Near infrared spectroscopy (NIRS) to monitor tissue haemoglobin (and myoglobin) oxygenation

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Introduction: Tissue oxygenation may be monitored noninvasively by near infrared spectroscopy (NIRS) both on the thenar eminescence (muscle) and on the forehead (brain). Thenar measurement have been used to guide therapy in trauma patients (1) and to determine the prognosis of septic patients (2). The cerebral measurements have been shown beneficial in managing patients at risk of cerebral ischemic injury (3), e.g. during cardiopulmonary bypass (4). Up to now no information exists on the value of NIRS monitoring during general surgery. Tissue oxygenation may be jeopardized during high-risk surgery, particularly in high-risk patients. We compared intraoperative tissue oxygenation obtained in high and low risk patients undergoing high and low risk surgery.

Methods: NIRS is based on the fact that oxygenated and desoxygenated hemoglobin (and myoglobin) have different absorption spectra of near infrared light (700-950 nm). These can be determined at distinct wavelengths by several commercially available NIRS devices such as InSpectra (muscle), Invos and Foresight (both cerebral). In our study, tissue oxygenation was measured intraoperatively on the thenar eminescence by near infrared spectroscopy (StO_2, InSpectra, Hutchinson Tech.) in a total of 152 patients. Patients were stratified as high risk (HRP, ASA status $\geq$III, age >65yr, n=82) or low risk patients (LRP, ASA status $\leq$II, age <65yr, n=70) and to receive high risk (HRS, tumor surgery, n=121) or low risk surgery (LRS, kidney transplantation n=31). We defined a cut-off StO_2 value of 80% to separate normal tissue oxygenation ($StO_2 \geq 80\%$) from tissue hypoxia ($StO_2 < 80\%$).

Results: In cardiac surgical patients it has been shown that a protocol aimed at increasing cerebral oxygen supply restored cerebral oxygenation assessed by NIRS in 84% of cases (5). Similarly, the occurrence of StO_2 values below 50% increased the risk of cognitive dysfunction and prolonged hospital stay threefold (6). In our study, tissue hypoxia occurred in 39% of HRP and in 19% of LRP at any time during surgery (p<0.05, Wilcoxon test). The difference was even greater when looking at the occurrence of more severe forms of tissue hypoxia ($StO_2 < 70\%$): 8 vs. 3%, p<0.01. In addition, tissue hypoxia occurred significantly more often in HRS compared to LRS (19 vs. 6%).

Discussion: Tissue hypoxia occurs frequently in the intraoperative setting, particularly in high-risk patients undergoing high-risk surgery. In cardiac anaesthesia, where NIRS is more widely used, this technique may offer advantages in the prevention of cerebral hypoxia, e.g. during hypothermic circulatory arrest (7). Further studies should look at the impact of intraoperative tissue hypoxia as well as of therapeutic interventions on postoperative patients' outcome.

References:

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