Journal of Clinical Anesthesia 40 (2017) 127–138

Contents lists available at ScienceDirect

Journal of Clinical Anesthesia

Review

Inhalation versus intravenous anaesthesia for adults undergoing on-pump or off-pump coronary artery bypass grafting: A systematic review and meta-analysis of randomized controlled trials

Regina El Dib [a,b,c,*], José E. Guimarães Pereira [b], Arnav Agarwal [d], Huda Gomaa [e], Ana Patricia Ayala [f], Andresa Graciutti Botan [a], Leandro Gobbo Braz [b], Luciane Dias de Oliveira [a], Luciane Cruz Lopes [g], Preethy J. Mathew [h]

[a] Institute of Science and Technology, Unesp - Univ Estadual Paulista, São Paulo, São José dos Campos, Brazil
[b] Department of Anaesthesiology, Botucatu Medical School, Unesp - Univ Estadual Paulista, São Paulo, Botucatu, Brazil
[c] McMaster Institute of Urology, McMaster University, Hamilton, Ontario, Canada
[d] Faculty of Medicine, University of Toronto, Toronto, Canada
[e] Department of Pharmacy, Tanta Chest Hospital, Tanta, Egypt
[f] Gerstein Science Information Centre, University of Toronto, Toronto, Canada
[g] Pharmaceutical Science Graduate Course, University of Sorocaba, São Paulo, Brazil
[h] Department of Anaesthesia and Intensive Care, Post Graduate Institute of Medical Education and Research, Chandigarh, India

ARTICLE INFO

Article history:
Received 1 April 2017
Received in revised form 3 May 2017
Accepted 20 May 2017

Keywords:
Inhalation anaesthesia
Intravenous anaesthesia
On-pump
Off-pump
Coronary artery bypass grafting
Grade
Systematic review
Randomized controlled trials

ABSTRACT

Study objective: To compare the use of inhalation versus intravenous anaesthesia for adults undergoing on-pump or off-pump coronary artery bypass grafting.
Design: A systematic review.
Setting: A hospital-affiliated university.
Measurements: The following databases were searched: the Cochrane Central Register of Controlled Trials (CENTRAL 2016, Issue 10), MEDLINE, EMBASE, and LILACS (from inception to October 2016). We used the GRADE approach to rate overall certainty of the evidence.
Results: In total we included 58 studies with a total of 6105 participants. The methodological quality was difficult to assess as it was poorly reported in 35 included studies (three or more domains were rated as unclear risk of bias). Two trials of sevoflurane showed a statistically significant reduction in death within 180 to 365 days of surgery (on-pump) (RR 4.10, 95% CI 1.42 to 11.79; $p = 0.009$; I^2 = not applicable; high quality of evidence). There was also a statistically significant difference favouring sevoflurane compared to propofol on both inotropic (RR 2.11, 95% CI 1.53 to 2.90; $p < 0.00001$; $I^2 = 0\%$) and vasoconstrictor support needed (RR 1.51, 95% CI 1.04 to 2.22; $p = 0.03$; $I^2 = 0\%$) after coronary artery bypass grafting on-pump. Two trials of sevoflurane (MD −0.22, 95% CI −0.41 to −0.03; $p = 0.02$; $I^2 = 0\%$) and two further trials of desflurane (MD −0.33, 95% CI −0.45 to −0.20; $p < 0.00001$; $I^2 = 82\%$) showed a statistically significant difference on cardiac index during and after coronary artery bypass grafting on-pump, respectively.
Conclusions: There is high quality evidence that sevoflurane reduces death within 180 to 365 days of surgery and, inotropic and vasoconstrictor support compared to propofol for patients undergoing coronary artery bypass grafting. There is also some evidence showing that the cardiac index is minimally influenced by administration of sevoflurane and desflurane compared to propofol.

Contents

* Corresponding author at: Institute of Science and Technology, Department of Biosciences and Oral Diagnosis, Unesp - Univ Estadual Paulista, Av. Eng. Francisco José Longo, 777 - Jardim São Dimas, SP, P.O. Box 12245-000, São José dos Campos, Brazil.
E-mail addresses: eldib@fmb.unesp.br, eldib@ict.unesp.br (R. El Dib).

http://dx.doi.org/10.1016/j.jclinane.2017.05.010
0952-8180/

1. Introduction

Inhalation anaesthetics such as isoflurane, desflurane and sevoflurane have been shown to depress myocardial contractility in animal and human studies [1], and their haemodynamic effects have been observed in humans with or without heart disease [2]. There is also evidence to suggest that inhalational anaesthetics may have cardioprotective properties [3]. Two reviews of the MEDLINE and Science Citation Index databases, respectively, reported that sevoflurane and desflurane reduce biomarker of cardiac injury in the postoperative period and that sevoflurane improves long-term outcomes [4,5]. Furthermore, a systematic review comparing inhalational with intravenous anaesthesia for coronary artery bypass grafting surgery found that the use of volatile agents was associated with lower serum troponin I concentrations (indicating a potential reduction in cardiac injury) and also a reduced length of hospital stay [6].

Several experimental studies using a variety of protocols have shown that anaesthetic agents protect against ischemia and reperfusion injury [7–10]. Several groups have reported that inhalational anaesthetics confer organ protection through this mechanism, and it has been proposed that there are similarities between pharmacological preconditioning afforded by halogenated anaesthetics and ischemic preconditioning [11].

The outcome of this review is expected to yield information to help clinicians decide the anaesthetic plan that may benefit public health at large. As the extent of cardioprotection is influenced by the choice of anaesthetic agent, identifying the best approach for patients undergoing on-pump or off-pump coronary artery bypass grafting reduces complications and costs. Therefore, we verified the efficacy and safety of intravenous versus inhalation anaesthesia in decreasing mortality and morbidity for adults undergoing on-pump or off-pump coronary artery bypass grafting.

2. Materials and methods

The Cochrane Handbook for Intervention Reviews [12] guided our choice of methods. This systematic review of the literature on interventional studies was conducted in accordance with the PRISMA (Preferred Reposting Items for Systematic Reviews and Meta-analysis) statement [13].

2.1. Eligibility criteria

We considered all RCTs evaluating inhalation anaesthesia (e.g. sevoflurane, isoflurane, desflurane, enflurane) compared to intravenous anaesthesia (e.g. propofol, fentanyl) in adults (aged 18 years old and above) undergoing on-pump or off-pump coronary artery bypass grafting, regardless of gender. We excluded participants having valve surgery and those who had central neuraxial blockade.

Eligible studies reported one or more of the following: a) death within 24 h of surgery; b) death within 30 days of surgery; c) death within 180 to 365 days of surgery; d) renal insufficiency from the date of randomization, measured by neutrophil gelatinase-associated lipocalin (NGAL), 'Risk, Injury, Failure, Loss, End-stage' kidney disease (RIFLE), creatinine, cistatin or other; e) cardiac depression measured by haemodynamic variables and/or by vasoactive drugs (e.g., noradrenaline) or inotropic (e.g., dopamine, adrenaline); f) intraoperative awareness (as subsequently reported by the participant); g) length of stay in both hospital and intensive care unit and; h) adverse postoperative outcomes such as:

- pneumonia, defined as an acute or chronic disease marked by inflammation of the lungs determined by clinical examination or x-ray, or both;
- stroke, defined as a sudden loss of brain function measured by magnetic resonance imaging (MRI) or computed tomography (CT);
- acute renal failure, defined as the inability of the kidneys to excrete waste measured by the RIFLE classification [14] or Acute kidney injury Network (AKIN) criteria [15] or other biomarkers such as NGAL, interleukin 18 and kidney injury molecule-1;
- arrhythmia, defined as any abnormality in the rhythm of the heart measured by electrocardiogram or echocardiography;
- nausea and vomiting measured by frequency and severity;
- pain measured by any validated tool such as the visual analogue scale (VAS);
- brain injury measured by the cerebral performance category (CPC) or other equivalent validated scales;
- heart failure, defined as the inability of the heart to pump blood, measured by clinical signs, X-ray, electrocardiogram or echocardiography;
- myocardial infarction, defined as sudden chest pain, shortness of breath,