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Incidence of Complications in Obese Patients Undergoing Elective Spine Surgery Under General Anesthesia: A Retrospective Study

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Abstract

Background The prevalence of obesity has been increasing worldwide. Simultaneously, the number of obese patients undergoing anesthesia and the risk of anesthesia-related complications are increasing. Our study aimed to identify the incidence of intraoperative anesthetic complications in obese patients undergoing elective spine surgery.

Methods Electronic medical records of patients with a body mass index (BMI) $\geq$ 30 kg/m^2 who underwent elective spine surgery at the Neurological Institute of Thailand between January 2018 and December 2020 were retrospectively reviewed. The primary outcome was the incidence of five anesthetic adverse events: difficult intubation, oxygen desaturation, hypotension, major adverse cardiac and cerebrovascular events (MACCE), and pressure skin lesions. Logistic regression was used for statistical analysis.

Results A total of 165 obese patients' medical records were analyzed. Their mean age was 56.8 ± 11.9 years, and median BMI (interquartile range) was 32.04 kg/m^2 (31.11–34.69 kg/m^2). Fifty-one patients (30.9%) experienced adverse events. Six patients (3.6%) with class 3 obesity had anesthetic complications. The most common adverse event was intraoperative hypotension (26.7%), followed by pressure skin lesions (4.2%), intraoperative oxygen desaturation (1.2%), and MACCE (0.6%). No difficult intubations or deaths occurred.

Conclusion The incidence of overall intraoperative anesthetic complications in obese patients undergoing spine surgery was 30.9%, and class 3 obesity was an independent risk factor for these complications. Consequently, well-trained, vigilant, and experienced anesthesiologists should manage anesthesia in these patients.

Keywords
- general anesthesia
- complications
- obesity
- spine surgery

Introduction

The global prevalence of obesity among adults has increased. According to the World Health Organization (WHO) data, approximately 650 million or 13% of adults were obese in 2016, representing a threefold higher number than that in 1975.[1] With the increasing prevalence of obesity and a reported association between obesity and spinal disease, an increase in the number of patients with obesity

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undergoing spine surgery is anticipated.[2–5] Additionally, anesthetic challenges, attributable to various anatomical and physiological changes, may pose various risks in this population, increasing cardiovascular and pulmonary complications.[6,7] Furthermore, a higher rate of complications (e.g., surgical site infection and reoperation) was reported in patients with obesity undergoing spine surgery than in the nonobese group.[8–10] In previous studies, most intraoperative complications reported in patients with obesity undergoing spine surgical procedures were surgically related.[11–13] However, reports of anesthetic complications in this patient population are limited. Our study aimed to identify the incidence of overall anesthesia-related complications in obese patients who underwent nonemergent spine surgical procedures.

Materials and Methods

This retrospective study was approved by our institutional review board (number 29/2021), which waived the need for informed consent because of the retrospective nature of our study. The study was registered in the Clinical Trials Registry (TCTR20220315001). The inclusion criteria were as follows: age between 18 and 80 years, American Society of Anesthesiologists (ASA) grades 1 to 3, those with a body mass index (BMI) greater than or equal to 30 kg/m^2, defined by the WHO as obesity (the categories of obesity based on BMI are shown in ►**Appendix 1**), and those who underwent elective spine surgery. The exclusion criteria were as follows: patients who had uncontrolled systemic diseases, such as hypertension, diabetes mellitus, and coronary artery disease; ASA grade $>$ 3; and missing or incomplete patient data. The electronic medical records of patients were reviewed between January 2018 and December 2020. During this period, 165 records were found and none were incomplete. Data on baseline characteristics, medical conditions, current medications, ASA physical status, type of surgical procedure, patient position during surgery, level of spinal fusion, and history of previous spinal surgeries were collected. Details regarding technique or device for intubation (e.g., direct or videolaryngoscope), operative time, blood loss, and blood transfusion requirements were also recorded.

Anesthetic Management

The patients were preoxygenated with an FiO2 of 1 before induction with propofol. A videolaryngoscope was used as the first attempt at tracheal intubation. Tracheal intubation was performed by experienced anesthetists. Following intubation, anesthesia was maintained with an FiO2 of 0.5 (in air or nitrous oxide), sevoflurane, or desflurane. Muscle relaxation was maintained with an intermittent bolus or continuous infusion of atracurium or cis-atracurium. Intraoperative analgesia was provided with an intermittent bolus of morphine. In cases where neurophysiological monitoring was planned, anesthesia was maintained with propofol infusion and muscle relaxant was withheld following intubation. The lungs were mechanically ventilated with a tidal volume of 6 to 8 mL/kg of the predicted body weight. Positive end-expiratory pressure was added based on the judgment of the attending anesthesiologist. When intraoperative hypotension occurred, the choice of administering an intermittent bolus or continuous infusion (if indicated) of vasopressors (ephedrine or norepinephrine) and intravenous fluid and blood transfusion depended on the etiology and decision of the attending anesthesiologist.

In the operating room, standard electrocardiogram monitoring, noninvasive blood pressure monitoring (measured every 3 minutes), and pulse oximetry were applied. Intraoperative invasive monitoring (e.g., arterial or central venous catheter insertion) was placed (if indicated) according to the decisions of the attending anesthesiologist. Bispectral index (BIS) was monitored in patients who underwent surgery with neurophysiology monitoring.

Patients operated for posterior approach to spine were made prone. Wilson's frame was used for patient support. (In our institute, head pinning to hold the head is used only in patients undergoing cervical or upper thoracic spine surgery and not for lower thoracic spine surgery.) In prone position, face rested on a gel-pad. The arms were kept by the side of patients only in spine procedure performed at cervical or upper thoracic level. Otherwise, they were flexed at elbows and rested on arm rests. In patient with lateral position, an axillary roll was placed under the dependent thorax, and the arm was secured to armboard using armboard strap. Upper arm was placed on an armrest and secured similarly. A pillow was placed between the legs. Pillow was used for headrest. Standard practices for preventing pressure skin lesions (using cushions, regular inspection of pressure susceptible area) were applied in patients undergoing surgery in prone position.

Definitions

We focused on the following adverse events occurring under anesthesia: difficult tracheal intubation (requiring $\geq$ 3 attempts at intubation), oxygen desaturation ($<$ 90% lasting for $>$ 3 minutes or a single episode of $<$ 85%), and intraoperative hypotension (systolic pressure $<$ 90 mm Hg during anesthetic period).

In addition, we noted various other adverse events that happened during anesthesia, including pressure skin lesions, major adverse cardiac and cerebrovascular events (MACCE), and any other adverse effect.[14,15]

Statistical Analysis

Continuous data are presented as means with standard deviations for normally distributed data, and medians with interquartile ranges (IQRs) for skewed data. Categorical variables were presented as percentages. Normality and skewness of the data were evaluated using kurtosis and skewness statistics. The association between each variable and intraoperative anesthetic complication was analyzed individually using univariable regression model with binary logistical regression. Subsequently, factors with a p-value of $<$ 0.2 were tested using multiple logistic regression. Statistical significance was set at a two-tailed p-value of $\leq$ 0.05. All statistical analyses were performed using the Statistical Package for the Social Sciences (version 16.0; IBM Corp., Armonk, New York, United States).

Results

A total of 165 eligible patients were included. The mean age of the patients was 56.8 ± 11.9 years, and 114 (69%) patients were women. The median BMI (IQR) was 32.04 kg/m^2 (31.11–34.69 kg/m^2), and 128 (77.6%) patients were classified as having class 1 obesity. The demographic and clinical characteristics of patients are shown in ►**Table 1**. A videolaryngoscope was the first device of choice for intubation in 80 (48.5%) patients. The median BMI (IQR) in this group was 33.33 kg/m^2 (31.72–36.18 kg/m^2), whereas it was 31.60 kg/m^2 (IQR, 30.82–33.26 kg/m^2) in the conventional laryngoscopy group ($p < 0.001$). No difficult intubation was encountered in both the videolaryngoscopy as well as conventional laryngoscopy group.

One hundred twenty-nine (78.2%) patients underwent surgery in prone position (►**Table 1**). The most common procedure in this population was posterior spinal decompression without fusion which was done in 72 (43.6%) patients.

The mean duration of surgery was 4.04 ± 1.81 hours. The median blood loss (IQR) was 400 mL (110–975 mL) and 38 patients (23%) required blood transfusions. The anesthetic complications observed are listed in ►**Table 2**.

In our study, intraoperative hypotension was the most common adverse event, identified in 44 (26.7%) patients (►**Table 2**). Of these, 27 (61.4%), 11 (25%), and 6 (13.6%) patients were in class 1, 2, and 3 obesity, respectively. In patients with intraoperative hypotension, the median BMI (IQR) was 34.0 kg/m^2 (31.4–36.7 kg/m^2), whereas it was 30.9 kg/m^2 (IQR, 30.9–33.7 kg/m^2) in patients without this complication ($p = 0.001$). In our study, only an intermittent bolus of vasopressors was administered to support circulation under anesthesia.

Intraoperative oxygen desaturation occurred in two (1.2%) patients. In one patient, the cause of this adverse event was bronchospasm, which subsequently improved after treatment with bronchodilators. Another patient developed hypoxemia after extubation.

Out of seven patients (4.2%) with pressure skin lesions, five patients had class 1 obesity, whereas the remaining two had class 2 obesity. Pressure skin lesions were limited to the facial area (cheek and lip) and occurred only in patients who underwent surgery in the prone position.

Regarding the incidence of MACCE, one (0.6%) patient had asystole, as observed on electrocardiogram during surgical manipulation of the spinal cord. However, sinus rhythm reverted without any intervention, within few seconds. No mortality was observed in our study.

The results of the univariate analysis are presented in ►**Table 3**. In the multivariate analysis (►**Table 4**), class 3 obesity was identified as a significant predictor of anesthetic adverse events ($p = 0.037$).

Table 1 Demographic and clinical profiles of the patients ($n = 165$)

	N (%)
Sex	
Male	51 (30.9)
Female	114 (69.1)
Age (y)	
18–34	10 (6.1)
35–50	37 (22.4)
51–64	65 (39.4)
65–80	53 (32.1)
Mean ± standard deviation	56.8 ± 11.9
Class of obesity	
Class 1	128 (77.6)
Class 2	29 (17.6)
Class 3	8 (4.8)
BMI	
Median, interquartile range	32.04 (31.11–34.69)
ASA physical status	
1	0 (0)
2	62 (37.6)
3	103 (62.4)
Position during surgery	
Supine	34 (20.6)
Prone	129 (78.2)
Lateral	2 (1.2)
Medical condition	
Hypertension	113 (68.5)
Diabetes mellitus	64 (38.8)
Dyslipidemia	72 (43.6)
Coronary artery disease	10 (6.1)
Cerebrovascular disease	6 (3.6)
Obstructive sleep apnea	8 (4.8)
Technique of intubation	
Videolaryngoscope	80 (48.5)
Conventional laryngoscope	85 (51.5)

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index.
Note: Some patients had more than one medical condition.

Discussion

In our study, the incidence of overall intraoperative anesthetic complications in obese patients undergoing spine surgery was 30.9%. The most common complication was hypotension which was observed in 26.7% of patients, whereas pressure skin lesions were noted in 4.2%. The incidence of oxygen desaturation and MACCE was 1.2 and 0.6%, respectively. We did not encounter any incidence of difficult intubation.

Intraoperative hypotension is associated with negative postoperative outcome, and even a brief episode of 1 to

Table 2 Anesthetic complications relative to the class of obesity

Type of complications	N (%)	Class of obesity N (%)		
		1	2	3
Overall anesthetic complications	51 (30.9)	32 (19.4)	13 (7.9)	6 (3.6)
Hypotension	44 (26.7)	27 (16.4)	11 (6.7)	6 (3.6)
Pressure skin lesions	7 (4.2)	5 (3.0)	2 (1.2)	–
Oxygen desaturation	2 (1.2)	1 (0.6)	–	1 (0.6)
Major adverse cardiac and cerebrovascular events	1 (0.6)	1 (0.6)	–	–

Note: Some patients had more than one complication.

Table 3 Univariable analysis of risk factors for anesthetic complications

Factors	With Complication ($n = 51$)	Without complication ($n = 114$)	Crude odds ratio (95% CI)	*p*-Value
	N (%)			
Female	32 (62.7)	82 (71.9)	1.00 (–)	0.275
Male	19 (37.3)	32 (28.1)	1.52 (0.76–3.06)	
ASA 1 or 2	13 (25.5)	49 (43)	1.00 (–)	0.037
ASA 3	38 (74.5)	65 (57.0)	2.20 (1.06–4.58)	
Class of obesity				0.003
Class 1	32 (62.7)	96 (84.2)	1.00 (–)	
Class 2	13 (25.5)	16 (14.0)	2.44 (1.06–5.61)	
Class 3	6 (11.8)	2 (1.8)	9.00 (1.73–46.84)	

Abbreviations: ASA, American Society of Anesthesiologists; CI, confidence interval.
Note: Statistically significant at $p < 0.05$.

Table 4 Multivariable analysis of risk factors for anesthetic complications

Factors	Adjusted odds ratio	95% confidence interval	*p*-Value
Class of obesity			0.037
Class 1	1.00	–	
Class 2	2.05	0.58–7.23	
Class 3	12.87	1.76–94.10	

Note: Statistically significant at $p < 0.05$.

5 minutes can result in unfavorable outcome.[16,17] In a retrospective analysis of cervical spine surgery for cervical spondylosis, Chiang et al reported 43.4% incidence of intraoperative hypotension and was associated more in older patients, male sex, chronic hypertension, and increased number of spine segment treated.[18] The incidence of intraoperative hypotension in the current study was lower (26.7%) from that reported by Chiang et al. It may be due to the fact that the level of surgery was not restricted to cervical spine only and the pathologies also varied. The hypothesized etiologies are overdosage of the induction agent (when calculated according to the lean body weight) and the unique physiological changes in the cardiovascular system of patients with obesity contributing to cardiomyopathy (e.g., hypervolemic state with venous hypertension, myocardial hypertrophy, diastolic dysfunction, and biventricular dilatation) along with preexisting preoperative dehydration.[19]

Pressure skin lesions are a significant complication that may lead to pain, infection, additional treatment cost, and longer hospital stays. They are chiefly seen on facial bony prominences. Skin damage is due to prolonged and excessive pressure and/or shear that blocks capillary blood flow.[20] Literature has reported 5 to 66% incidence of pressure skin lesions in prone position surgery.[21] Despite all the precautions, the incidence of pressure skin lesion was 4.2% in our study and it was seen only in prone position surgery. The face was the only area to develop pressure skin lesions in our study. In all these affected patients, gel headrest was used to support the face in prone position. Excessive weight of the patient may exert more pressure on dependent parts in obese patients leading to more chances of injuries to the tissues overlying bony prominences.

Transient oxygen desaturation in patients undergoing surgery requiring general anesthesia with intubation, more commonly results from difficult intubation. We did not observe any incidence of hypoxia during intubation presumably because we selected videolaryngoscope for the first attempt at intubation. We observed intraoperative oxygen desaturation in two (1.2%) patients only. In one patient, hypoxemia occurred after extubation, which was thought to be due to an overdose of morphine that improved following naloxone administration. Atterhem et al reported a 6.8% incidence of intraoperative oxygen desaturation (peripheral saturation $\leq$ 92%) and showed that the incidence of desaturation increased as the BMI increased.[19] In an observational study by Rodanant et al involving patients with a BMI $\geq$ 35 kg/m^2, among the 2,206 incidence reports of general anesthesia in all types of surgery, the incidence of oxygen desaturation (oxygen saturation of $<$ 85 or $<$ 90% for more than 3 minutes) was 51.7%.[22] We observed that an increase of 1 kg/m^2 in BMI above 35 kg/m^2 was significantly associated with an approximately threefold increase in the likelihood of using a videolaryngoscope as the intubating device.

Our study has a few limitations. First, it is a single-center retrospective study. Second, only eight (4.8%) of the total patients belonged to the class 3 obesity group. Moreover, being a retrospective study, all the drawbacks of retrospective study are applicable to this study also.

Conclusion

We observed that the incidence of overall intraoperative anesthesia-related complications, such as intraoperative hypotension, pressure skin lesions, and desaturation, was 30.9% in obese patients who underwent elective spinal procedures, and class 3 obesity was an independent risk factor for the occurrence of these complications. Hence, extra vigilance and appropriate monitoring are recommended for these patients.

Conflict of Interest
None declared.

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Appendix 1 Classification of obesity according to the World Health Organization classification[23]

Body mass index (kg/m^2)	Class of obesity
30.0–34.9	Class 1
35.0–39.9	Class 2
40.0–49.9	Class 3

