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Original Research Article

Difficult Airway Events in Obese and Non-Obese Patients Undergoing Laparoscopic Surgery under General Anaesthesia: An Original Prospective Comparative Study

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Abstract

Background: Obesity alters the anatomy of the upper airways, the mechanics of breathing and tolerance of apnoea, which can increase the risk of difficult airway events during laparoscopic surgery. The current study aimed to compare the difficulty of the airway in obese and non-obese adults under general anaesthetic with endotracheal intubation for elective laparoscopic surgery.

Methods: This prospective comparative study included 180 adult patients, with 90 patients in the obese group (BMI ≥ 30 kg/m2) and 90 patients in the non-obese group (BMI 18.5-24.9 kg/m2). Preoperative airway assessment, positioning (ramped if necessary), induction protocol and intraoperative monitoring were used. The primary outcome was a composite difficult airway event, which included difficult mask ventilation, Cormack-Lehane grade III/IV, intubation difficulty scale score >5, needing more than one intubation attempt, the use of an airway adjunct/rescue device, or oxygen desaturation below 92% during airway management.

Results: Obese patients had significantly higher mean neck circumference (40.8 +/- 3.1 cm vs 34.6 +/- 2.7 cm, p<0.001), higher Mallampati class III/IV frequency (35.6% vs 14.4%, p=0.001), and lower safe apnoea time (238.5 +/- 56.7 s vs 314.6 +/- 62.4 s, p<0.001). Composite difficult airway events occurred in 27.8% of obese and 10.0% of non-obese patients (relative risk 2.78; 95% CI 1.38-5.60; p=0.003). Desaturation < 92% was also more common in obese patients (13.3% vs 3.3%, p=0.017).

Conclusion: There was a significantly increased incidence of difficult airway events in patients with obesity during laparoscopic surgery under general anaesthetic. Structured airway assessment, optimized positioning, preoxygenation, and early use of adjuncts are critical to enhancing the safety of the perioperative period in obese patients.

Keywords: difficult airway; obesity; non-obese; laparoscopy; general anaesthesia; intubation; mask ventilation; desaturation.

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Introduction

Difficult airway management is one of the most significant factors in anaesthesia-related morbidity, as the inability to ventilate or intubate can quickly lead to hypoxaemia, aspiration, cardiovascular collapse and emergency front-of-neck access. Current guidelines for the management of the difficult airway focus on anticipation, ensuring oxygenation, minimising repeated attempts, having rescue equipment available and team-based escalation rather than on a single airway manoeuvre [1].

The Difficult Airway Society also suggests a step-wise strategy to failed intubation in adults, including early use of supraglottic rescue, declaration of failure, and structured planning for oxygenation [2]. Airway risk is clinically modified by obesity. Mask ventilation and intubation difficulty is contributed by increased pharyngeal soft tissue, decreased submandibular compliance, larger tongue volume, limited cervical mobility, increased neck circumference, gastro-oesophageal reflux risk and high prevalence of obstructive sleep apnoea.

Furthermore, obese patients have a decreased functional residual capacity and increased oxygen consumption, leading to a more rapid desaturation after induction. Management of the obese surgical patient is therefore recommended to be performed with careful assessment before surgery, use of appropriate equipment, positioning with a ramp or

a head elevation, effective preoxygenation, and planning for extubation [3].

Laparoscopic surgery poses extra anaesthetic problems. Pneumoperitoneum and Trendelenburg or reverse Trendelenburg position affect the excursion of the diaphragm, decrease respiratory compliance, increase airway pressure, and can exacerbate ventilation-perfusion mismatch. The effects are generally well tolerated in healthy, non-obese patients, but may be clinically relevant in obese patients due to the reduced respiratory reserve. Respiratory changes associated with pneumoperitoneum have been studied and have been found to be associated with reduced compliance and increased airway pressures during laparoscopy [4].

Previous clinical studies have tried to elucidate the relationship between obesity and difficult intubation. The difficult tracheal intubation rate was found to be higher in obese than lean patients by Juvin et al. [5] and later prospective studies with the intubation difficulty scale indicated that intubation was slightly more difficult in obese than in lean patients, but was more difficult to mask ventilate [6]. Wang et al. conducted a meta-analysis of studies that examined the association of obesity with difficult tracheal intubation, difficult laryngoscopy and Mallampati class III/IV, with heterogeneity between cohorts being significant [7].

Obstructive sleep apnoea should also be taken into account when assessing risk in obese patients. The STOP-Bang questionnaire has been evaluated as a screening tool to predict difficult airway in obese surgical patients, and a higher score is correlated with a higher risk of difficult airway [8]. Other parameters like neck circumference, thyromental distance, and the ratio of neck circumference to thyromental distance have also been studied as simple bedside predictors, but their performance is population dependent and operator dependent [9].

Although there is an increasing body of evidence, there are fewer studies that have specifically studied difficult airway events in laparoscopic surgery, where the difficulty of the airway and rapid desaturation may be exacerbated by pneumoperitoneum and surgical positioning. The aim of the present study was to compare the incidence and type of difficult airway events in obese and non-obese adult patients undergoing elective laparoscopic surgery under general anaesthetic. The main aim was to compare the overall incidence of difficult airway events. Secondary endpoints included difficulty with mask ventilation, laryngoscopic view, intubation attempts, use of adjuncts, desaturations, airway trauma, and immediate postoperative airway symptoms.

Materials and Methods

Study design and setting: Prospective comparative observational study in department of Anaesthesiology in tertiary care teaching hospital during 12 months. Patients aged 18 and older who were referred for elective laparotomy or laparoscopy in the abdomen or pelvis under general anaesthetic with endotracheal intubation were screened during their pre-anaesthetic assessment appointment. Patients aged 18 years and older referred for elective laparotomy or laparoscopy in the abdomen or pelvis under general anaesthetic with endotracheal intubation were screened at the pre-anaesthetic assessment appointment.

The number of patients and grouping: 180 patients were consecutively sampled. Patients were randomly assigned to two groups: Group O, obese patients (BMI $\geq$ 30 kg/m2); and Group N, non-obese patients (BMI 18.5-24.9 kg/m2). A sample size of 90 patients per group was deemed sufficient to demonstrate a clinically significant difference in difficult airway events between groups with 80% power and 5% alpha error, with the possibility of incomplete records.

Inclusion criteria: Patients aged 18-65 years, ASA physical status I-III, elective laparoscopic surgery, planned oral endotracheal intubation, and written informed consent were included. Surgeries performed included laparoscopic cholecystectomy, appendectomy, hernia repair, ovarian cystectomy, diagnostic laparoscopy, and total laparoscopic hysterectomy.

Exclusion criteria: Patients with pregnancy, emergency surgery, anticipated full stomach, craniofacial abnormality, airway tumour, restricted mouth opening less than 2 cm, cervical spine instability, previous tracheostomy, severe cardiopulmonary instability, conversion to open surgery before pneumoperitoneum, or refusal of consent were excluded.

Demographic data, BMI, ASA grade, comorbidities, history of snoring or obstructive sleep apnoea, modified Mallampati class, mouth opening, thyromental distance, sternomental distance, neck circumference at the thyroid cartilage level, upper lip bite test, and neck extension were recorded. STOP-Bang score was recorded in obese patients and in non-obese patients when clinically indicated.

Anaesthetic technique: All patients were fasted as per institutional protocol and monitored using electrocardiography, non-invasive blood pressure, pulse oximetry, capnography and temperature monitoring. Patients were preoxygenated with 100% O2 for at least 3 min, with the exception of obese patients, who were placed in a ramped or head-elevated position to position the external

auditory meatus at the level of the sternal notch; non-obese patients were placed in sniffing position unless clinically indicated otherwise. Mask ventilation was evaluated after induction and prior to laryngoscopy.

Airway management: Intubation was done by an anaesthesiologist with a minimum of three years' experience. Initially direct laryngoscopy with a Macintosh blade was performed, and bougie, second generation supraglottic airway, videolaryngoscope and fibreoptic bronchoscope were available as rescue devices. Cormack-Lehane grade, number of attempts, intubation time, external laryngeal manipulation, airway adjuncts, lowest oxygen saturation and airway trauma were recorded. The pneumoperitoneum pressure was kept at 12–14 mmHg. Ventilation was adjusted to keep the end-tidal CO2 between 35 and 45 mmHg.

Primary outcome: difficult airway event (DAE) was defined as difficult mask ventilation, Cormack-Lehane grade III/IV, intubation difficulty scale (IDS) score >5, >1 intubation attempt, bougie/videolaryngoscope/rescue supraglottic device, desaturation <92%, or visible airway trauma. Secondary outcomes were the individual components of the composite endpoint, intubation time, safe apnoea time, sore throat, hoarseness, and cough within 2 hours after extubation.

Data analysis: SPSS version 26.0 was used for statistical analysis. The continuous variables were presented as mean ± SD and analyzed by independent-samples t-test. Categorical variables were expressed as frequency and percentage and compared using chi-square or Fisher exact test. The primary outcome was calculated using relative risk and 95% confidence interval. A p-value <0.05 was considered statistically significant.

Results

A total of 193 patients were screened, of whom 180 fulfilled the eligibility criteria and completed the study. Ninety patients were included in the obese group and 90 in the non-obese group. No patient required emergency front-of-neck access or unplanned postoperative mechanical ventilation.

Table 1: Baseline demographic and airway assessment characteristics

Variable	Obese group (n=90)	Non-obese group (n=90)	p-value
Age (years), mean +/- SD	42.8 +/- 10.6	40.9 +/- 11.2	0.244
Male/Female, n	38/52	36/54	0.764
BMI (kg/m2), mean +/- SD	33.8 +/- 3.6	22.9 +/- 1.8	<0.001
ASA II/III, n (%)	62 (68.9)/18 (20.0)	44 (48.9)/6 (6.7)	0.002
Neck circumference (cm), mean +/- SD	40.8 +/- 3.1	34.6 +/- 2.7	<0.001
Mallampati class III/IV, n (%)	32 (35.6)	13 (14.4)	0.001
Thyromental distance <6.5 cm, n (%)	20 (22.2)	8 (8.9)	0.014
Restricted neck extension, n (%)	14 (15.6)	5 (5.6)	0.030
STOP-Bang score >=3, n (%)	46 (51.1)	12 (13.3)	<0.001

Obese patients had significantly higher BMI, neck circumference, Mallampati class III/IV frequency, short thyromental distance, restricted neck extension, and STOP-Bang score >=3 compared with non-obese patients (Table 1). ASA III status was also more frequent in the obese group.

Table 2: Intraoperative airway events and intubation characteristics

Airway variable	Obese group (n=90)	Non-obese group (n=90)	p-value
Difficult mask ventilation, n (%)	16 (17.8)	5 (5.6)	0.010
Cormack-Lehane grade III/IV, n (%)	18 (20.0)	7 (7.8)	0.017
More than one intubation attempt, n (%)	21 (23.3)	8 (8.9)	0.008
IDS score >5, n (%)	14 (15.6)	4 (4.4)	0.012
Use of bougie/stylet, n (%)	24 (26.7)	10 (11.1)	0.007
Videolaryngoscope rescue, n (%)	8 (8.9)	2 (2.2)	0.050
Intubation time (seconds), mean +/- SD	39.6 +/- 14.8	28.2 +/- 9.7	<0.001
Safe apnoea time (seconds), mean +/- SD	238.5 +/- 56.7	314.6 +/- 62.4	<0.001
SpO2 <92% during airway management, n (%)	12 (13.3)	3 (3.3)	0.017

Difficult mask ventilation, poor laryngoscopic view, repeated intubation attempts, IDS score >5, airway adjunct use, and desaturation were significantly more frequent in obese patients (Table 2). Mean intubation time was approximately 11 seconds longer in the obese group, and safe apnoea time was significantly shorter.

Table 3: Composite difficult airway outcome and postoperative airway symptoms

Outcome	Obese group (n=90)	Non-obese group (n=90)	p-value
Composite difficult airway event, n (%)	25 (27.8)	9 (10.0)	0.003
Relative risk for composite event	2.78 (95% CI 1.38-5.60)	Reference	-
Visible lip/oropharyngeal trauma, n (%)	7 (7.8)	2 (2.2)	0.088
Postoperative sore throat, n (%)	20 (22.2)	9 (10.0)	0.026
Hoarseness within 2 h, n (%)	11 (12.2)	4 (4.4)	0.058
Cough after extubation, n (%)	15 (16.7)	8 (8.9)	0.118
Need for prolonged PACU oxygen >30 min, n (%)	18 (20.0)	7 (7.8)	0.017
Unplanned ICU admission, n (%)	0 (0.0)	0 (0.0)	-

The primary composite difficult airway event occurred in 25 obese patients (27.8%) and 9 non-obese patients (10.0%), corresponding to a relative risk of 2.78. Postoperative sore throat and need for prolonged oxygen supplementation in the post-anaesthesia care unit were significantly higher among obese patients (Table 3).

Discussion

The present study revealed that there was a significant increase in the incidence of difficult airway events in obese adults undergoing laparoscopic surgery under general anaesthetic compared to non-obese adults. The overall difficult airway event rate was 27.8% in obese patients and 10.0% in non-obese patients. This difference was attributed mainly to the poor laryngoscopic view, poor mask ventilation, more intubation attempts, more use of adjuncts, and more oxygen desaturations during airway management.

These findings are clinically plausible as obesity impacts both anatomical and physiological parameters of airway management. Post-induction soft tissue around the upper airway can affect mask seal and collapsibility of the airway. Higher Mallampati class and increased neck circumference may decrease laryngoscopic exposure. Meanwhile, diminished functional residual capacity and increased oxygen demand lead to a decrease in safe apnoea time, and even brief delays to laryngoscopy have clinical significance. A review of oxygenation strategies in obese patients highlighted that functional residual capacity is decreased after induction in obese patients compared to lean patients, particularly in the supine position [10].

The increased difficult mask ventilation rate in the obese group is consistent with previous comparative studies by Shailaja et al., who found that obese patients were more difficult to mask ventilate and slightly more difficult to intubate using the intubation difficulty scale [6].

The intubation difficulty pattern is also similar to that of Juvin et al., who found that difficult intubation was significantly more common in obese patients than in lean patients [5]. The risk, however, is variable between studies due to the varying definitions of difficult airway, experience of the airway operator, positioning and the availability of the device. In the current study, desaturation was four times more common in obese patients when it was < 92%. This is because difficult intubation is dangerous primarily when it is associated with poor oxygenation. Futier et al. have shown that pneumoperitoneum has a negative effect on respiratory mechanics in healthy weight and obese patients, and that some of these effects can be reversed by recruitment manoeuvres during laparoscopic surgery [11]. The combination of obesity, induction of anaesthesia, neuromuscular blockade, supine position and pneumoperitoneum can result in a small oxygenation margin in routine clinical practice before any surgical manipulation has taken place.

The obese group had significantly higher neck circumference and STOP-Bang score. Toshniwal et al. reported that a high STOP-Bang score may be useful to identify obese surgical patients who are at higher risk of difficult airway events [8]. The present study did not conduct multivariate modelling, but the observed association between airway markers and difficult events suggests that the use of BMI alone is not a sufficient airway marker and that combining BMI with Mallampati class, neck circumference, thyromental distance, upper lip bite test, OSA screening, and previous airway history is valuable.

Planning for the airway in obese laparoscopic patients should thus be proactive. Ramped positioning, early use of apnoeic oxygenation (if available), use of a bougie or videolaryngoscope, and avoiding repeated direct laryngoscopy attempts may help minimise airway trauma and hypoxaemia. Rao et al. showed that head-elevated laryngoscopic positioning improved intubating conditions in obese patients compared with the traditional supine position [12]. In our protocol, ramped positioning was used routinely in obese patients, which may be the reason for the lack of emergency surgical airway access.

The results also have implications for postoperative care. In the post-anaesthesia care unit, there were more patients with sore throat and longer duration

of oxygen requirement in obese patients. These symptoms may be indicative of increased airway instrumentation, increased airway pressures, atelectasis, and continued upper airway vulnerability following extubation. Extubation should thus be carefully planned, as it is with intubation, and should involve full reversal of the neuromuscular blockade, head-up positioning, suctioning under direct vision if necessary, oxygen supplementation, and proper monitoring for obstruction or desaturation.

The advantages of this study are that it is prospective, the groups are equal in size, the airway definitions are standardized, both intubation and oxygenation outcomes are included, and it focuses on laparoscopic surgery. There are also some limitations of the study. It was single-centre and observational, and may not be generalizable.

In most patients, direct laryngoscopy was the first method used, and the results may differ in institutions where videolaryngoscopy is the primary method. The study included only a small number of morbidly obese patients and only compared obese and normal BMI patients, not overweight patients. Lastly, long-term postoperative pulmonary outcomes were not assessed.

In summary, the present findings confirm that obesity is not only a demographic factor, but also a risk modifier for airway and oxygenation issues during laparoscopic surgery. The best way to do this is to not assume that all obese patients will be impossible to intubate, but to expect that they may be more likely to be difficult to ventilate, may need to be intubated more than once, may have a shorter safe apnoea time, and may require oxygen after the procedure. A written airway plan for these risks can enhance safety and minimise preventable complications.

Conclusion

The rate of difficult airway events was significantly higher in obese patients who underwent laparoscopic surgery under general anaesthesia than in non-obese patients. The excess risk was seen in the form of poor mask ventilation, poor laryngoscopic view, repeated intubation attempts, use of more airways, reduced safe apnoea time, oxygen desaturations, and higher postoperative airway symptoms.

The results of this study emphasize the importance of careful preoperative airway screening, rammed positioning, proper preoxygenation, early use of airway adjuncts, and careful extubation and recovery monitoring in obese patients undergoing laparoscopic procedures.

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