# Incidence of Adverse Perioperative Airway Complications in Obese Non-Pregnant and Pregnant Patients Undergoing General Anesthesia

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## ABSTRACT

**Objective:** Airway complications in obese patients are a major concern during surgical operation. This study aimed to determine the incidence of airway- and respiratory-related anesthetic complications for obese (including maternal) patients undergoing general anesthesia.

**Materials and Methods:** This multicenter, retrospective, observational study evaluated obese female patients (BMI ≥ 30 kg/m$^2$), both non-pregnant and pregnant, undergoing general anesthesia in 5 hospitals across Thailand during May 2013 - August 2016. The primary observation was anesthesia-related airway complications (difficult and failed intubations, aspiration, desaturation, and airway injuries) detected during anesthesia. An analysis was performed to compare the incidents of the adverse events and to determine the risk factors for airway-related adverse events in both groups.

**Results:** There were 1,347 obese patients enrolled (777 non-pregnant and 570 pregnant). The overall incidence of airway and respiratory complications was observed in 129 patients (9.6%), with a higher rate in pregnant patients (12.5% vs. 7.5%; p<0.05). The most common complications were desaturation (5.6%) followed by airway injuries (3.6%) and difficult intubation (1.5%). The factors significantly associated with adverse airway-related events were obesity class II (OR=1.63 [1.05–2.54]), obesity class III (OR=2.25 [1.19–4.25]), pregnancy (OR=1.73 [1.18–2.54]), Mallampati classifications III–IV (OR=1.69 [1.16–2.48]), and neck circumference <43 cm (OR=3.33 [1.02-10.81]), p<0.05).

**Conclusion:** The incidence of the anesthesia-related airway and respiratory complications was 9.6%, with a higher rate in pregnant patients. The most common adverse airway event was desaturation. However, the frequency of serious airway events was low.

**Keywords:** Airway; obesity; perioperative; complication (Siriraj Med J 2022; 74: 178-184)

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## INTRODUCTION

Obesity is a major risk factor of various diseases and associated with an increase in all-cause mortality.[1] According to the World Health Organization, obesity rates have almost tripled worldwide since 1975. In 2016, 39.8% of adults in the USA were overweight,[2] and during 2013-2014, 7.7% of adults in the USA were extremely obese.[3]

Performing general anesthesia in obese patients is challenging, beginning from induction to immediate post operation. The airway and respiratory system are the most common area in which complications occur in obese patients, accounting for more than 80% of all events.[4] The incidence of difficult intubation in obesity varies from 4% to 15%[5], depending on the population and the definition of difficult intubation utilized by studies. The incidence of difficult airway in obese patients was 3 times that of non-obese patients.[6] Moreover, it is a risk factor for aspiration, which is one of the main causes of airway-related mortality in anesthesia.[7]

Anesthesia is one of the leading cause of maternal mortality. Of all the causes of maternal complication from anesthesia, difficult intubation and aspiration is the second only to high spinal block in frequency.[8] The pregnancy-related anatomical and physiological changes heighten the risk of airway and respiratory problems occurring during general anesthesia. Thus, it is important to be aware of the risks of complications associated with general anesthesia in obese patients. Furthermore, it is very likely that the risk would be even higher in obese patients with pregnancy.

The main aims of the present study were to determine the incidences of airway- and respiratory-related anesthetic complications in female obese patients, and to ascertain the resulting airway management outcomes. The secondary objectives were to compare the airway-complication incidences between obese non-pregnant patients and obese pregnant patients, and to assess the characteristics of the patients in order to identify factors associated with the occurrence of such complications.

## MATERIALS AND METHODS

This retrospective analysis evaluated on obese non-pregnant and pregnant female patients undergoing general anesthesia during May 2013 to August 2016 from a university hospital (Siriraj Hospital, Bangkok) and 4 tertiary hospitals across Thailand (Taksin hospital, Bangkok; Surat Thani Hospitals, Surat Thani Province; Phaholpolpayuhasena Hospital, Kanchanaburi Province; and Maharat Nakhon Ratchasima Hospital, Nakhon Ratchasima Province).

The inclusion criteria were female patients, aged ≥18 years old, having undergone surgery under general anesthesia with conventional endotracheal tube intubation, a BMI of ≥30 kg/m$^2$, and gestational age of 34-42 weeks for obese pregnant patients. Exclusion criteria included patients who had a significant orofacial pathology likely to disturb intubation; having a history of difficult intubation; having a condition leading to an abnormally increased BMI (such as a huge intra-abdominal tumor, massive ascites, or a patient with a full stomach).

Data collected were extracted by an anesthesiologist from each hospital. The details were compiled on a standardized data collection form and comprised each patient's demographic profile (sex, age, body weight, and height), ASA physical status, diagnosis, type of operation, and airway assessment parameters. In this study, the airway and respiratory adverse events during anesthesia were (1) difficult intubation, (2) desaturation, (3) aspiration, (4) failed intubation and (5) airway injury. Difficult intubation was defined and classified according to the Intubation Difficulty Scale,[9] a score of > 5 indicates difficult intubation. Desaturation was defined as having at least one episode of oxygen saturation ($SpO_2$) below 90% for more than 10 seconds intra-operatively.[10] Aspiration was defined as the entry of liquid or solid material into the trachea and/or lungs.[11] An airway injury included various levels of injury, ranging from a sore throat; lip, gum, or tongue trauma; palate and tonsil abrasion; to tooth mobility or tooth extraction. The postponement of the operation; remaining on endotracheal intubation to the post anesthesia care unit as a result of an airway or respiratory event; an unplanned, intensive-care-unit admission; brain damage; and an in-hospital, anesthesia-related death were also recorded.

### Statistical analysis

Using the estimated prevalence of 3% and a 1% error, a minimum sample size of 1,118 cases was obtained. To compensate for a 20% dropout for unforeseen reason, the size was adjusted to 1,342 cases. Demographic variables were presented as median and interquartile range for continuous data, and frequency and percentage for categorical data. Comparison of the categorical data were performed using Chi-square or Fisher's exact test. Comparison of the continuous data were performed using T-test or Mann-Whitney U test. The characters associated with the adverse airway events were identified using logistic regression. Risk factors with a univariable p–value of < 0.2 were entered into a multiple logistic regression model. Crude odds ratio (OR) and adjusted odds ratios, with their respective 95% confidence intervals, were

reported. The data were analyzed using SPSS Statistics for Windows, version 18 (SPSS Inc., Chicago, IL, USA).

## RESULTS

The study included a total of 1,347 obese patients (777 not pregnant, and 570 pregnant) who had undergone surgery under general anesthesia using conventional endotracheal intubation. The median age of the patients was 37 years old. Their average BMI was 33.1 kg/m$^2$; the majority were in obesity class I under World Health Organization criteria (66.5%), with about 8.3% being morbidly obese. As to ASA status, 69.0% were class II due to obesity or pregnancy (Table 1). The most frequently performed surgical procedure types were general surgery; gynecological; head, neck, and breast surgery; and cesarean sections. Mallampati classification III or IV was recorded in 30.5% of the patients. The median mentosternal distance and neck circumference were 16.0 and 37.0 cm, respectively. Almost all patients were successfully intubated on the first attempt by the first operator, with the initial technique being applied without the need for a high lifting effort or external laryngeal pressure. Most patients had a laryngoscopic-view grade of I or II (66.1% and 28.5%, respectively).

The incidence of anesthesia-related airway and respiratory complications was observed in 129 patients (9.6%), with a higher incidence occurring among pregnant than non-pregnant patients (12.5% vs. 7.5%; p=0.002) (Table 2). Among them, there were over all 147 airway-related complications. The most common was a briefly sustained, oxygen desaturation below 90% (5.6%), with a significantly greater incidence for the pregnancy group than the non-pregnancy group (11.6% vs. 1.3%; p<0.001). The second most common event was airway injury (3.6%), followed by difficult intubation (1.5%). There was no patients experiencing aspiration or a failed intubation.

The characteristics of the patients with airway and respiratory complications are listed in Table 3. Compared with patients without any complications, those with complications had a higher frequency of Mallampati classifications III and IV (39.5% vs. 28.2%). Patients with obesity class III had a higher incidence of complications (15.2%) than those with obesity class I (7.9%), and II (12.1%). In the multivariate analysis, the independent risk factors for adverse airway-related events were determined to be obesity class II (OR=1.63 [1.05–2.54]; p=0.031), obesity class III (OR=2.25 [1.19–4.25]; p=0.012); pregnancy (OR=1.73 [1.18–2.54]; p=0.005); and Mallampati classifications III–IV (OR= 1.69 [1.16–2.48]; p=0.007). Neck circumference > 42 cm had adjusted odds ratio of 0.30 [0.09–0.98]; p=0.046).

Only 1 patient remained on endotracheal intubation upon transferred to the post anesthesia care unit. No operation postponement, unplanned intensive care unit admission, brain death, or in hospital mortality occurred.

## DISCUSSION

Obesity can have a profound impact on anesthesia-related morbidity and mortality, particularly the airway and respiratory system. In the current research, the incidence of airway and respiratory complications was 9.6% (7.5% for the non-pregnancy group, and 12.5% for the pregnancy group; p=0.002), which was higher than the overall incidence of airway-related events in the Thai general population previously reported (0.61%).[12]

Difficult intubation and airway injuries occur in the presence of the excess fatty tissue.[13] Physiological changes that arise during pregnancy can cause difficult intubation through both capillary engorgement and enlarged breasts.[14] Additionally, obesity causes reduced functional residual capacity; atelectasis; greater work of breathing; and worsened ventilation-perfusion mismatch. All of these resultant conditions cause rapid desaturation in obese patients relative to non-obese patients, and they are aggravated during pregnancy.[15]

In the current research, desaturation was found to be the most common adverse event among obese patients (5.6%), and its incidence was significantly higher among the obese pregnant patients than the non-pregnant patients (11.6% vs. 1.3%; p<0.001). A total of 66 out of 78 events (84.6%) in the pregnancy group involved oxygen desaturation. In 2 studies reporting anesthesia-related events in Thailand[16,17], the most common adverse event during cesarean delivery was desaturation (13.8%–17.39% of all adverse events).

More than half of the patients in our study were easily intubated (60.3%). The incidence of difficult intubation was 1.5%, which was higher than the figure of 0.08% reported for general patients by the Perioperative Anesthetic Adverse Events in Thailand Study.[4] A meta-analysis has found the incidences of difficult intubation for obese patients to be 4.2%-4.3%.[5] As for the current research, the low incidence of difficult intubation relative to other studies could result from 3 factors. Firstly, the majority of the patients were of class I obesity status (which carries a lower risk for difficult intubation than the higher obesity classes). Secondly, the population in the current study were female patients; fat in females tends to be localized to the hips and buttocks, where it has a negligible effect on intubation difficulty. Thirdly, the present study was undertaken at tertiary hospitals, where the anesthesiologists are likely to have had considerable

**TABLE 1.** Demographic and airway management data.

| Characteristic | Total (n = 1347) | Obesity without pregnancy (n=777) | Obesity with pregnancy (n=570) | p-value |
|---|---|---|---|---|
| Age (years) | 37.0 (29.0, 51.0) | 49.0 (38.0, 59.0) | 29.0 (25.0, 34.0) | <0.001 |
| Body mass index (kg/m$^2$) | 33.1 (31.2, 36.1) | 33.0 (31.2, 36.1) | 33.2 (31.2, 36.0) | 0.405 |
| Obesity (kg/m$^2$) | | | | 0.977 |
| Obesity class I (30–34.9) | 896 (66.5) | 515 (66.3) | 381 (66.8) | |
| Obesity class II (35–39.9) | 339 (25.2) | 197 (25.4) | 142 (24.9) | |
| Obesity class III (≥ 40) | 112 (8.3) | 65 (8.4) | 47 (8.2) | |
| ASA classification | | | | <0.001 |
| II | 929 (69.0) | 599 (77.1) | 330 (57.9) | |
| III | 414 (30.7) | 178 (22.9) | 236 (41.4) | |
| IV | 4 (0.3) | 0 | 4 (0.7) | |
| Operation | | | | <0.001 |
| Cesarean section | 570 (42.3) | 0 | 570 (100) | |
| General surgery | 237 (17.6) | 237 (30.5) | 0 | |
| Gynecology | 175 (13) | 175 (22.5) | 0 | |
| Head-neck and breast | 131 (9.7) | 131 (16.9) | 0 | |
| Orthopedic | 83 (6.2) | 83 (10.7 | 0 | |
| Ear, nose, and throat | 52 (3.9) | 52 (6.7) | 0 | |
| Other | 99 (7.3) | 99 (12.7) | 0 | |
| Mallampati classification | | | | <0.001 |
| I | 315 (24.3) | 250 (32.2) | 65 (12.5) | |
| II | 585 (45.2) | 296 (38.1) | 289 (55.8) | |
| III | 305 (23.6) | 150 (19.3) | 155 (29.9) | |
| IV | 90 (6.9) | 81 (10.4) | 9 (1.7) | |
| Sternomental distance (cm) | 16 (15.0, 17.2) | 16.0 (15.0, 17.5) | 16.0 (15.0, 17.0) | 0.038 |
| Neck circumference (cm) | 37.0 (36.0, 39.0) | 37.5 (36.0, 39.5) | 37.0 (35.0, 38.0) | <0.001 |
| Intubation data | | | | |
| First attempt successful | 1325 (98.4) | 756 (97.3) | 569 (99.8) | <0.001 |
| First operator successful | 1334 (99.0) | 769 (99.0) | 565 (99.1) | 0.415 |
| First technique successful | 1335 (99.1) | 772 (99.4) | 563 (98.8) | 0.099 |
| Lifting force | | | | 0.002 |
| Little effort | 891 (66.1) | 523 (67.3) | 368 (64.6) | |
| Increase lift force | 384 (28.5) | 201 (25.9) | 183 (32.1) | |
| Maximal lift force | 72 (5.3) | 53 (6.8) | 19 (3.3) | |
| No external pressure | 1171 (86.9) | 688 (88.5) | 483 (84.7) | 0.040 |
| Cord position: Abduction | 1164 (86.4) | 660 (84.9) | 504 (88.4) | 0.066 |
| Laryngoscopic view | | | | 0.006 |
| I | 891 (66.1) | 523 (67.3) | 368 (64.6) | |
| II | 384 (28.5) | 201 (25.9) | 183 (32.1) | |
| III | 67 (5) | 49 (6.3) | 18 (3.2) | |
| IV | 5 (0.4) | 4 (0.5) | 1 (0.2) | |

Data presented as n (%) or median (IQR)

**TABLE 2.** Airway and respiratory system adverse events.

| Adverse events | Total (n = 1,347) | without pregnancy (n = 777) | with pregnancy (n = 570) | p-value |
|---|---|---|---|---|
| Patients experiencing ≥1 adverse event | 129 (9.6) | 58 (7.5) | 71 (12.5) | 0.002 |
| Overall adverse events (n) | 147 (100) | 69 (46.9) | 78 (53.1) | 0.002 |
| Difficult intubation | | | | 0.107 |
| Easy (IDS score = 0) | 812 (60.3) | 478 (61.5) | 334 (58.6) | |
| Slight difficulty (IDS score = 1-5) | 515 (38.2) | 291 (37.5) | 224 (39.3) | |
| Major difficulty (IDS score >5) | 20 (1.5) | 8 (1.0) | 12 (2.1) | |
| Desaturation | 76 (5.6) | 10 (1.3) | 66 (11.6) | < 0.001 |
| Airway injury: Patients with injury | 48 (3.6) | 48 (6.2) | 0 | < 0.001 |
| Lip, gum, tongue injury | 17 (1.2) | 17 (2.2) | 0 | |
| Sore throat | 30 (2.2) | 30 (3.9) | 0 | |
| Tooth injury | 3 (0.2) | 3 (0.4) | 0 | |
| Soft palate injury | 1 (0.1) | 1 (0.1) | 0 | |

Data presented as n (%), IDS = Intubation Difficulty Scale

**TABLE 3.** Characteristic of patients with airway and respiratory events.

| Factor | Without event (n = 1,218; 90.4%) | With event (n = 129; 9.6%) | Crude OR (95% CI) | p-value | Adjusted OR (95% CI) | p-value |
|---|---|---|---|---|---|---|
| Age (years) | 37 (29, 52) | 35 (29, 49) | 1.00 (0.98-1.01) | 0.423 | | |
| Obesity (kg/m$^2$) | | | | | | |
| Obesity class I | 825 (67.7) | 71 (55.0) | 1 | | 1 | |
| Obesity class II | 298 (24.5) | 41 (31.8) | 1.60 (1.07-2.40) | 0.024 | 1.63 (1.05-2.54) | 0.031 |
| Obesity class III | 95 (7.8) | 17 (13.2) | 2.08 (1.18-3.68) | 0.012 | 2.25 (1.19-4.25) | 0.012 |
| ASA classification | | | | | | |
| II | 850 (69.8) | 79 (61.2) | 1 | | | |
| III–IV | 368 (30.2) | 50 (38.8) | 1.46 (1.01-2.13) | 0.047 | 1.04 (0.67-1.63) | 0.853 |
| Pregnancy | 499 (41.0) | 71 (55.0) | 1.76 (1.22-2.54) | 0.002 | 1.73 (1.18-2.54) | 0.005 |
| Mallampati Classification | | | | | | |
| I–II | 874 (71.8) | 78 (60.5) | 1 | | 1 | |
| III–IV | 344 (28.2) | 51 (39.5) | 1.66 (1.14-2.42) | 0.008 | 1.69 (1.16–2.48) | 0.007 |
| SMD < 12 cm | 62 (5.1) | 6 (4.7) | 0.91 (0.39-2.15) | 0.829 | | |
| NC < 43 cm | 78 (6.4) | 3 (2.3) | 2.87 (0.89-9.24) | 0.076 | 3.33 (1.02-10.81) | 0.046 |

Data presented as n (%) or median (IQR), OR: Odds ratio; 95% CI: 95% confidence interval, SMD = sternomental distance, NC = Neck circumference

experience in the intubation of obese patients. This is supported by the absence of failed intubations despite 30.5% of the patients having Mallampati classifications III-IV. The neck circumference < 43 cm was a sensitive predictor for uneventful airway intubation.[18] In contrast, the current research found neck circumference < 43 cm to be risk factor for airway complication, which could be explained by the complication recorded in the study were not only difficult airway but the most common adverse event was desaturation.

Airway injuries were recorded in 3.6% of the cases, and all were in the non-pregnancy group. Of the injuries, the most common was a sore throat (2.0%). The absence of airway injuries in the pregnancy group might have resulted from the use of smaller-sized endotracheal tubes in the pregnancy group than in the non-pregnancy group.

The major consequences of events was very low (0.1%). The endotracheal tube remained intubated in only 1 patient, who had undergone a tonsillectomy with a difficult intubation. However, the sample size in this study does not mirror the population since the incidence of fatal complications in the general population during anesthesia is low (0.004%-0.006%).

The risk factors associated with adverse airway-related events have previously been identified to be Mallampati classification III or IV, obstructive sleep apnea syndrome, reduced mobility of the cervical spine, limited mouth opening, severe hypoxemia (< 80%), and coma.[19] Some of those factors were observed in the current research. From the multivariate analysis conducted for this study, it was found that a higher obesity class and that Mallampati classifications III–IV were associated with a higher frequency of adverse airway events. Pregnancy was also determined to be associated with elevated risks of adverse airway events, compared with that for obesity without pregnancy.

This research compared obese female patient and showed that difference pathophysiology associated with obesity might contribute to difference adverse events. Pregnant obese patients were more susceptible to desaturation. Therefore, ensuring optimum pre-oxygenation are crucial. While non pregnant patient associated with higher incidence of airway injury, appropriate intubation plans and prophylaxis technique should be considered.

This study had limitation primarily due to its retrospective design. Another limitation was that no records of pre-pregnancy weights were available, not possible to ascertain whether the pregnant patients were obese before - or only during - their pregnancy. The durations might have influenced the pathophysiology and consequences of the obesity. Because the present study did not compare obese and non-obese patients, a comparison of the incidence of adverse events with those might prove difficult.[12] Differences in the intubation management of the pregnancy and non-pregnancy groups might have provided relatively easier access for the endotracheal tube in the pregnancy group. As well, the rapid sequence induction employed for the pregnant patients might have increased their susceptibility to rapid desaturation. On the other hand, as the respective anesthesia techniques used for the non-pregnant and pregnant patients were standard, the incidence of adverse events would still reflect what is found in normal anesthesiological practice. It would be beneficial if a future study compared obese non-pregnant patients and obese pregnant patients in a controlled design. Further study is also recommended to improve the anesthesiological procedures for patients with different levels of obesity.

## CONCLUSION

The incidence of anesthesia-related airway and respiratory events was 9.6%, with a significant higher incidence in the pregnant than the non-pregnant patients. Based on the findings, patients with obesity should be closely monitored during general anesthesia. Anesthesiologists should be aware on the most common complication as identified in this study so as to be well prepared to minimize undesirable outcomes.

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