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Research Article

Effect of esmolol infusion on myocardial oxygen consumption during extubation and quality of recovery in elderly patients undergoing general anesthesia: randomized, double blinded, clinical trial



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KEYWORDS

Esmolol;
Myocardial oxygen consumption;
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Quality

Abstract *Background:* Upon recovery from anesthesia and during extubation, there will be mechanical stimulation of receptors in the respiratory tract that results in both respiratory and cardiovascular reflex responses. Heart rate plays a major determinant of myocardial oxygen consumption and cardiac workload, so decreasing the heart rate will increase the ischemic threshold and improve the cardiac performance.

Objective: To evaluate the effect of esmolol infusion on myocardial oxygen consumption during extubation and quality of recovery in elderly patients undergoing general anesthesia.

Methods: Hundred adult patients ASA I & II scheduled for elective open unilateral inguinal hernia were randomized, double-blindly into one of two parallel groups, esmolol group (E) ($n = 50$) and control group (C) ($n = 50$). In the esmolol group, 1 mg/kg esmolol was given as bolus over 30 s then followed by a continuous esmolol infusion of 100 $\mu\text{g}/\text{kg}/\text{min}$ starting 10 min before end of surgery till 5 min after extubation. While patients in group C received normal saline bolus of the same volume followed by a continuous normal saline infusion of the same volume per hour as group E. Mean heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean blood pressure (MBP), rate pressure product (RPP), anesthesia time, recovery time, postoperative nausea & vomiting, number of doses of antiemetic agent and quality of extubation were recorded.

Results: The results showed that patients in the esmolol group had lower values of (RPP) after esmolol infusion with statistically significant difference when compared with patients in the control

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group using unpaired *t*-test ($P < 0.05$), this will decrease oxygen consumption in esmolol group. Also, there was statistically significant difference between both groups regarding values of HR (beat/min), SBP (mmHg), DBP (mmHg) and MBP (mmHg) starting 2 min after esmolol infusion and continued till 10 min after extubation using unpaired *t*-test ($p < 0.05$). As regards PONV, there was lower incidence in esmolol group when compared to control group using unpaired *t*-test with statistically significant difference ($P < 0.05$).

Conclusions: Esmolol is a safe, effective and well-tolerated drug that can be used in elderly patients undergoing general anesthesia to reduce the myocardial oxygen consumption and improve the quality of recovery.

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1. Introduction

Upon recovery from anesthesia and during extubation, there will be mechanical stimulation of receptors which present in the larynx, trachea and bronchi. Stimulation of these receptors results in both respiratory and cardiovascular reflex responses [1]. Respiratory responses can be in the form of straining at aspiration, coughing, breath holding, or laryngospasm. However, the cardiovascular responses can be in the form of transient tachycardia, transient hypertension, arrhythmias, myocardial ischemia or infarction [2].

The hemodynamic changes can be explained by sympathetic overactivity during extubation which will lead to increased serum level of epinephrine and nor-epinephrine that results in tachycardia and hypertension. These hemodynamic changes can be well tolerated in healthy individuals but will have deleterious effects in patients with coronary artery disease, hypertension and cerebrovascular diseases [3].

In elderly patients, due to change in vascular elasticity, the hemodynamic changes associated with extubation are more likely to be exaggerated and may lead to increase oxygen consumption that results in myocardial ischemia and arrhythmia [4].

Myocardial ischemia occurs due to imbalance between myocardial oxygen supply and oxygen demand. Heart rate plays a major determinant of myocardial oxygen consumption and cardiac workload, so decreasing the heart rate will increase the ischemic threshold and improve the cardiac performance [5]. Myocardial ischemia is variable throughout the entire perioperative period, but it was found that postoperative myocardial ischemia occurs more often than preoperative (approximately 3:1) and intraoperative ischemia (approximately 5:1) [6].

Studies showed that postoperative myocardial ischemia can be used as a reliable predictor for in-hospital and long-term cardiac morbidity and mortality [7]. Because of myocardial oxygen consumption is difficult to be measured directly and the rate pressure product (RPP) index was found to correlate strongly with myocardial oxygen consumption, so RPP index can be used for estimation of myocardial oxygen consumption as it is easily measurable parameter [8].

Rate pressure product (RPP) is the product of systolic blood pressure (SBP) by heart rate (HR) and used for observation of myocardial oxygen consumption. It increases when myocardial oxygen requirements or consumption exceeds myocardial oxygen supply [9].

Many pharmacological agents have been used to control the hemodynamic changes during tracheal extubation with varying

success rate such as local anesthetics, opioids, beta-blocking agents, and calcium channel blockers [10,11]. Among all these drugs β -adrenoceptor antagonists can be considered the only well-established prophylaxis against myocardial ischemia that demonstrates a reduction of patient morbidity and mortality [12]. Esmolol is an ultra-short acting cardioselective β_1 -receptor antagonist with half-life approximately 2 min and peak effect about 6–10 min. Because of these pharmacokinetic characteristics usually esmolol is used as a loading dose followed by continuous infusion [13]. It has been used for prevention and treatment of intra-operative and postoperative tachycardia and hypertension. Also, it has been reported to decrease plasma catecholamine levels and preventing hemodynamic changes during intubation, laryngoscopy and extubation [14].

The goal of this study was to evaluate the effect of esmolol infusion on myocardial oxygen consumption during extubation and quality of recovery in elderly patients undergoing general anesthesia.

2. Patients and methods

2.1. Study groups

After getting approval from the ethical committee of Dallah Hospital, Riyadh, Saudi Arabia, written informed consents were taken from all patients before entry into the study. This study was conducted on hundred (100) old adult male and female patients American Society of Anesthesiologist (ASA) physical status I–II, scheduled for elective open unilateral inguinal hernia repair during the period from May 2013 to April 2014, those patients were enrolled into one of two randomized, double-blind, controlled parallel group study using sequentially numbered, sealed, opaque envelopes.

Patients with uncontrolled systemic diseases (e.g. diabetes mellitus, asthma and chronic obstructive lung disease), significant organ dysfunctions (e.g. cardiac, respiratory, renal or liver disorders), morbid obese (BMI > 40), non-smokers, history of allergy to the drugs used, use of β -blockers or calcium channel blockers, chronic use of opioids or non-steroidal anti-inflammatory drugs, history of postoperative nausea & vomiting (PONV) or motion sickness were excluded from the study.

Patients were randomly divided into two groups, Esmolol group (group E $n = 50$) and Control group (group C $n = 50$). All patients were premedicated orally with bromazepam (3 mg) and ranitidine (150 mg) 1–2 h preoperatively. Ten minutes before end of surgery till five minutes after extubation, group E patients will receive unknown solution (A), while

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