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ORIGINAL PAPER

Effect of Preoperative Volume Loading on the Intraoperative Variability of Blood Pressure and Postoperative Nausea and Vomiting

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Introduction: Preoperative volume loading (PVL) in addition to counteract the decreases in blood pressure during intraoperative period, also may decrease postoperative nausea and vomiting (PONV). This study was designed to investigate the effect of preoperative volume loading on the intraoperative blood pressure variability and postoperative nausea and vomiting. **Methods:** Thirty subjects scheduled for elective orthopedic procedures randomly divided into case and control groups. The patients in the case group received lactated Ringer 10 ml/kg before induction of general anesthesia. Mean arterial blood pressure (MAP) and heart rate were recorded in two groups every 3 minutes from induction of anesthesia until five minutes after extubation. Variability of mean arterial blood pressure and heart rate were defined as the standard deviation (SD) of the measured values for each patient. Means of these individual SD values were compared between two groups using Mann-Whitney U test. **Results:** The mean variability of mean arterial blood pressure and heart rate ware significantly lower in case group (8.3 ± 3 mmHg and 8.4 ± 2.5 bpm vs. 13 ± 6 mmHg and 11 ± 2.6 bpm in control group; $p < 0.5$). The severity of nausea (measured as a ten-point visual analog scale) was significantly lower in case group (1.2 ± 0.9 vs. 3.9 ± 1.8 in control group; $p < 0.05$). No patients in case group developed postoperative vomiting (compared to 5 patients in control group). **Conclusions:** The results of this study shows that preoperative volume loading is associated with lower variability of blood pressure and heart rate during operative period and also reduces the severity and incidence of postoperative nausea and vomiting. **Key words: Preoperative volume loading, blood pressure, nausea, vomiting.**

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1. INTRODUCTION

Post-operative nausea and vomiting (PONV), although is not life threatening, is an important anesthesia and surgery complication (1). The complication of PONV may range from patient discomfort to pulmonary aspiration (2). The incidence of PONV has been reported to be widely varied from 20 to 92% (2). Certain patients are at increased risk for the development of PONV (including obese, diabetic, and pregnant) which necessitate the prophylaxis against it (3, 4).

A lot of studies have been performed to evaluate the effectiveness of different drugs and techniques to prevent PONV. Drugs such as anticholinergics, dopaminergics, antihistamines, steroids, neuroleptics, and serotonin antagonists have been used with variable effectiveness (5, 6, 7, 8, 9, 10, 11, 11). Still, PONV has remained a common postoperative complication. It is likely that due to multiplicity of receptors in chemoreceptor trigger zone, a single drug may not be effective for preventing PONV (1, 2). On the other hand, combination of multiple drugs may be clinically infeasible and associated with major side effects. Therefore, researches into the problem still have its merits and searches for pharmacologic and non-pharmacologic alternatives with lower complications and cost are continued.

Hypovolemia and intraoperative hypotension has documented role for the development of PONV (12, 13). Intraoperative hypotension may be due to anesthetic drugs (14), surgical factors, preexisting cardiovascular disorders, and autonomic dysfunction. Pusch et al (15, 16) have shown that variation of systolic blood pressure of more than 35% during induction of anesthesia is associated with increased incidence of PONV. Functional status of vestibular apparatus and vomiting center perfusion in brain stem may compromise during hypotensive state (15). In addition, hypovolemia may exaggerate the hypotensive effects of anesthetics and narcotics. Hypo perfusion of enteric mucosa may lead to the development of abnormal pH and mucosal ischemia which lead to release of mediators such as serotonin during hypotension. These ischemic mediators may play important roles for the development of PONV (12).

In previous studies, the effects of hy-

povolemia and hypotension on PONV have been evaluated. The present study was designed to investigate the effect of preoperative volume loading on the intraoperative variation of blood pressure and incidence of PONV in a sample of adult patients undergoing anesthesia for orthopedic surgery.

2. METHODS

After institutional approval and informed written patient consent, 30 non-smoking adult patients in class I-II of American Society of Anesthesiologists (ASA) scale who were scheduled for elective orthopedic procedures on the limbs were included in the study. Patients with the history of motion sickness and those in whom tourniquet application was mandatory during the procedure were excluded from the study. Random Allocation Software (17) was used to produce a simple randomized list of two equal groups (2 × 15).

Patients in the case group received a loading volume of 10 ml/kg Ringer solution in 20 minutes, and those in the control group rested for the equivalent period of time on the operating room prior to the induction of anesthesia. No patient received antiemetic medication prior to the anesthesia induction. The baseline arterial blood pressure (systolic, diastolic, and mean) and heart rate were recorded before induction of anesthesia and after establishment of monitoring systems (pulse oxymetry, electrocardiography (ECG), non-invasive blood pressure measurement and end-tidal CO_2).

Anesthesia was induced using sodium thiopental 5 mg/kg, atracurium 0.6 mg/kg, and fentanyl 2 μg/kg followed by tracheal intubation. Anesthesia was maintained with halothane 1% and 50% N_2O in O_2. At the end of the procedure, residual muscle relaxation was reversed with prostigmine 0.04 mg/kg and atropine 0.02 mg/kg and the patient was extubated after return of the protective airway reflexes. Thereafter, patients were transferred to the recovery room and received supplemental O_2 via an oxygen mask.

Heart rate and mean arterial blood pressure were measured every 3 minutes throughout the surgical procedure until 5 minutes after extubation. In the recovery room and in the surgical ward, the patient was asked for the presence of nauseas and its severity based on a ten-point visual analog scale (VAS). In addition, total number of vomiting episodes and the amount of consumed antiemetic drug given (metoclopramide) were recorded. Patients were given metoclopramide if the severity of nausea, as stated by the patient, was greater than 4 on VAS.

2.1. Statistical Analysis

For each subject, the variation of heart rate and mean arterial blood pressure were calculated as percent coefficient of variation (PCV).

Maximum and minimum values for variations also were recorded.

Data were expressed as mean ± SD or n (%) where appropriate. Means of PCVs, nausea VAS, episodes of vomiting, and amount of administered metoclopramide were compared between two groups using Mann-Whitney U test. Frequency data were compared between two groups using Fisher's Exact test. Pearson correlation analysis was used to determine the relationship between variation in blood pressure or heart rate in one hand and severity of nausea, episodes of vomiting, and amount of metoclopramide the other hand. Correlation coefficients of two groups were compared after Z-transformation of individual coefficient values and following the method stated by Cohen (18). A p-value < 0.05 was considered as statistically significant. Data were analyzed on a computer using $SPSS_{10.0}$ (version 10.0, SPSS Inc., Chicago, IL) software.

3. RESULTS

A total of 30 patients were studied. No patient was lost to follow-up. All patients were the same sex (male). Two groups were comparable with respect to age, weight, height and other baseline data (Table 1).

PCVs for the heart rate and mean arterial blood pressure were significantly lower in case compared to control group (Table 2).

Postoperative nausea or vomiting occurred totally in 32% of the patients (26.6% in case and 73% in control group; p < 0.05). No patient in case group developed postoperative vomiting and therefore no one received metoclopramide. Therefore no statistical analysis was applicable with respect to episodes of vomiting or amount of administered metoclopramide. In control group, the episodes of vomiting and metoclopramide usage were 0.33 ± 0.08 and 1.67 ± 0.28, respectively. Pearson correlation analysis showed a strong and significant positive relationship between PCVs of mean arterial blood pressure and heart rate in both groups; but this relationship was significantly stronger in case compared to control group (Table 3).

	Case	Control
Age (Year)	24 ± 14	25 ± 16
Weight (kg)	60 ± 17	62 ± 18
Height (cm)	167 ± 28	165 ± 31
ASA I	11 (73)	10 (67)
II	4 (27)	5 (33)
Blood Pressure (mmHg)		
Systolic	128 ± 18	126 ± 21
Diastolic	83 ± 8	81 ± 9
Mean	98 ± 12	97 ± 13
Hear Rate (/min)	83 ± 18	81 ± 19

Table 1. Comparison of demographic and baseline data between two groups Data are mean ± SD, or n (%) No significant differences between two groups. ASA: American Society of Anesthesiologists

	Case	Control
Heart Rate PCV (%)	9.2 ± 1.7*	15.75 ± 2.5
MAP PCV (%)	8.6 ± 1.9†	17 ± 2.8
Nausea VAS	1.27 ± 0.15†	3.93 ± 1.1

Table 2. Comparison of variation in heart rate and mean arterial blood pressure (in terms PCV) between two groups Data are mean ± SD * P < 0.05, † P < 0.01 compared to control group PCV: Percent Coefficient of Variation as expressed by the formula in the methods; MAP: Mean Arterial Blood Pressure; VAS: Visual Analog Scale.

	Nausea VAS		
	Case	Control	Total
MAP PCV	0.8*†	0.51	0.7*
Heart Rate PCV	0.65*†	0.18	0.52*

Table 3. Correlation analysis of variations in intraoperative blood pressure and heart rate with postoperative nausea in two groups Data are correlation coefficients * P < 0.01 for correlation between nausea and PCVs, † P < 0.05 for comparison of correlation coefficients between two groups. PCV: Percent Coefficient of Variation as expressed by the formula in the methods; MAP: Mean Arterial Blood Pressure; VAS: Visual Analog Scale.

4. DISCUSSION

The purpose of this study was to determine the effect of preoperative volume loading on intraoperative variation of blood pressure and heart rate and also on the severity of PONV. The result of this study shows PONV is more frequent in volume preloaded patients. This is evident from low level of nausea VAS in volume preloaded patients. In addition, these patients have relatively lower levels of variation in intraoperative blood pressure and heart rate. Evidence for this is the low level of PCVs for blood pressure and heart rate in the volume preloaded patients and no occurrence of postoperative vomiting in the case group.

Previous studies reported the incidence of PONV from 20 to 92% (2). In the present study, the incidence of PONV was 32%. The incidence of PONV in volume preloaded patients was 26.6% and in control group 73% which is similar to the findings of Ali et al (12). Studies about the effect of preoperative volume loading on the incidence and severity of PONV have not evaluated simultaneously its effect on the variation in intraoperative blood pressure and also the effect of the later on PONV. These studies on the effect of preoperative volume loading on the incidence and severity of PONV have confirmed the finding of this study that preoperative volume loading decreases the incidence and severity of PONV. Usually, patients are hypovolemic prior to induction of anesthesia which can lead to reduced perfusion of gastrointestinal mucosal (12). The resulting ischemia may lead to PONV, intensified by the use of anesthetic drugs due to increasing sensitivity of efferent pathways of gastrointestinal tract. The later causes release of serotonin which is an important mediator for the development of PONV.

Pusch et al. (15) showed that a large fall in systolic blood pressure during induction of general anesthesia is associated with increased incidence of PONV.

In this study, variation of intraoperative heart rate and blood pressure has been strongly associated with increasing levels of postoperative nausea, which may be due to autonomic nervous system. In fact, disturbances of autonomic nervous system play an important role in the development of precursors of nausea and vomiting namely dizziness and vertigo (19). Both vagal and sympathetic stimulation can lead to increased incidence of PONV (2,20). Many preoperative factors including preoperative hypovolemia, surgical stimulation, pain, and anesthetic drugs can cause an imbalance in the activity of autonomic nervous system.

Preoperative volume loading can be associated with more stability of cardiovascular system and better perfusion of gastrointestinal mucosa which prevent liberation of mediators and reduction of PONV.

Conflict of interest: none declared.

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