse oximeter.

Conclusions

Good quality photoplethysmographic signals were obtained from all splanhnic sites in patients undergoing laparotomy. Preliminary splanchnic SpO_2 values are in good agreement with those obtained from a commercial pulse oximeter. These preliminary results suggest that the fibre optic sensor may be capable of providing a reliable means of estimating blood oxygen saturation. Further clinical trials are being conducted prior to further miniaturisation.

Acknowledgement

EPSRC

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