Hemodynamıc Effects And Emergence Tımes Of Desflurane, Sevoflurane And Propofol Infusıon In Laparoscopıc Gastrıc Bandıng

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Citation

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Abstract

Objective: Bariatric surgery is a widely used method for achieving sustained weight loss in severly obese patients. The aim of this study was to investigate the emergence times and hemodynamic changes during laparoscopic gastric bypass in morbid obese patients with different anaesthetic agents. Methods: After receiving local ethics commitee written consent, 60 morbid obese (BMI>35) patients aged 19-61 scheduled for elective laparoscopic gastric banding surgery and randomly allocated to 3 groups. Anesthesia induction was standart for all groups and maintained by TIVA 8-10 mg $kg^{-1}hr^{-1}$,6% desflurane and 2% sevoflurane in groups T, D and S respectively. Hemodynamic variables were measured and recorded before induction(A), after induction(B), before insuflation(C), 5 minutes after(D) and 15 minutes after insuflation of CO_2 (E). Emergence times are also recorded.Results: There was no significant difference between the baseline(A) hemodynamic variables among the groups ($p>0.05$). In group D, there is a statistically significant decrease in systolic arterial blood pressure (SABP) after induction(B) and before insuflation(C) compared to baseline values(A) ($p<.05$). There was no significant difference in emergence and in extubation times($p>0.05$). Conclusion: These findings showed us that desflurane, sevoflurane and propofol are ideally suited both for maintenance of anaesthesia in obese patients with stable hemodynamic variables and all groups had similar emergence times as measured by time to eye opening and extubation.

INTRODUCTION

The prevalence of obesity has markedly increased worldwide in the last years, not only in industrialized western countries but also in the developing countries. The prevalence of obesity has been reported to be about 37% in the United States, and almost 5% of the population are morbidly obese status(1). A BMI< 25 $kg.m^{-1}$ is considered normal, a BMI between 25 and 30 kgm^{-1} is considered overweight, patients with a BMI >30 $kg.m^{-1}$ or BMI >35 kgm^{-1} are defined as obese and morbid obese respectively(2).

Obesity is associated with many other conditions, some of which have important implications for the administration of anaesthesia. There is an increase in the frequency of chronic diseases such as diabetes mellitus, hypercholesterolemia, hypertensive heart disease, gastro-oesophageal reflux and cardiorespiratory complications e.g. obesity-hypoventilation sendrome, pulmonary arterial hypertension, obstructive sleep apne syndrome and right and left ventricular failure(3).

Morbid obesity is associated with reductions in functional residual capacity (FRC), expiratory reserve volume (ERV) and total lung capacity (TLC) (4). Oxygen consumption and carbon dioxide production are increased in the obese as a result of the metabolic activity of the excess fat and the increased workload on supportive tissues(5,6). Morbidly obese individuals usually have only a modest defect in gas exchange preoperatively with a reduction in PaO_2 and increases in alveolar-to-arterial oxygen difference and shunt fraction. These deteriorate markedly on induction of anaesthesia and high inspired fractions of oxygen are required to maintain adequate arterial oxygen tension(7). Reduced compliance is associated with a decrease in the FRC, encroachment on the closing volume and impairment of gas exchange(8,9).

Pharmacokinetics should also be given special consideration in obese patients. Obese patients have a smaller than normal fraction of total body water, greater than normal tissue content and increased blood volume, volume distrubition, and renal blood flow. Thus, drug distribution and effect may be different in this patient population and should be considered carefully before surgery. Desflurane has the lowest coefficient of the currently marketed anaesthetics and has been empricially favored as the volatile agent for morbid obese (MO) patients because of its presumed faster emergence profile. However, it has several cardiovascular and respiratory side effects related to its airway irritating properties(10). Sevoflurane also has a lower blood-gas solubility and a faster emergence profile and both sevoflurane and desflurane have markedly different respiratory and cardiovascular profiles that might influence morbidity in the MO patient(10).

Propofol is the second most extensively used intravenous anaesthetic. It is highly lipophylic drug with very fast onset and short, predictable duration of action because of its rapid penetration of the blood-brain barrier and distribution to the central nervous system, followed by rapid redistribution to inactive tissue depots, such as muscles and fat. Because of its favorable pharmacokinetic properties, propofol is also ideally suited for maintanance of total intravenous anesthesia(TIVA) and as there were no signs of propofol accumulation or of any prolongation of its duration, it is suitable for obese patients(11).

Remifentanil has an interesting charactheristic that; it is susceptible to hydrolysis by blood and tissue esterases, resulting in rapid metabolism to essentially inactive products. The clearence of remifentanil was similar in obese and nonobese patients(12). The Study of Egan et al(12) demonstrated that remifentanil pharmacokinetic parameters are more closely related to lead body mass, remifentanil dosing also should be based on IBW (12). Laparoscopy offers many advantages in comparison to open surgery, such as minimal tissue trauma, less postoperative pain, reduced postoperative complications, early mobilization, and rehabilitation(13). However, pneumoperitoneum, which is associated with increased abdominal pressure and CO2 absorbsion, and Trendelenburg position, which is required for certain types of surgery, may cause deterioration of the cardiovascular and respiratory functions in morbidly obese individuals(13).

The aim of this study was to investigate the emergence times as measured by time to eye opening and extubation and hemodynamic changes during laparoscopic gastric bypass in morbid obese patients with different anaesthetic agents.

MATERIAL AND METHOD

After receiving local ethics commitee written consent, 60 MO (BMI>35) Turkish patients aged 19-61 sheduled for elective laparoscopic gastric banding surgery. American Society of Anesthesiologists physical status II-III patients were randomized using a computer generated random number table to one of 3 equal groups. Group T received total intravenous anaesthesia (TİVA), Group D received desflurane, Group S recieved sevoflurane.

Exclusion criteria included: Adolecents and children less than 18 years of age, those with a history of coronary artery disease, myocardial infarction, congestive heart failure, chronic obstructive lung disease, drug abuse, history of malignant hypertermia, a positive pregnancy test, nursing mothers, cardiac ejection fraction of less than %30. The study took place at Ministry of Health Etlik Education and Research Hospital Anesthesiology and Reanimation Clinic.

A clinical research coordinator who was blinded to the anaesthetic agent and randomization process collected study data. Intravenous medications were dosed to ideal body weight and included midazolam 0.01 to 0.04 mg.kg^{-1} in all groups for premedication. The general anesthesia was induced with 2.5 mg.kg^{-1} propofol and a bolus dose of remifentanil 0.5-1 µg.kg^{-1} in all groups. Vecuronium bromide 0.1 mg.kg^{-1} was used for entubation of the trachea in all groups and anaesthesia was maintained by intravenous propofol (TIVA)8-10 mgkg^{-1}hr^{-1} and 6%desflurane and 2% sevoflurane in groups T, D and S respectively. Remifentanil infusion of 0.05-2 µg kg^{-1}min^{-1} was administered in all groups. Vecuronium bromide was administered in titrated doses to maintain adequate abdominal muscle relaxation in all groups.

Standard monitoring included (oxygen saturation [SpO2], electrocardiogram (EKG), end-tidal carbon-dioxide (ETCO2), indirect blood pressure (BP) for all patients. Systolic arterial blood pressure (SABP), diastolic arterial blood pressure (DABP), mean arterial blood pressure (MABP), heart rate (HR), ETCO2 and SpO2 was measured and recorded before induction of anaesthesia (A), after induction of anaesthesia (B), before insuflation of CO2 (C), 5 minutes (D) and 15 minutes after insuflation of CO2(E). The frequency of ventilation was increased from 12 to 14 before insuflation of CO2.

Upon completion of surgery and initiation of surgical closure, the anaesthetic provider decreased the inhalational agent to 0.5 MAC and turned it off (no inhalation agent delivered) simultaneously with the placement of the last closing suture(agent off) in groups D and S. In group T, propofol was decreased to 2 $mgkg^{-1}hr^{-1}$ and remifentanil was decreased to 0.05$\mu g\ kg^{-1}min^{-1}$ at the initiation of surgical closure and turned off with the placement of the last closing suture in all groups. In addition emetril (granisetron) (1 mg) was given to all patients for prophylaxis of postoperative nause and emesis. Intravenous contramal (tramadol) (1$mg.kg^{-1}$) was used approximately 15 minutes before the end of surgery to control early postoperative pain. Because morbidly obese patients are at risk for postoperative respiratory obstruction, all patients received reversal of muscle relaxation. Just before skin closure and before application of surgical dressing, neuromusculer blockade was reversed with neostigmine (0.07 $mg.kg^{-1}$) and atropine (0.01 $mgkg^{-1}$).

Fresh gas flows were increased to 10 $Lmin^{-1}$ and mechanical ventilation (10$mL.kg^{-1}$ ideal body weight) was continued until the first spontaneous respiration began, followed by assisted manuel ventilation. A verbal command to ‘open your eyes’ was given every 10 seconds. Criteria for tracheal extubation included the ability to sustain spontaneous ventilation, a tidal volume greater than 5 $mLkg^{-1}$ reversal of muscular relaxation in all patients and response to verbal command. Blinded study personnel recorded the time from discontinuation of the anesthetic gas to eye opening and extubation are also noted.

STATISTICAL ANALYSIS

Statistical analysis was performed by Statistical Package for Social Sciences (SPSS) 11.5 software (SPSS Inc., Chicago, IL, United States). Whether the continuous variables were normally distributed or not were determined by using Shapiro Wilk test. Whereas, age, weight, height and body mass index were shown as mean ± standard deviation, median (minimum-maximum) was used for hemodynamic measurements. While, means were compared using One-Way ANOVA, otherwise, Kruskal Wallis test was applied for the comparisons of the median values. Whether the differences between pairwise repeated measurements within groups were statistically significant or not were evaluated by Wilcoxon Sign Rank test. Actual differences in hemodynamic measurements, acccording to the baseline, were also calculated. A p value less than 0.05 was considered statistically significant. But, all possible multiple comparison tests, Bonferroni Adjustment was applied for controlling Type I error.

RESULTS

This prospective, single-blinded, randomized study took place from October 2007 to December 2008 and 60 patients were retruited into the study. 20 patients were randomized into each group and completed the protocol, no complications occured in any of the groups (Table 1). Sample size was determined according to the previous studies(14). Demographics and ASA status of the groups were similar ($p>0.05$) (Table I).

There were no significant difference between the baseline(A) hemodynamic variables (SABP, DABP, MABP, HR, SpO_2, $ETCO_2$) between the groups ($p>0.05$)(Table II).

In group D, there is a statistically significant decrease in SABP after induction(B) and before insuflation(C) compared to baseline values ($p<0.05$)(Figure 1). The was no significant difference in SABP; DABP; MABP and HR of groups after induction(B), before insuflation(C), 5 minutes after insuflation(D) and 15 minutes after insuflation(E) among the groups in regards to the baseline values(A) ($p>0.05$) (Figure 2,3,4). There was a transient advantage towards TİVA group in terms of postoperative recovery but it was not statistically significant so we found no difference in emergence in times from turning inhalation agent off to eye opening and extubation($p>0.05$).

Figure 1

Table I: Demographics and ASA status of groups

	Group T (mean ± SD)	Group D (mean± SD)	Group S (mean± SD)	p
Age (yr)	38,6 ± 8,6	38,1 ± 7,7	37,9 ± 11,5	0,975
Gender(male/female)	15/5	16/4	15/5	0,909
Weight (kg)	121,0± 25,8	118,7 ± 16,7	122,1 ± 16,3	0,862
Height (cm)	164,7 ± 7,5	165,3 ± 6,5	161,5± 9,7	0,276
Body Mass Index (kg/m2)	44,6 ± 9,8	43,7 ± 8,1	47,1 ± 7,2	0,439
ASA	2-3	2-3	2-3	0,145

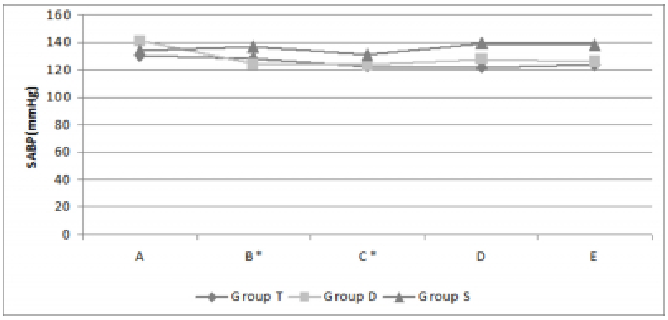
Figure 2

Table II: Baseline (A) hemodynamic variables of groups

	Group T (median±interquartile range)	Group D (median±interquartile range)	Group S (median±interquartile range)	p
SABP-A(mmHg)	130,0 ± 28,5	141,0 ± 29,7	134,5 ± 23,2	0,108
DABP-A(mmHg)	80,0 ± 16,7	86,0 ± 21,2	80,0 ± 12,2	0,078
MABP-A(mmHg)	92,5 ± 16,7	102,5 ± 22,2	98,0 ± 12,7	0,072
HR -A(beat/min)	85,5 ± 20,0	90,5 ± 21,0	88,0 ± 15,2	0,611
$EtCO_2$-A(mmHg)	32,5 ± 6,5	32,5 ± 7,0	33,0 ± 8,2	0,851
SpO2-A(%)	96,5 ± 2,7	98,0 ± 2,0	97,0 ± 2,0	0,490

Figure 3

Figure 1: SABP of 3 groups in regards of different times



*p<0.05 for Group D

Figure 4

Figure 2: DABP of 3 groups in regards of different times

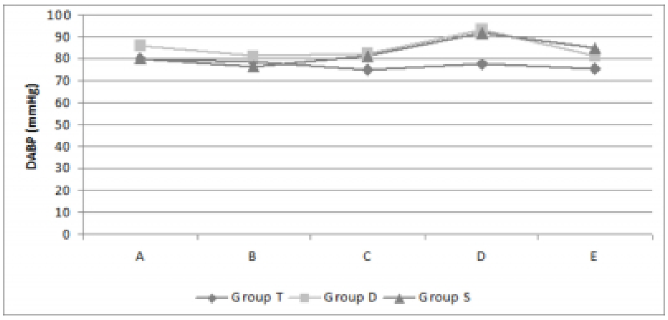


Figure 5

Figure 3: MABP of 3 groups in regards of different times

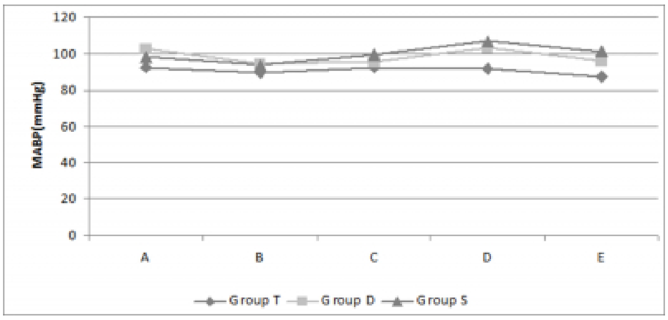
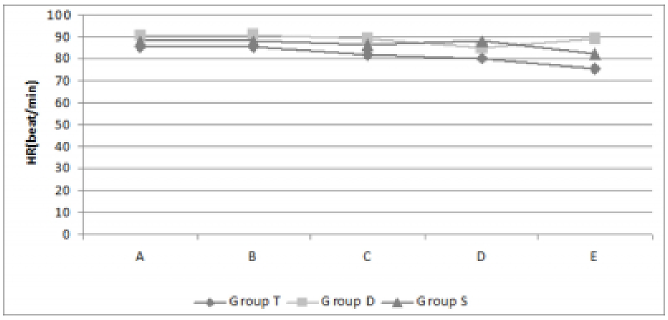


Figure 6

Figure 4: HR of 3 groups in regards of different times



DISCUSSION

Bariatric surgery is a widely used method for achieving sustained weight loss in severly obese patients. Laparoscopic gastric banding is becoming the most common type of bariatric surgery with minimal invasion, in spite of the fact that there is considerable literature regarding the anesthetic considerations of this surgery(15).

In laparoscopic bariatric surgery cardiac output is usually well preserved but systemic vascular resistance can be increased; tachycardia, bradycardia and hypertension are common depending on the levels of surgical stimulation and the adrenergic state of the patient. Five percent to 10% of the patients become hypotensive for a brief period after instutition of the pneumoperitoneum and steep reverse-trendelenburg positioning. This hypotension appears to be related to preoperative hypovolemia and responds quickly to treatment with intravenous fluid boluses of 500 to 1000 ml(16).

In patients with difficult airway, such as morbid obese patients, sevoflurane is considered to be an excellent induction drug that has definitive advantages, such as the maintanance of spontaneous ventilation. Both desflurane and sevoflurane have a low blood/gas partition coefficient, giving the advantage of rapid induction and rapid emergence during general anesthesia, resulting in fewer respiratory complications compared with other inhalational agents that have higher blood/gas partition coefficient(17). During desflurane anaesthesia with controlled ventilation cardiac output is maintained in humans despite dose dependent depression of cardiovascular function and myocardial contractility. Tachycardia may be prominent with desflurane at >1 MAC(18). The cardiovascular effects of desflurane and sevoflurane appears similar, both agents cause a decrease in systemic arterial pressure, diastolic more than systolic, with little overall influence on heart rate and neither agent appears to sensitize the myocardium to the effect of catecholamines(19). İncreasing the concentration of desflurane from 1 MAC to 1.5 MAC results in sympatho-exitation, hypertension and tachycardia in healty, young volunteers(20). In our study there was no significant difference between the heart rates of groups but in the first three sistolic blood pressures were significantly lower than the first measure in desflurane group which is not correlated with the previous study.

Absorption by delivery to body tissues is mainly determined by drug solubility, few studies have compared the kinetic curves of sevoflurane and desflurane in obese patients. Three factors govern the uptake and distribution of potent inhaled anaesthetics. Cardiac output, alveolar-to-venous partial pressure difference, and solubility in blood, defined as the blood–gas partition coefficient, contribute to the wash-in curves observed in different ways. These wash-in curves show a higher FA/FI ratio in the desflurane group compared with the sevoflurane group from the 15th to the 30th min. As reported in non-obese patients, this result can be explained by the slower distribution of desflurane to the peripheral compartments, which in turn causes a more rapid saturation of the central compartment. In fact, the apparent distribution volume of desflurane is smaller than the apparent distribution volume of sevoflurane, therefore the uptake of desflurane is lower (21).

Two different studies compared sevoflurane with isoflurane for use during bariatric surgery and favored sevoflurane because of its more rapid recovery, good hemodynamic control, infrequent incidence of nause and vomiting, prompt regaining of psychological and physical functioning. Some other studies demonstrated a rapid awakening after desflurane versus sevoflurane anesthesia as determined by the time to eye opening(22,23) In Vallejo et al' study (17) and Arain et al's (10) study they did not find any difference between the emergence times as measured by time to eye opening. In our study there was a transient but not statistically significant advantage towards TIVA group but no statistically significant difference was found between the groups.When the concentration at the time the agent is turned off, is ≤80 % of the maintenance dose, the difference in emergence time between desflurane and sevoflurane is minimal. However, when the concentration at the time the agent is turned off is ≥ 80 of the maintenance dose, a difference becomes apparent(17). The reason we did not find any difference in emergence time between the groups is that, upon initiation of surgical closure we decreased the inhalation agent to 0.5 MAC and therefore the decrease from 0.5 MAC to changing the agent off was not ≥ 80%. Rapid elimination and analgesic properties make nitrous oxide a good inhaled choice during bariatric surgery, but high oxygen demand in the obese limits its use(25).

Both agents at about 1 MAC concentration cause a moderate increase (approximately 20%) in arterial or end tidal carbondioxide tension(26) but in our study there was not a significant difference in carbondioxide tension in regards to bazal values and between the groups.

Morbidly obese patients are at increased risk for complications from general anaesthesia and surgery (17). In a study comparing desflurane, propofol and isoflurane anaesthesia among morbid obese patients undergoing laparoscopic gastroplasty, Juvin et al(27) determined that no one in the desflurane treated group, compared with 45 % each in the propofol and isoflurane treated groups, had a SpO2 value below 95%. Strum et al (28) compared desflurane with sevoflurane in obese patients who underwent open laparotomy and found that desflurane group had a higher SpO2. In a prospective randomized study of morbidly obese patient who underwent laparoscopic gastroplasty, desflurane was shown to have higher SpO2 values and less sedation. However, we did not find any appreciable difference in SpO2 in all groups.

Propofol was selected as the main anaesthetic agent because it permitted rapid awakening with minimal residual sedative effects, thereby decreasing the need for artificial ventilation postoperatively. It also carried a low risk of postoperative nausea and vomiting (29). Propofol is a lipid-soluble anaesthetic and may therefore have a prolonged effect in obese patients, whose proportion of fat in their total body weight is increased (27). The pharmacokinetic and dynamic properties of remifentanil allow it to suppress moments of surgical stress and raised arterial pressure rapidly due to a quicker equilibration between plasma concentration and effect-site concentration(30). Due to their unique pharmacokinetic pharmacodynamic characteristics and recovery profiles, propofol and remifentanil are ideally suited both for sedation and for maintenance of anaesthesia even in obese patients(31).

CONCLUSION

In conclusion, we report the use of a desflurane, sevoflurane, propofol and remifentanil infusion for laparoscopic gastric banding. There was not a significant difference between the groups in regards of hemodynamic variables and SPO2 and EtCO2 values. Only significant difference was the decrease in the first three sistolic arterial pressure values of desflurane group.Although there is a transient advantage towards TIVA group, we found no difference in emergence in times from turning inhalation agent off to eye opening and extubation time. These findings showed us that desflurane or sevoflurane with low blood/gas partition coefficient and unique pharmacokinetic pharmacodynamic characteristics of propofol with remifentanil are ideally suited both for maintenance and emergence of anaesthesia in obese patients with stable hemodynamic variables during general anesthesia. The choice of anesthetic agent used should be preferred by the co morbid diseases of the patients. Anesthetic managment of these patients should take into consideration the specific problems associated with obesity and optimize them before surgery.

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