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Esmolol hypotension maintains tissue perfusion during myomectomy judged by Masimo monitoring of regional cerebral oxygen saturation and pleth variability index

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ABSTRACT

Objectives: To evaluate outcome of elective abdominal myomectomy under esmolol hypotensive anesthesia (HA) compared to normotensive anesthesia (NA).
Methods: Patients were randomly divided into NA Group received NA and HA Group received esmolol (0.5 mg/kg) bolus then infusion (0.05–0.3 mg/kg/min) to maintain mean arterial pressure at 60–70 mmHg till completion of myomectomy. Masimo Radical 7 was used to monitor regional cerebral oxygenation (rSO_2), total hemoglobin (Hb.) and pleth variability index (PVI). Fluid therapy (FT) included initial bolus of 5% human plasma protein followed by intraoperative (IO) Lactated Ringer's (LR) solution. Amount of IO blood loss, blood transfusion and urine output (UOP) were determined. Postoperative (PO) Hb. conc. was measured at laboratory (Lab).
Results: IO blood pressure was significantly lower, while PVI was significantly higher with significantly lower ΔPVI with HA than NA. Operative time was significantly shorter with significantly less IO blood loss and blood transfusion with HA. Regional cerebral and peripheral tissue oxygen saturations showed non-significant difference between both groups. PO Masimo measured and Lab estimated Hb. was significantly higher with significantly lower ΔHb% in HA than NA group. Masimo measurement was significantly higher with significantly lower ΔHb% than lab estimation in both groups. Patients of NA group received significantly greater amount of LR, but UOP was non-significantly higher than in HA group.
Conclusion: Esmolol HA allowed better control of IO bleeding, blood transfusion and FT. Masimo continuous monitoring of rSO2 assured preserved cerebral perfusion. Masimo measured PVI could non-invasively monitor tissue perfusion.

1. Introduction

Uterine fibroids are common benign neoplasms [1] that can significantly impact woman's health [2]. Myomectomy is the gold standard uterine-sparing surgery [2] but may be associated with excessive bleeding [3]. Hypotensive anesthesia significantly decreases blood loss with no significant changes in organ functions [4] and significantly reduces transfusion requirements [5].

Esmolol is cardioselective short-acting β blocker [6] that so it is highly effective in prevention and treatment of perioperative tachycardia [7]. Esmolol was administered as intermittent intravenous boluses or continuous infusion [8]. Low dose induces vasodilation thus provide cardiac safety [9] but require continuous monitoring [10].

2. Aim of work

Evaluation of outcome of elective abdominal myomectomy under esmolol hypotensive anesthesia (HA) compared to normotensive anesthesia (NA).

3. Setting

Tertiary referral hospital, KSA.

4. Design

Prospective comparative study.

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5. Methods and materials

The current study was conducted since Jan 2014 until March 2016. The study protocol was approved by the Local Ethical Committee. The study intended to include women assigned for myomectomy. Women with multiple myomas necessitating hysterectomy, suspected or proven gynecological malignancy, history of cardiac, renal, hepatic diseases, and history of endocrinopathy or coagulopathy were excluded from the study. All enrolled women signed a fully informed written consent for study participation. Clinical evaluations entail collection of demographic data including age and body mass index data. All patients underwent routine laboratory investigations including complete blood count.

6. Randomization & grouping

Patients fulfilling the inclusion criteria were randomly allocated into two equal study groups according to the applied anesthetic procedure. Randomization was conducted using sealed envelops prepared by an assistant blinded about target for each group and envelops were chosen by patient herself. Studied groups are Group NA, which included patients assigned to receive normotensive anesthesia and Group HA, which included patients, assigned to receive hypotensive anesthesia.

7. Anesthetic procedure

All patients were premedicated by midazolam 0.02 mg/kg; anesthesia was induced using propofol 2 mg/kg, fentanyl 1–2 ug/kg, and rocuronium 0.6 mg/kg. For both groups, balanced anesthesia was continued with sevoflurane, fentanyl and rocuronium adapted to the patient's physiological reaction to surgical stimuli. After intubation of the trachea, the lungs were ventilated with 100% O_2 using a semi-closed circle system. For group HA, esmolol 0.5 mg/kg diluted in 10 ml of 0.9% normal saline was given as an intravenous bolus followed by esmolol (Esmolol hydrochloride 100 mg/10 ml, Baxter Healthcare Corporation, Deerfield, USA) infusion at rate of 0.05–0.3 mg/kg/min to maintain MAP of 60–70 mmHg until myomectomy was completed. Then, esmolol infusion was stopped to allow restoration of blood pressure so that perfect hemostasis could be achieved. For both groups, ventilation was controlled with a tidal volume of 6–8 ml/kg, and the ventilatory rate was adjusted to maintain an end-tidal carbon dioxide ($ETCO_2$) of 30–35 mmHg. Patients were continuously monitored for electrocardiogram, non-invasive arterial blood pressure (SBP, DBP and MAP), heart rate (HR) and temperature.

The O3 Rad sensor was applied to patient's forehead for continuous monitoring of regional cerebral oxygen saturation (rSO_2). Also O3 monitoring provides ΔSpO_2 defined as the difference between forehead and finger O_2 saturation calculated as SpO_2 minus rSO_2. The sensors were connected to O3 MOC-9 module); the module was connected to one of the Root of MOC-9 ports. Masimo Radical 7 finger pulse oximeter device was equipped with a software ver. 7.8.0.1 (Masimo Corp., Irvine, CA, USA) for continuous non-invasive measurement of total hemoglobin (SpHb), SpO_2, perfusion index (PI) which is the ratio of non-pulsatile to pulsatile blood flow through the peripheral capillary bed [11]. Pleth variability index (PVI) which is an automatic measure of the dynamic change in PI that occurs during the respiratory cycle and equals PI (maximum-minimum) divided by PI maximum; PVI helps to predict fluid responsiveness [12]. ΔPVI was calculated as PVI measured at 30-min, 60-min and immediate postoperative (PO) minus baseline PVI.

8. Fluid therapy targets and policies

Both groups received an initial bolus of human plasma protein (5%; Octapharma, Octapharma AG, Switzerland) in a dose of 5 ml/kg over 15–20 min and Lactated Ringer's (LR) solution in a dose of 5 ml/kg/h throughout operative time. Intraoperative supplemental fluid therapy consisted of additional blouses of LR according to the target of each study group. The target for group HA to maintain MAP in range of 60–70 mmHg and mean arterial blood pressure (MAP) ≥75 mmHg in group NA around the post-induction MAP so as to get urine output (UOP) > 0.5 ml/kg/h for both groups.

9. Evaluated parameters

1. IO blood loss was calculated as the sum of the amount of blood collected in the suction canister and the calculated net weight of gauze swabs.
2. At end of surgery, blood sample was obtained for immediate PO estimation of hemoglobin concentration. In addition, hemoglobin concentration measured by Masimo was recorded. Hemoglobin deficit for both estimation modalities was calculated versus the preoperative concentration.
3. The frequency of the need and amount of intra and postoperative blood transfusion. Blood loss of ≥20% of patient's estimated blood volume was replaced by blood transfusion in 1:1 ratio.
4. Calculated amount of Urine output (UOP).

10. Statistical analysis

Sample size was calculated using the standard nomogram proposed by Kraemer & Thiemann [13] and a sample size of ≥40 patients per group was determined to be sufficient to detect a difference at the 5% significance level and give the trial 80% power [14]. Sample size and power were re-calculated and assured using Power and Sample Size Calculation Software program provided by Department of Biostatistics, Vanderbilt University. Obtained data were presented as mean ± SD, ranges, numbers and ratios. Results were analyzed using Student *t*-test and Chi-square test (X^2 test). Statistical analysis was conducted using the SPSS (Version 15, 2006) for Windows statistical package. P value < 0.05 was considered statistically significant.

11. Results

The study included 86 patients with mean age of 34.9 ± 7; range: 24–44 years and mean BMI 29.6 ± 2.5; range: 23.4–37.2 kg/m^2 with non-significant ($p > 0.05$) difference between both groups. Intraoperative (IO) blood pressure and heart rate measures were significantly lower in patients of group HA compared to patients of group NA. Details of IO hemodynamic findings are shown in Table 1.

Despite of induced hypotension in group HA, arterial blood oxygenation was non-significantly ($p > 0.05$) lower compared to patients who received normotensive anesthesia throughout duration of surgery. Details of regional cerebral and peripheral arterial blood oxygen saturation data are shown in Table 2.

Intraoperative PVI measurements were significantly lower compared to baseline PVI measurements for both groups. PVI was significantly higher with significantly lower ΔPVI in group HA compared to group NA. Immediate PO PVI was non-significantly higher, but ΔPVI was significantly lower with HA than with NA. Details of PVI measurement are shown in Table 3.

Hypotensive anesthesia was associated with significantly lower IO blood loss with and significantly shorter operative time than NA. Masimo measured Hb. Conc. was significantly higher than laboratory estimated Hb. Conc. in both groups. At end of surgery Masimo and laboratory estimated Hb. conc. was significantly lower than preoperative measures with significantly lower measures but significantly higher ΔHb% in NA group than in group HA. Patients of group NA received significantly greater amount intraoperative LR solution compared to patients of group HA. Details of operative findings are showed in Table 4