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OBESITY AS A RISK FACTOR FOR SEDATION-RELATED COMPLICATIONS DURING PROPOFOL-MEDIATED SEDATION FOR ADVANCED ENDOSCOPIC PROCEDURES

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Abstract

Background—There is limited data on the safety of anesthesia-assisted endoscopy using propofol-mediated sedation in obese individuals undergoing advanced endoscopic procedures (AEPs).

Objective—To study the association between obesity [as measured by body mass index (BMI)] and the frequency of sedation-related complications (SRCs) in patients undergoing AEPs.

Design—Prospective cohort study.

Setting—Tertiary referral center.

Patients—1016 consecutive patients undergoing AEPs [BMI<30: 730(72%), 30-35:159(16%), >35:127(12%)].

Intervention—Monitored anesthesia sedation with propofol alone or in combination with benzodiazepines and/or opioids.

Main Outcome Measures—SRCs: airway modifications (AMs), hypoxemia, hypotension requiring vasopressors, and early procedure termination were compared across three groups.

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Results—There were 203 AMs in 13.9% patients, hypoxemia in 7.3%, need for vasopressors in 0.8% and premature termination in 0.6% of patients. Increasing BMI was associated with an increased frequency of AMs (BMI:<30–10.5%, 30-35–18.9%, >35–26.8%, p<0.001) and hypoxemia (<30–5.3%, 30-35–9.4%, >35–13.4%, p=0.001); there was no difference in the frequency of need for vasopressors (p=0.254) and premature termination of procedures (p=0.401). On multivariable analysis, BMI [OR 2.0 (95% CI 1.3-3.1)], age [OR 1.1 (95% CI 1.0-1.1)] and ASA class ≥ 3 [OR 2.4 (95% CI 1.1-5.0)] were independent predictors of SRCs. In obese individuals (n=286), there was no difference in the frequency of SRCs in patients receiving propofol alone or in combination (p=0.48).

Limitations—Single tertiary center study.

Conclusions—Although obesity was associated with an increased frequency of SRCs, propofol sedation can be used safely in obese patients undergoing AEPs when administered by trained professionals.

Keywords

Obesity; propofol; monitored anesthesia care; advanced therapeutic endoscopy

INTRODUCTION

Anesthesia administered sedation has become increasingly common for advanced endoscopic procedures such as endoscopic retrograde cholangiopancreatography (ERCP) and endoscopic ultrasound (EUS). Propofol (2, 6-diisopropylphenol) is a sedative that offers the advantage of a rapid onset of action (30-45 seconds), the ability to achieve adequate sedation, and a short duration of effect (4-8 minutes), leading to rapid recovery [1]. The popularity of using propofol for sedation during advanced endoscopic procedures derives from its favorable pharmacokinetic profile. The safety of propofol for advanced endoscopic procedures has now been reported in multiple trials [2-8].

There is a dearth of prospective data on the clinical predictors of developing sedation related complications during advanced endoscopic procedures [2, 3, 7]. Obesity [defined as a body mass index (BMI) of ≥ 30 kg/m^2] has previously been identified as an independent predictor of sedation related adverse events in patients undergoing advanced endoscopic procedures [2, 8, 9]. It is postulated that obese patients have a high prevalence of obstructive sleep apnea [10, 11] and propofol accentuates airway collapse as patients become unresponsive to verbal stimulation potentially increasing the risk of cardiopulmonary adverse events [12]. In addition, patients with morbid obesity can have restrictive lung disease, pulmonary hypertension and development of significant alveolar-to-arterial oxygen gradients [13]. Data on the association of obesity and sedation related outcomes in patients undergoing advanced endoscopy is limited; specifically defining the frequency of adverse events in the setting of a BMI ≥ 30 kg/m^2.

In addition, the optimal sedation regimen for achieving deep sedation in this high risk group of patients is unclear. Recent studies suggest that propofol with midazolam and/or opioids (combination propofol) may be synergistic in action. Therefore the combined application of

these drugs may permit smaller doses of each to be used and potentially lead to a reduction in risk of complications and in the dose of propofol needed while retaining the individual advantages of each compound [14-20]. Whether this synergistic interaction decreases sedation related complications in obese subjects undergoing these high risk procedures is unclear.

The primary aim of this study was to study the association between obesity (as measured by BMI) and the frequency of airway maneuvers and sedation-related complications in patients undergoing advanced endoscopic procedures. The secondary aims were to define independent predictors of airway maneuvers and sedation-related complications and compare sedation related outcomes between combination propofol with propofol alone in obese subjects.

METHODS

Patients

This is a prospective cohort of patients undergoing advanced endoscopic procedures (ERCP, EUS, single-balloon or spiral overtube-assisted deep enteroscopy, and enteral stenting) at Washington University in St. Louis, Barnes Jewish Medical Center, a tertiary referral medical center. Patients undergoing these procedures from May, 2008 through October, 2009 were enrolled. The study was approved by the local Human Research Protection Office.

It is routine practice in this endoscopy unit to sedate patients undergoing advanced endoscopic procedures with propofol alone or in combination with low dose opiate and/or benzodiazepine. Propofol-based sedation and patient monitoring were directed by a certified nurse anesthetist (CRNA) under the medical direction of an anesthesiologist. The endoscopic unit at Barnes-Jewish Hospital Center for Advanced Medicine is staff by a team of anesthesia providers that has provided this service for more than six years. During this time the team has refined its practices and techniques to provide optimal conditions for the endoscopist while delivering optimal care with a high level of patient satisfaction. One anesthesiologist (L.W) and 3 CRNAs participated in this study, all with extensive experience in the sedation of patients undergoing advanced endoscopic procedures (> 25 years of anesthesia practice and > 6 years of exclusive GI anesthesia experience). The anesthesiologist enrolled the patient in the study and obtained informed consent. For induction of sedation, the use of propofol alone or in combination with low-dose benzodiazepine and/or opioids was left to the discretion of the CRNA and anesthesiologist. Sedative dosing was adjusted to maintain deep sedation throughout the procedure [21]. The following information regarding all patients was collected: demographics, procedural and pharmacologic data. Other than the inability to provide informed consent, there were no exclusion criteria.

Patient monitoring

All patients were monitored using continuous electrocardiography and heart rate, pulse oximetry, nasal capnography and non-invasive blood pressure monitoring during the

procedure. If hypopnea/apnea (defined as < 6 breaths per minute) was suggested on nasal capnography, the CRNA evaluated for air flow and chest expansion before intervening as it is not uncommon to receive data that represents artifacts and not true end-tidal CO_2. If there was an absence of gas exchange it was then determined whether this was due to airway obstruction or due to apnea. The CRNA also moved the nasal cannula in front of the oropharynx to assess end-tidal CO_2. The CRNA used all of these variables in assessing the presence of hypopnea/apnea. In the case of airway obstruction the anesthesia provider performed the necessary airway modification which involved a chin lift, jaw thrust or the insertion of a nasal airway. If the patient was apneic the anesthesia provider attempted to stimulate the patient using noxious stimuli. When the stimuli were not adequate to restore respiration the endoscope was removed to allow bag-mask ventilation. Supplemental oxygen by nasal cannula (2-3 L/min) was provided to all patients at the onset of sedation. Administration of propofol and benzodiazepines/opioids was determined solely by the CRNA whose sole responsibility was to monitor the patient during the procedure. Opioids were used when pain was present at the onset of the procedure or was anticipated at the end of the procedure. In addition, opioids were also administered when vital signs demonstrated significant sympathetic stimulation (elevated heart rate and blood pressure) during the procedure despite increasing propofol dosing. Benzodiazepines were predominantly administered to treat nausea refractory to conventional therapy [22]. Patients undergoing ERCP were typically placed in the prone position whereas those undergoing EUS, deep enteroscopy and enteral stenting were in the left lateral decubitus position.

Definition of airway maneuvers and sedation-related complications

Airway maneuvers were defined as active interventions required during the sedation period and sedation-related complications were defined as the endpoint of unsuccessful airway maneuvers and adjustments to the sedation regimen to maintain patient stability. Airway maneuvers were classified *a priori* as chin lift maneuver, nasopharyngeal airway, modified mask airway, bag-mask ventilation (positive-pressure ventilation), or endotracheal intubation. Chin lift was classified as any manipulation of the chin or a jaw thrust maneuver to improve upper airway patency for optimal airflow. The modified mask airway is a simple O_2 mask that was modified to allow passage of the endoscope while providing a higher FiO_2 than can be achieved with a nasal cannula but not capable of providing positive pressure ventilation. A nasopharyngeal airway involved the insertion of a tube through a nostril and into the nasopharynx to prevent the tongue from blocking air flow. Positive pressure ventilation and endotracheal intubation were reserved for patients who did not respond to less invasive airway maneuvers along with alteration in the sedation regimen. These maneuvers were performed at the discretion of the CRNA for laryngospasm, upper-airway obstruction, and hypopnea/apnea (defined as < 6 breaths/min), which may have occurred with or without hypoxemia. Although all patients with hypoxemia required one or more airway maneuvers, not all patients who required an AM necessarily developed hypoxemia. Sedation-related complications included hypoxemia (defined as a pulse oximetry or SpO_2 of < 90% for any duration), hypotension (defined as systolic blood pressure of < 90 mmHg requiring use of vasopressors), and the need to terminate the endoscopy prematurely for issues related to sedation.

Data collection

Demographics and clinical characteristics that included age, gender, body mass index (BMI, kg/m^2), Mallampati score [23], and American Society of Anesthesiologists (ASA) class were documented before endoscopy. These data points were recorded by the anesthesiologist who also assessed the Mallampati score and ASA class for all patients in this study. The induction dose (mg/kg) and total propofol dose (mg/kg/min) were recorded, along with doses of concomitant sedatives used for induction and during the endoscopy. The total propofol dose on a per-minute basis was used to account for variable infusion times and length of endoscopy. The patient's level of responsiveness at the time of endoscopy intubation was also documented: response (i.e. grimace, withdrawal, coughing) and no response. Patient positioning (prone or other) and Aldrete score, a simple reliable test for determining recovery and discharge after sedation, at arrival to the recovery area were recorded [24]. These data points were recorded by the CRNA on a clinical research form.

Outcome variables and statistical analysis

To study the association between obesity [as measured by body mass index (BMI)] and frequency of airway maneuvers and sedation-related complications in patients undergoing advanced endoscopic procedures, patients were categorized into three groups: BMI < 30, 30-35, and > 35. The primary outcome of this study was to compare the frequency of airway maneuvers and sedation-related complications in these groups. The secondary outcomes included comparison of demographics and clinical characteristics and induction and propofol dose between the three groups. By assessing clinical, procedural and pharmacologic data, independent predictors of airway maneuvers and sedation-related complications in each group were evaluated. Finally, in the subgroup of patients with obesity (BMI ≥ 30), procedural and pharmacologic data of patients who received combination propofol versus propofol alone for induction were compared.

Categorical variables were described using frequencies with percents, and were compared across levels of BMI (<30, 30-35, >35) using chi-square tests. Due to the non-normal behavior of continuous variables, they were summarized using medians with inter-quartile ranges and compared across levels of BMI using Kruskal-Wallis tests. Outcomes (any airway maneuvers, individual airway maneuvers and sedation-related complications) were calculated overall and within each BMI category using percents with exact 95% confidence intervals. Percents were compared across levels of BMI using the Mantel-Haenszel chi-square test for trend. Where applicable, statistical analysis for multiple testing was performed using the Bonferroni correction to the comparisons of the multiple event rates by adjusting the level of significance to 0.05/9=0.006. A multivariable logistic regression model was built using any airway modification or sedation-related complication as the outcome (binary outcome). The models included patient characteristics including BMI, procedural, and pharmacologic variables. Factors were also reduced using backward elimination and odds ratios with 95% confidence intervals were calculated within the BMI categories (< 30 vs. ≥ 30). Comparisons of procedural and pharmacologic data in the subgroup of patients with BMI ≥ 30 sedated with propofol alone versus propofol in combination with benzodiazepine and/or opioids were performed using chi-square tests or Rank-sum tests as appropriate and outcomes were compared using chi-square tests. All

statistical analyses were performed using SAS 9.2 (SAS Institute, Cary, NC), and p-values <0.05 were considered statistically significant.

RESULTS

A total of 1016 patients were enrolled during the study period: 504 (50%) ERCP, 470 (46%) EUS and 42(4%) small bowel enteroscopy and others. The demographic characteristics, procedural data and pharmacologic data have been highlighted in Table 1. The median BMI in this cohort was 26.6 (IQR 22.8-30.8) and the vast majority of the patients (62.2%) met criteria for ASA class 3 or higher. No response to endoscopic intubation was noted in 88.9% of patients consistent with the definition of deep sedation at the onset of endoscopy. Combination propofol for induction was used in 55.9% of cases. Airway maneuvers and sedation-related complications in the entire cohort have been summarized in Table 2. Overall, there were 203 airway maneuvers performed in 141 (13.9%) patients (chin lift 11.1%, modified mask ventilation 4.6%, nasal airway 3.9%, bag mask ventilation 0.3%). Hypoxemia was noted in 7.3%, hypotension requiring vasopressors in 0.8% (treated with fluids and vasopressors) and premature termination in 0.6% of patients (4, sedation related issues with hypotension requiring vasopressors and 2, refractory laryngospasm and apnea). None of the patients required endotracheal intubation.

Obesity and deep sedation outcomes

The distribution of patients in the 3 groups was as follows: BMI < 30: 730 (72%), 30-35: 159 (16%) and > 35: 127 (12%). There was no difference between the three groups in the median age, ASA class ≥ 3, Mallampati score, total endoscopy time, and patient position (prone vs. other). The BMI < 30 group had a higher proportion of patients with no response to endoscopic intubation consistent with at least deep sedation (BMI: < 30 – 90.7%, 30-35 – 84.1%, > 35 – 85%, p=0.018). Patients in the BMI < 30 group were less likely to receive combination propofol for induction (BMI: < 30 – 53.5%, 30-35 – 66.6%, > 35 – 55.9%, p=0.011). In addition, this group received a higher induction (p<0.01) and total propofol dose (p<0.01) (Table 3).

The distribution of airway maneuvers and sedation-related complications across the three groups has been highlighted in Table 4. Increasing BMI was associated with an increased frequency of airway maneuvers (BMI: < 30 – 10.5%, 30-35 – 18.9%, > 35 – 26.8%, p<0.001) and hypoxemia (BMI: < 30 – 5.3%, 30-35 – 9.4%, > 35 – 13.4%, p for trend = 0.001). There was no difference in the frequency of need for vasopressors (BMI: < 30 – 1%, 30-35 – 0.6%, > 35 – 0%, p for trend = 0.254) and premature termination of procedures (BMI: < 30 – 0.7%, 30-35 – 0.6%, > 35 – 0%, p=0.401). On multivariable logistic regression analysis that included BMI as a covariate, BMI [OR 2.0 (95% CI 1.3-3.1), p<0.001] and age [OR 1.1 (95% CI 1.0-1.1), p=0.02] were independent predictors of any airway maneuver and sedation related complications (Table 5). In a separate model within the BMI categories (BMI < 30 vs. ≥ 30), ASA class ≥ 3 was an independent predictor of any airway maneuver and sedation related complication in the BMI category > 30 [OR 2.4 (95% CI 1.1-5.0), p=0.02] (Table 6).

Combination propofol versus propofol alone in obese patients

In obese individuals (n=286) undergoing advanced endoscopic procedures, combination propofol was used in 177 (62%) and propofol was used alone in 109 (38%) of cases. Procedural and pharmacologic data between the two groups have been summarized in Table 7. Although the induction propofol ($p<0.0001$) and total propofol dose ($p<0.0001$) was lower in the combination group, there was no difference in the frequency of airway maneuvers and sedation-related complications between the two groups [airway maneuvers: 22.6% vs. 22%, p=0.9; hypoxemia: 10.2% vs. 12.8%, p=0.48].

DISCUSSION

Obesity is a significant health problem in the United States that continues to rise at epidemic proportions. In a recent study, the National Health and Nutrition Examination Survey reported an age-adjusted prevalence of obesity of 33.8% (95% CI 31.6-36) among adults aged older than 20 years. The prevalence rates of obesity in the BMI ≥ 35 and ≥ 40 were 14.3% (95% CI 12.7-15.8) and 5.7% (95% CI 4.9-6.6), respectively [25]. There is limited data on the safety of anesthesia administered sedation with propofol in obese subjects (BMI ≥ 30) undergoing advanced endoscopic procedures. Defining the frequency and predictors of airway maneuvers and sedation related complications and the optimal sedation regimen for this high risk population is of paramount importance.

Results of this prospective cohort that included 1016 patients undergoing advanced endoscopy demonstrate that increasing BMI was associated with an increased frequency of airway maneuvers ($p<0.001$) and hypoxemia (p=0.001). However, there was no difference in the frequency of need for vasopressors (p=0.254) and premature termination of the procedure (p=0.401). In fact, none of the patients in this cohort required endotracheal intubation and premature termination of procedure was required in <1% of all procedures (in only one patient with BMI > 30). On multivariable logistic regression analysis, BMI [OR 2.0 (95% CI 1.3-3.1), $p<0.001$] was an independent predictor of any airway maneuver and sedation related complications. This study provides important estimates for health-care providers of sedation related outcomes in obese patients and although obesity was associated with increased frequency of airway maneuvers and hypoxemia, need for vasopressors and premature procedure termination was rare.

Consistent with previous reports, the ASA class ≥ 3 [OR 2.4 (95% CI 1.1-5.0), p=0.02] was the most powerful predictor of airway maneuvers and sedation related complications [2, 3, 26, 27]. Increased risk of cardiopulmonary events begins at ASA class 3 [OR 1.8 (95% CI 1.6-2)] and nearly doubles for each subsequent ASA class [26]. In a recent study, Berzin et al reported an overall sedation-related adverse event rate of 20.6% with hypoxemia being the most common event (12.5%) among 528 patients undergoing ERCP with anesthesiologist-administered care. Higher ASA class and BMI were associated with increased rate of cardiac and respiratory events during ERCP [2]. Age was also identified as an independent predictor of sedation related outcomes in this study [OR 1.1 (95% CI 1.0-1.1), p=0.02]. This may be related to the presence of increasing number of comorbidities.

The optimal method for achieving deep sedation in this high risk group of patients is unclear. In obese subjects, the pharmacokinetics of drugs may be unpredictable and the volume of distribution is increased for lipid soluble agents such as propofol and fentanyl possibly resulting in the need for a higher dose of these agents to reach the target level of sedation and prolonged elimination [13]. Recent studies suggest that propofol with midazolam and/or opioids may be synergistic in action and thus by combining small doses of several drugs that interact synergistically, each drug's therapeutic action is potentiated whereas the side effects of each are minimized because of the small doses used and retaining the individual advantage of each compound [14-20]. The profound synergism between propofol and opioids for analgesia and sedation has been well described [28]. There is limited data evaluating the synergistic effect of propofol with midazolam and opioids in patients undergoing advanced endoscopy procedures. Ong et al reported a higher patient tolerance by the endoscopist and anesthesiologist during ERCP using midazolam, ketamine and pentazocine (sedato-analgesic cocktail) for induction along with propofol for maintenance compared with propofol alone [29]. Paspatis et al reported higher dosage of intravenous propofol required in patients being sedated with propofol alone compared with that required in patients receiving oral dose of midazolam with propofol for ERCPs. In addition, the patients' anxiety levels before the procedures were lower in the combination group and the mean percentage decline in the oxygen saturation during the procedure was significantly greater in propofol alone group [7]. However, these studies excluded patients deemed to be at a high risk for sedation related complications. Patients with ASA class ≥ 3 were excluded, the mean BMI was less than 25, and included only patients at average risk for complications associated with sedation. In obese subjects (BMI ≥ 30) undergoing advanced endoscopy procedures, this study showed no difference in the frequency of airway maneuvers (22% vs. 22.6%, p=0.9) and sedation related complications (hypoxemia 12.8% vs. 10.2%, p=0.48, hypotension 0.9% vs. 0%, p= 0.38, early termination of procedure 0% vs. 0.6%, p=1) between the propofol alone and combination propofol group. The combination propofol group required a lower induction dose of propofol ($p<0.0001$) and total propofol infusion dose ($p<0.0001$). In addition, based on the higher incidence of airway maneuvers and hypoxemia in patients with BMI > 35, sedation in this highest risk group of patients should be managed by professional trained in advanced airway interventions (trained anesthesia professionals).

In this study, approximately 90% of patients had no response to endoscopic intubation. Although this is a crude surrogate for monitoring sedation depth, these patients would meet criteria for deep sedation or rarely general anesthesia at the onset of endoscopy. It is reasonable to consider endoscopic intubation as a painful stimulus; however, reaction to endoscopic intubation has not been classified within the ASA continuum. Based on intermittent clinical assessments, the Modified Observer's Assessment of Alertness/Sedation scale appears to be the best indicator of sedation depth [30]. Based on this scale, many patients intended to receive moderate sedation with meperidine and midazolam actually meet the criteria for deep sedation during standard and advanced procedures [30, 31]. Similarly, patients receiving propofol targeted for deep sedation likely meet ASA criteria for deep sedation and potentially general anesthesia. Future studies measuring sedation-related complications, especially with varying depths of sedation, should use validated tools such as

the Modified Observer's Assessment of Alertness/Sedation over the ASA classification as many patients sedated with propofol maintain normal ventilation and perfusion despite becoming unresponsive to noxious stimuli.

There are several limitations of this study. The therapeutic endoscopy unit at this tertiary care center includes a dedicated anesthesia team with an anesthesiologist and CRNAs with extensive experience in sedation of patients undergoing advanced endoscopic procedures. It is unclear whether the rates of airway maneuvers and sedation related complications from this study can be generalized to other less experienced providers. In addition, the method of sedation for advanced endoscopy procedures at this center is not the norm at other centers where endotracheal intubation is routinely performed again limiting the generalizability of the results of this study. Procedure satisfaction by the patient, clinician and nursing staff was not evaluated. Lower rates of hypoxemia and other sedation related complications may be related to the use of capnography in this study. Capnography has been shown to significantly decrease the incidence of hypoxemia and apnea in patients undergoing ERCP and EUS receiving midazolam and fentanyl, particularly advantageous in patients with a BMI ≥ 30 [9, 13]. Based on these data, experts believe that capnography, supported by anesthesiology societies, should be the standard of care in this setting because most patients intentionally or unintentionally are beyond the level of moderate conscious sedation. This analysis did not account for unrecorded confounding variables such as medical comorbidities, tobacco and alcohol use. Although there was no difference in the frequency of sedation related outcomes in obese subjects sedated with combination propofol and propofol alone, the possibility of a Type II error cannot be excluded. In addition, the use of combination propofol was not standardized and was administered at the discretion of the anesthesiologist and CRNA introducing the potential for selection bias. This study may be underpowered to detect any serious complications including the requirement of endotracheal intubation and evaluate predictors of complications such as hypotension requiring vasopressors and early termination of procedures. However, the results of this study demonstrate the low rate of serious complications in > 1000 advanced endoscopy procedures being sedated by anesthesia assisted propofol sedation. The definition of hypotension of SBP < 90 mm of Hg may not be adequate because the blood pressure, in particular the mean arterial pressure, should ideally be in correlation to baseline values. Many obese patients have hypertension and would with a decrease of MAP by 20% qualify as hypotensive even though the SBP is above 90. However, the definition of hypotension of SBP < 90 mm Hg is consistent with that used in previous publications. Future studies defining the safety of sedation in obese individuals should consider using this definition. Future studies should also focus on defining risk factors and optimal pre-procedure assessment. A sedation risk score that combines clinical variables in identifying patients at risk for sedation related complications during advanced endoscopy procedures is highly desirable. The optimal sedation regimen for obese subjects and the role of combination propofol in this setting should be clarified and is currently being evaluated in a multicenter randomized controlled trial.

In the background of an ongoing obesity epidemic, this study provides estimates of sedation related complications in obese patients undergoing advanced endoscopic procedures. Results of this study demonstrate that despite the increased frequency of airway maneuvers and sedation related complications such as hypoxemia, anesthesia administered sedation with

propofol in obese individuals undergoing advanced endoscopic procedures is safe and early termination of procedure is a rare event. Development of a risk stratification system and defining the optimal sedation regimen in large multicenter trials in this high risk population should be a priority.

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Glossary

AEPs	advanced endoscopic procedures
AMs	airway modifications
BMI	body mass index
CRNA	certified registered nurse anesthetist
ERCP	endoscopic retrograde cholangiopancreatography
EUS	endoscopic ultrasound
OR	odds ratio
SRCs	sedation related complications

Table 1
Patient demographics, procedural and pharmacologic data

Variable	
Patient characteristics	
Age, yrs, median (IQR)	58 [46, 68]
Male sex, %	46.34
BMI, median (IQR)	26.6 [22.8, 30.8]
ASA class ≥ 3, %	62.29
Mallampati score 4, %	0.63
Procedural data	
Endoscopy time (min), median (IQR)	25 [15, 39]
Position, prone, %	47.69
No response to endoscopic intubation, %	88.99
Aldrete score in recovery, median (IQR)	9 [8, 9]
Pharmacologic data	
Combination propofol for induction, %	55.91
Induction propofol dose (mg/kg), median (IQR)	1.65 [1.04, 2.76]
Total propofol dose (mg/kg/min), median (IQR)	0.20 [0.13, 0.29]
Propofol infusion time (min), median (IQR)	30 [20, 44]

Table 2

Airway maneuvers and sedation related complications in the entire cohort

Intervention/complication	Number (%)
Airway maneuvers (n=141)	
Chin Lift	113 (11.1)
Modified Mask	47 (4.6)
Nasal Airway	40 (3.9)
Bag Mask Ventilation	3 (0.3)
Endotracheal intubation	0 (0)
Sedation related complications (n=88)	
Hypoxemia	74 (7.3)
Hypotension requiring vasopressors	8 (0.8)
Early termination of procedure	6 (0.6)

Table 3

Patient demographics, procedural and pharmacologic data based on body mass index

Variable	BMI			
Patient characteristics	**< 30 (n=730)**	**30-35 (n=159)**	**> 35 (n=127)**	**p value**
Age, yrs, median (IQR)	59 [47, 70]	58 [45, 67]	56 [43, 65]	0.063
Male sex, %	46.83	52.20	36.22	0.024
ASA class ≥ 3, %	61.26	62.18	68.25	0.328
Mallampati score 4, %	0.44	0.65	1.67	0.289
Procedural data				
Endoscopy time (min), median (IQR)	25 [15, 40]	23 [15, 37]	26 [15, 39]	0.752
Position, prone, %	49.48	44.68	40.71	0.166
No response to endoscopic intubation, %	90.73	84.18	85.04	0.018
Aldrete score in recovery, median (IQR)	9 [8, 9]	9 [8, 10]	9 [8, 10]	0.004
Pharmacologic data				
Combination propofol for induction, %	53.56	66.67	55.91	0.011
Induction propofol dose (mg/kg), median (IQR)	1.81 [1.15, 3.15]	1.35 [0.91, 2.22]	1.28 [0.87, 2.19]	<.001
Total propofol dose (mg/kg/min), median (IQR)	0.21 [0.14, 0.31]	0.16 [0.11, 0.21]	0.17 [0.11, 0.23]	<.001
Propofol infusion time (min), median (IQR)	30 [20, 44]	30 [20, 39]	31 [20, 46]	0.595

Table 4
Airway maneuvers and sedation related complications based on body mass index

Intervention/complication	BMI			p value*
	< 30 (n, %)	30-35 (n, %)	> 35 (n, %)	
Any airway maneuver	**77 (10.5)**	**30 (18.9)**	**34 (26.8)**	**<0.001**
Chin Lift	68 (9.3)	23 (14.5)	22 (17.5)	0.003
Modified Mask	16 (2.2)	12 (7.5)	19 (15)	<0.001
Nasal Airway	16 (2.2)	9 (5.7)	15 (11.8)	<0.001
Bag Mask Ventilation	1 (0.1)	1 (0.6)	1 (0.8)	0.142
Endotracheal intubation	0 (0)	0 (0)	0 (0)	1.000
Sedation related complications				
Hypoxemia	42 (5.3)	15 (9.4)	17 (13.4)	0.001
Hypotension requiring vasopressors	7 (1)	1 (0.6)	0 (0)	0.254
Early termination of procedure	5 (0.7)	1 (0.6)	0 (0)	0.401

*Mantel-Haenszel test for trend

Table 5

Multivariable logistic regression analysis (full and reduced models) for any airway maneuver and sedation related complication

	Full Model		Reduced Model	
	OR (95% CI)	**p value**	**OR (95% CI)**	**p value**
BMI (≥30 vs. <30)	2.0 (1.3, 3.1)	<.001	2.3 (1.5, 3.3)	<.001
Gender (Male vs. female)	1.4 (0.9,2.1)	0.102	-	-
ASA class (≥ 3 vs. <3)	1.5 (0.9, 2.3)	0.091	-	-
Malampati score (4+ vs. <4)	4.0 (0.7, 20.8)	0.101	-	-
Position (Not Prone vs. Prone)	1.1 (0.6, 1.6)	0.787	-	-
Response at Induction	1.3 (0.7, 2.3)	0.432	-	-
Combination Propofol for Induction (Yes vs. No)	1.3 (0.8, 2.1)	0.265	-	-
Age	1.0 (0.9, 1.1)	0.121	1.1 (1.0, 1.1)	0.024
Endoscopy Time	1.0 (1.0, 1.0)	0.861	-	-
Induction Propofol Dose	1.0 (0.7,1.2)	0.723	-	-
Total Propofol Dose	0.9 (0.6, 1.2)	0.451	-	-

Table 6

Multivariable logistic regression analysis (full and reduced models) for any airway maneuver and sedation related complication within BMI categories (< 30 vs. ≥ 30)

	BMI <30				BMI ≥ 30			
	Full Model		Reduced Model		Full Model		Reduced Model	
	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	P
Gender (Male vs. Female)	1.2 (0.7, 2.0)	0.555	-	-	1.8 (0.9, 3.4)	0.09	-	-
ASA class (≥3 vs. <3)	1.3 (0.7, 2.2)	0.369	-	-	2.0 (0.8, 4.4)	0.096	2.4 (1.1, 5.0)	0.022
Malampati score(4+ vs. <4)	2.8 (0.2, 30.5)	0.443	-	-	6.7 (0.5, 81.3)	0.133	-	-
Position (Not Prone vs. Prone)	1.1 (0.6, 1.9)	0.764	-	-	1.0 (0.5, 2.1)	0.906	-	-
Response at Induction	1.0 (0.4, 2.4)	0.99	-	-	1.7 (0.7, 4.0)	0.223	-	-
Combination Propofol for Induction (Yes vs. No)	1.4 (0.7, 2.8)	0.211	-	-	1.1 (0.5, 2.4)	0.816	-	-
Age	1.0 (0.9, 1.0)	0.354	-	-	1.0 (0.9, 1.0)	0.159	-	-
Scope Time	1.0 (1.0, 1.0)	0.622	-	-	1.0 (1.0, 1.0)	0.569	-	-
Induction Propofol Dose	0.9 (0.7, 1.2)	0.622	-	-	1.0 (0.6, 1.7)	0.876	-	-
Total Propofol Dose	0.8 (0.5, 1.2)	0.424	-	-	1.1 (0.4, 2.3)	0.86	-	-

Table 7

Procedural and pharmacologic data and deep sedation outcomes in patients with combination propofol versus propofol alone in obese patients (BMI ≥ 30, n=286)

Variable	Combination propofol (n=177)	Propofol alone (n=109)	p value
Procedural data			
Endoscopy time (min), median (IQR)	23 [15, 35]	29 [14, 41]	0.218
Position, prone, %	39.33	48.08	0.166
No response to endoscopic intubation, %	83.52	86.24	0.537
Aldrete score in recovery, median (IQR)	9 [8, 10]	9 [8, 9]	<.0001
Pharmacologic data			
Induction propofol dose (mg/kg), median (IQR)	1.05 [0.82, 1.54]	2.10 [1.48, 2.48]	<.0001
Total propofol dose (mg/kg/min), median (IQR)	0.15 [0.10, 0.20]	0.21 [0.15, 0.26]	<.0001
Propofol infusion time (min), median (IQR)	29 [21, 40]	32 [19, 46]	0.247
Airway maneuvers			
Any airway modification (n, %)	40 (22.6)	24 (22)	0.9
Chin lift (n, %)	30 (17)	15 (13.8)	0.46
Modified mask airway (n, %)	14 (7.9)	17 (15.6)	0.04
Nasal airway (n, %)	14 (7.9)	10 (9.2)	0.7
Bag mask ventilation (n, %)	1 (0.6)	1 (0.9)	1.0
Sedation related complications			
Hypoxemia (n, %)	18 (10.2)	14 (12.8)	0.48
Hypotension requiring vasopressors (n, %)	0 (0)	1 (0.9)	0.38
Early termination of procedure (n, %)	1 (0.6)	0 (0)	1.0