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Performance of a novel optical sensor for intraoperative assessment of intestinal viability – ‘proof of principle’ study

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Introduction. Objective assessment of intestinal viability during surgery will allow surgeons to make informed decisions on the safety of intestinal anastomosis and to predict anastomotic related complications (1). We investigated the performance of a novel dual sensor incorporating two established methods – photoplethysmography (PPG) and laser Doppler flowmetry (LDF) in a ‘proof of principle’ study.

Methods. Using the new probe, infrared and red PPG amplitude and LDF flux of the bowel surface were recorded by LDF and PPG simultaneously in 30 patients undergoing large bowel resection with or without anastomosis. Each patient had measurements at eight different time points: before and after colonic mobilisation, over the tumour, before and after ligation of major vascular pedicle, immediately before and after anastomosis (+/- 5 minutes) at distal and proximal limbs. . Both laparoscopic and open resectional cases were included. The differences between the mean amplitude and flux between different measurements were analysed.

Results. Twenty four laparoscopic and six open bowel resection cases had a total of 121 measurements recorded using the new probe. The mean IR AC amplitude in pre-ligation was 433 (± 189) mV and the mean IR AC in post ligation was 301 (± 152) mV. A statistically significant difference ($P=0.047$) was observed between pre-ligation and post-ligation for the mean infrared PPG amplitude (student’s t-test). A considerable difference in mean amplitude between pre and post ligation for the red PPG was also observed (the mean amplitude for the red PPG fell by -25.6%). The amplitude of the infrared PPG increased after anastomosis by 38.2% at the proximal site and by 37.8% at the distal site. The amplitude of the red PPG also increased after anastomosis (by 6.3%) at the proximal site although the equivalent increase was not seen at the distal site. The LDF measurements did not follow the same pattern of the changes seen in PPG amplitude.

Conclusion. The preliminary results show that simultaneous PPG/LDF measurements from a combined sensor is feasible and provide useful information on changes in pulse volume and blood flow. Although the differences in PPG amplitude achieved statistical significance, the LDF measurements produced confounding results, perhaps explained by motion artefacts. Further refinements in design of the probe are required to improve the probe-tissue optical interface and reduce motion artefact.

- (1) World J Gastrointest Surg 2011 May 27;3(5):59-69, How to assess intestinal viability during surgery: A review of techniques. Urbanavičius L et al.