

Report for Sargent Grant awarded in 2015 to R Peter Alston

23 September 2016

Title: Coronary sinus blood isoflurane concentration in patients undergoing heart surgery

Background

There is evidence from the systematic review and meta-analysis of randomised controlled trials that compared to total intravenous anaesthesia, a volatile anaesthetic technique administered to patients undergoing cardiac surgery is associated with a lower mortality and a lower incidence of adverse myocardial outcome. However, it is unclear what dose of volatile anaesthetic agent is required to obtain the optimal outcome. Indeed, the concentration of volatile anaesthetic agents such as isoflurane, in the myocardium when it is administered into the oxygenator during cardiopulmonary bypass (CPB) has never been measured in humans. One way to estimate the myocardial concentration would be to measure the concentration of isoflurane in the coronary sinus blood by sampling from a catheter that is routinely placed for delivering cardioplegia.

Aims

The primary aim of the study is to measure the isoflurane concentration in coronary sinus blood.

The secondary aims are to assess whether:

- the myocardial concentration of isoflurane had equilibrated with its arterial concentration before the aortic cross-clamp had been applied by comparing the difference in concentrations between the coronary sinus and arterial blood.
- oxygenator exhaust levels of isoflurane may be used to estimate coronary sinus venous blood concentrations.

Methodology

The study was undertaken by Ka Ting Ng during his Student Selected Component 4. At the initiation of CPB after insertion of coronary sinus catheter before aortic cross-clamping, blood samples were aspirated, followed by radial artery blood and analysed for isoflurane with gas chromatography and mass spectrometry. The oxygenator exhaust isoflurane level was measured continuously with an anaesthetic gas analyser and recorded at the time of blood sampling.

Results

Recruitment proved problematic as to obtain the combination of surgeon who used retrograde cardioplegia and anaesthetist who used isoflurane was uncommon. Indeed, 20 patients who were recruited were excluded from the study for this reason. At the outset, sampling of coronary sinus blood had expected to be from the pressure monitoring line of the retrograde cannula. However, this proved difficult and slow so sampling was undertaken by the surgeon from the main lumen of the cannula.

Twenty-three patients undergoing elective cardiac surgery administered with 1 - 2.5% isoflurane were recruited and enrolled into the study. The concentrations of isoflurane in arterial and coronary sinus blood were 87.7 ± 50.1 (mean \pm SD) and $73.0 \pm 42.9 \mu\text{g.mL}^{-1}$, respectively. There was a significant mean difference of $14.7 \mu\text{g.mL}^{-1}$ (95% CI: 6.7, 22.8) between coronary sinus and arterial isoflurane concentrations. Oxygenator exhaust isoflurane levels were positively correlated with those in coronary sinus ($r = 0.68$, $p < 0.001$) and arterial blood ($r = 0.72$, $p < 0.001$).

Discussion

To our knowledge, this is the first study to sample and measure coronary blood for isoflurane concentration in patients undergoing cardiac surgery with CPB. There was a moderate correlation between oxygenator exhaust and coronary sinus isoflurane concentrations suggesting that it could be used as monitor of myocardial concentrations. However, as the coronary sinus concentration had not equilibrated with that in the arterial blood by the time of application of the aortic cross-clamp, suggesting that it is not an accurate estimate of myocardial concentration of isoflurane.

Conclusion

Coronary sinus blood can be sampled and measured for isoflurane concentration. Moreover, the coronary sinus isoflurane concentration could be estimated from those in the oxygenator exhaust gas. However, the coronary sinus isoflurane concentration probably does not accurately represent its level in the myocardium before the aortic cross-clamping during cardiopulmonary bypass.

• Presentations and publications

- The study was reported by Ka Ting Ng as scientific presentations at the following meetings
 - Edinburgh & East of Scotland Society of Anaesthetists, Bruntsfield Hotel, Edinburgh EH10 4HH, 1st March 2016.

- Royal Society of Medicine Anaesthesia Section Student Essay Prize; 1 Wimpole Street, London W1G 0AE, 3rd June 2016. Best Trainee Prize.
- European Association Cardiothoracic Anaesthesiology 31st Annual Congress 2016, Basel Switzerland, 11th May 2016.
- The study was reported on behalf of Ka Ting Ng by R Peter Alston at the 16th World Congress of Anaesthesiologists, Hong Kong, 29th August 2016.
- Abstract from EACTA Annual Congress published as Ting Ng K, Alston RP: Coronary sinus blood isoflurane concentration in patients undergoing heart surgery. *J Cardiothorac Vasc Anesth.* 30:S1-S2, 2016.
- A full paper reporting the study is in the final stages of preparation and will be submitted to *Anaesthesia* for publication.