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Review article

Intubation and obesity: key challenges – a narrative review

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Abstract

Background and purpose: *Obesity is a complex, multifactorial, chronic disease. It is defined as a body mass index (BMI) of 30 kg/m² or higher. The prevalence of obesity is on the rise worldwide. The aim of this paper is to present the complexity of airway management in obese patients and current recommendations.*

Materials and methods: *We searched the PubMed database using the keywords: "obesity" in combination with either "airway management" or "intubation, intratracheal". Between February 2020 and January 2025, a total of 34 articles relevant to this review were published.*

Discussion / Results: *Obese patients are a challenge for any anesthesiologist due to the increased risk of periprocedural complications. One of the major challenges is maintaining the airway in obese patients. An improved understanding of the specific anatomy of the airway, pathophysiology, and pharmacology of obesity makes it easier for an anesthesiologist to correctly and safely approach the patient.*

Abbreviations

AI	– artificial intelligence
AFOI	– awake fiberoptic intubation
ASA	– American Society of Anesthesiologists
BMI	– body mass index
CAFG	– Canadian Airway Focus Group
CICO	– can not intubate, can not oxygenate
CPAP	– continuous positive airway pressure
DAS	– Difficult Airway Society
ETT	– endotracheal tube
FONA	– front of neck airway
FRC	– functional residual capacity
GLP-1 agonists	– glucagon-like peptide-1agonists
HFNC	– high-flow nasal cannula
NC	– neck circumference
NC/TMD	– neck circumference to thyromental distance ratio
OSA	– obstructive sleep apnea
PEEP	– positive end-expiratory pressure
PoCUS	– point of care ultrasound
SARI	– Simplified Airway Risk Index
SAT	– safe apnea time
SGA	– supraglottic airway
SMD	– sternomental distance
SMDD	– sternomental displacement distance
THRIVE	– transnasal humidified rapid-insufflation ventilatorye exchange
TMD	– thyromental distance
WHO	– World Health Organization

***Conclusions**: When ensuring the airway of obese patients, it is crucial to objectively assess the risk in a timely manner and select appropriate respiratory management techniques to ensure a favorable outcome and minimize risks.*

INTRODUCTION

Obesity is a chronic multifactorial metabolic disease, often of a recurrent character. In obesity, there is an excessive accumulation of adipose tissue in the body. In adults, it is most often defined by the body mass index (BMI), which is equal to or greater than 30 kg/m2. According to BMI, obesity in the adult population is divided into 3 categories: class 1 (BMI of 30 to 34.9 kg/m2), class 2 (BMI of 35 to 39.9 kg/m2) and class 3 (BMI of > 40 kg/m2). In clinical practice, two subgroups of class 3 are often distinguished: super obesity (BMI of 50 to 59 kg/m2) and super-super obesity (BMI > 60 kg/m2).

World Health Organization (WHO) data state that in 2022, 2.5 billion adults aged 18 years and older were overweight, including over 890 million adults who were living with obesity*(1)*. The same source also noted that worldwide adult obesity has more than doubled since 1990, and adolescent obesity has quadrupled *(1)*.

Based on the data presented, it is clear that overweight and obesity is a pandemic of the modern age. Therefore, it is not surprising that this group of patients has become part of the daily work of anesthesiologists. Obese patients are a challenge for every anesthesiologist due to the increased risk of developing numerous complications, mostly those related to airway maintenance. Airway maintenance in obese patients involves a number of complex procedures and requires thorough risk assessment and careful preparation.

Given the growing prevalence of obesity, the aim of this paper is to present the current concepts of safe access to airway maintenance in obese patients.

MATERIAL AND METHODS

We searched the PubMed database for papers dealing with the treatment of difficult airway managent in obese

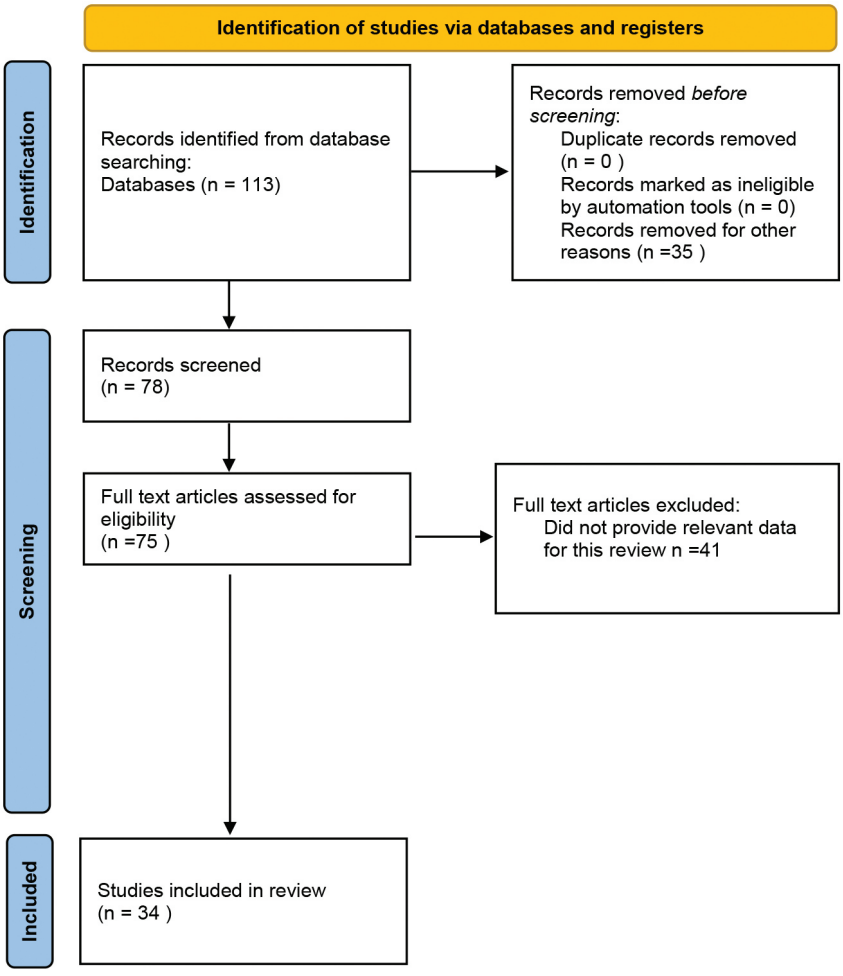

Figure 1. *The PRISMA flow diagram illustrates the process of literature search and selection in this review (2)*

patinets and tried to find what would be the best way to manage the airway in those patients. A literature review was conducted in 2025 using the search terms “obesity” in combination with either “airway management” or “ intubation, intratracheal.” The search was limited to publications published between February 2020 and January 2025. Additional inclusion criteria were that the articles were published in English and focused on populations aged 19 years and older.

Based on the criteria mentionned above, we found 34 publications relevant to the topic of the research (Figure 1).

DISCUSSION

Despite the advancement of technologies, the expansion of acquired skills, techniques and knowledge, a difficult airway, whether planned or unplanned, still remains an anesthesiologist's nightmare.The literature continues to report devastating data related to the consequences of inadequately cared for airway and consequently increased morbidity and mortality *(3).*

Various associations tried to define and explain what a difficult airway actually is. In 2013, the ASA Association defined a difficult airway when "a conventionally trained anesthesiologist experiences difficulty with facemask ventilation of the upper airway, difficulty with tracheal intubation, or both" *(4).* The guidelines of the same association (ASA) from 2022 try to explain the issue in even more details and divide and define the difficult airway into several categories: difficult facemask ventilation, difficult laryngoscope, difficult supraglottic airway ventilation, difficult or failed tracheal intubation, difficult or failed tracheal extubation, difficult or failed invasive airway, and inadequate ventilation *(5).*Likewise, ASA guidelines recommend limiting airway management attempts with any technique class (face mask, SGA, ETT) to three, with one additional attempt by a clinician with higher skills *(5).*

Airway access in obese people is even more complex, given that the incidence of difficult intubation in obese patients is three times higher that of normal weight patients *(6.* The Fourth National Audit Project (NAP- 4) study describes complications related to airway maintenance in the United Kingdom and clearly singles out obese patients who have a higher risk of complications during intubation and extubation *(7).*

In addition to the burden of comorbidities that accompany obesity (diabetes, hypertension, coronary artery disease, heart failure, obstructive sleep apnea, obesity hypoventilation syndrome, metabolic syndrome, stroke..), the circumstances are aggravating anatomical changes in the airway and pathophysiological changes in respiratory function.

With a wide, short neck, limited mobility, obese patients have increased fat deposits in the oral and pharyngeal areas, which can narrow the airway and alter the shape of the oropharynx *(8).*

Restrictive changes in pulmonary function in obese patients with increased oxygen requirements result in rapid desaturation in the process of induction and intubation. This limits the possibility of prolonged airway maintenance procedures *(9).*

Today there is still no consensus on the best method to assess a difficult airway *(10)*, however, by using predictors that can recognize a difficult airway, proper preparation and implementation of existing algorithms for the management of a difficult airway, it is possible to minimize the risk.

Preanesthetic evaluation – the prediction of difficult airway

Anamnesis

A thorough medical history is the first tool that can help us assess airway difficulties in general, including in the obese population. Sometimes it can be an almost banal information about a recent acute infection of the respiratory system wich will increase the risk of laryngospasm and bronchospasm. However, in obese individuals, the presence of multiple comorbidities often creates a complex relationship that makes airway access more difficult. For example, uncontrolled diabetes mellitus can exacerbate temporomandibular disorders and impair temporomandibular joint function. Authors showed a clear correlation between temporomandibular disorders' increasing incidence and severity with diabetes mellitus *(11).* Obesity often accompanies congenital diseases and malformations when the airway maintenance procedure can be even more complicated due to the anatomical characteristics of the head and neck (Sy Down, Sy Prader – Willi). Certainly, a history of previous severe or unsuccessful intubation is a significant predictor of future intubation difficulties *(12).*

Furthermore, it is important to have insight into the medications involved in the patient's therapy. In recent years, in addition to diabetes mellitus, glucagon-like peptide-1 (GLP-1) agonists have often been used in the treatment of obesity. Slow passage, longer retention of food in the stomach, increases the risk of aspiration even with adequate preoperative fasting. The complexity of the issue is clear from the need to find solutions when several professional associations offered guidelines for the treatment of patients on GLP-1 agonist therapy in 2024 *(13).* According to the guidelines for patients identified with an increased risk profile, use of a liquid diet for at least 24 h before preoperative fasting period showed to decrease the risk of retained gastric contents on the day of the procedure *(13).* Regarding the abolition of GLP-1 agonist therapy, an individual approach is recommended, a benefit-risk ratio, which refers to the potential risk of aspira-

tion on the one hand or poor glycemic regulation on the other. At this time, it is suggested to follow the guidance of the American Society of Anesthesiologists consensus-based guidance: holding the day of surgery for daily formulations and a week before surgery for weekly formulations *(14)*.

On the day of the procedure, it is necessary to assess in patients on GLP-1 agonist therapy whether there is a delay in gastric emptying, i.e. residual food, optimally by ultrasound. Gastric point-of-care ultrasound (PoCUS) is a noninvasive method that can be used to assess aspiration risk in the obese patient by evaluating gastric contents *(10)*. It is important not to forget that PoCUS cannot predict other risk factors that contribute to an increased risk of aspiration in induction into anesthesia in obese patients (gastroparesis, prolonged mask ventilation, hiatal hernia).

Due to the often present obstructive sleep apnea (OSA) in obese people, the use of tools that verify it is mandatory. The most commonly used is the STOP-BANG questionnaire. Seet and all state that moderate and severe OSA were associated with difficult intubation: a higher STOP-Bang score of 3 or more may be associated with difficult intubation *(15)*.

Physical examination

In general, predictors of difficult airway can be divided into anatomical, functional and broader, scoring systems. The most commonly used anatomical criteria are facial characteristics or measures of the distance of anatomical points, for example: structure and position of the mandible (retrognathia, micrognathia), mouth opening, inter-incisor gap, presence of prominent upper incisors, neck circumference, thyromental distance, sternomental distance, hyoidmental distance, ratio of neck circumference to thyromental distance, ratio of height to thyromental distance, thyromental height, the modified Mallampati test.

The upper lip bite test, cervical-spine mobility, sternomental displacement distance (SMDD) are examples of functional predictors of airway obstruction.

Since no feature alone is often sufficiently sensitive, there are also scores in the prediction of a difficult airway. For example, the Wilson score evaluates the airway using: body weight, head and neck movement, jaw movement, retrognathia, and prominent incisors *(16)*. The Simplified Airway Risk Index (SARI), described by El-Ganzouri et al., is a scoring system that considers factors such as the interincisor gap, thyromental distance, modified Mallampati test, neck mobility, mandibular protrusion, body weight, and a history of difficult intubation *(17)*.

The question arises: do the same predictors help us assess a difficult airway in obese people?

It is well-known that body mass index (BMI) as a predictor of difficult airway has remained controversial *(18)*. The authors state that in accordance with the increase in BMI, we can expect more difficult ventilation with a mask, but on the other hand, there are contradictory data related to endotracheal intubation and an increase in BMI. According to the above mentioned BMI, it is not a good predictor of difficult intubation, which is explained by the existence of different anatomical features of the face and neck at the same numerical BMI values *(19)*. BMI in adults is calculated by dividing weight in kilograms by height in meters squared. However, this definition highlights a key limitation - it doesn't directly account for body fat percentage. In other words, two people of the same height and weight can have the exact same BMI, yet one may have an athletic build with a high proportion of muscle mass, while the other may be obese with a higher percentage of body fat.

According to Kaya et al., obese patients have a higher incidence of high Mallampati scores compared to non-obese individuals *(20)*.Sinha et al. investigate several predictors of airway obstruction preoperatively (neck circumference – NC, BMI, STOP - BANG score, Mallampati score, obstructive sleep apnea grade and waist circumference) in 834 patients with BMI >35 kg/m2. In their work, they come to the conclusion that BMI and NC have a strong association with difficult airway in obese patients and are inversely related to safe apnea time (SAT). They point out NC as the strongest predictor of a difficult airway in obese patients and recommend it for screening *(18)*. Studies have reported that both increased neck circumference and restricted cervical spine mobility independently predict a difficult airway *(21)*.

Sternomental displacement (SMDD) is a parameter that quantifies the difference between the sternomental distance (SMD) measured with the head extended (SMD-extension) and the SMD measured in a neutral head position (SMD-neutral). According to what has been described, it is a reflective marker of cervical spine mobility, which in combination with NC highly predictive indicating a difficult *(22)*. Gorgy comes to the conclusion that SMDD and NC/SMDD ratios in obese surgical patients are excellent predictors for difficult laryngoscopy view *(23)*.

A prospective observational cohort study published in 2020 that included 401 patients of bariatric surgery, states that NC scored the highest statistically significant value in both difficult mask vetilation and difficult intubation. Other factors, such as OSA, BMI, and DM, showed a tendency to contribute to airway difficulties, but not in a statistically significant manner *(24)*. Paper from 2024 by Sharma and all. underlines its results according to which neck circumference (NC), thyromental distance (TMD), and neck circumference to thyromental distance ratio (NC/TMD) depicted high statistical significance and close association with airway difficulty in obese patients *(25)*.

Due to its non-invasiveness and accessibility, ultrasound has naturally become a valuable tool in analyzing

factors associated with a difficult airway. Ultrasound-guided measurements of anterior neck soft tissue thickness, BMI, and neck circumference are reliable predictors of difficult laryngoscopy in obese patients, with anterior neck soft tissue thickness being the strongest independent predictor *(26)*. Unfortunately, previous studies investigating the role of ultrasound in the assessment of difficult airway access include a smaller number of patients.

In addition to the above, we should not forget about simple „ bedsite" mnemonic tools / acronyms for difficult mask ventilation or difficult intubation where obesity is included as a risk factor:

MOANS: *M*ask seal / *O*bstructio / *O*besity / *A*ge > 55 years / *N*o teeth / *S*tiff lungs or C-spine

LEMON: *L*ook / *E*valuate 3-3-2 / *M*allampati / *O*bstruction / *O*besity / *N*eck *(27)*.

The mentioned acronyms can serve as an early warning for a difficult airway.

Airway management strategies and techniques

Positioning

It is well known that positioning the patient with the external auditory meatus aligned with the sternal notch, known as the ramp-up position, significantly improves both intubation success and oxygenation compared to the sniffing position *(28)*. Furthermore, the ramped position helps enhance lung mechanics, reduces the adverse effects of obesity on respiratory function and hemodynamics, and ultimately supports oxygenation while maximizing safe apnea duration *(19)*.

Oxygenation

Preoxygenation is a crucial step in obese patient airway management with a goal to increase the body's oxygen reserves before induction of anesthesia.

Anesthesia induction is accompanied by a period of breathing cessation that lasts until the recovery of spontaneous ventilation or the onset of mechanical ventilation. During this period, oxygen needs are met by the functional residual capacity (FRC) and mask ventilation (unless ventilation with a mask is not possible, like in rapid sequence induction). It has been proven that obese patients desaturate significantly faster than non-obese patients with a significant negative linear correlation between time to desaturation and obesity *(18,29)*.

Continuous oxygenation is mandatory during airway managemnet in obese patients. During the introduction of anesthesia, apnea in obese patients, oxygen insufflation through a nasopharyngeal airway and standard nasal cannula significantly increase the safe apneic time *(30)*. High-flow nasal cannula (HFNC) delivers up to 60 L of warm, humidified 100% oxygen through nasal prongs, generating positive end-expiratory pressure (PEEP). Studies investigating the role of HFNC in lengthening the SAT have conflicting results *(31,32)*.

While HFNC primarily provides high-flow oxygen, transnasal humidified rapid-insufflation ventilatorye exchange (THRIVE) takes it further by incorporating CPAP and improving gas exchange through dead space washout. THRIVE optimizes ventilation, especially in obese patients who have reduced lung capacity and oxygen reserves. The use of CPAP and PEEP during anesthesia induction in morbidly obese patients, especially when difficult airway management is expected, extends the duration of non-hypoxic apnea by 50% *(33)*.

Airway management

Management of difficult airway in obese people includes non-invasive and invasive methods. With adequate preparation, the clinician must choose the best method individually oriented to the patient with obesity, always readily expecting a difficult airway.

Knowledge of the guidelines for the management of airway difficulties of the three main associations in this field (American Society of Anesthesiologists - ASA, Difficult Airway Society - DAS, Canadian Airway Focus Group - CAFG) is necessary, and the choice of guidelines and implementation remains with the clinician and the best possible applicable practice.

Supraglottic airway devices

Supraglottic airway devices (SGAs) are often used as an alternative when mask ventilation is challenging or unsuccessful. In addition to the previously described beneficial effect SGAs can facilitate endotracheal intubation, especially when paired with an airway exchange catheter *(19,34)*.

Laryngoscopy

Liew et al., in their 2022 review article, emphasize that "the first attempt is the best attempt" when it comes to laryngoscopy and intubation, with the goal of securing the airway as quickly as possible *(35)*. Research seek to define which type of laryngoscopy: direct or video has an advantage in airway management in obese patients. Meta-analysis from 2024 suggests that videolaryngoscopy provides a safer airway management option for patients with obesity, as it enhances first-pass intubation success rates compared to direct laryngoscopy. Although the time to intubation did not show a significant difference between the two methods, the overall advantage of videolaryngoscopy in this high-risk group is clear *(36)*. As the use of the videolaryngoscope has entered everyday practice, it is clear that researches in recent years have highlighted its advantage due to the easier visualization of laryngeal structures. However, since the insertion of the tube itself

and with a videolaryngoscope can still be problematic, the authors conclude that the decision on the type of laryngoscope should be up to the anesthesiologist and the technique in which he is more skilled *(35)*.

Awake fiberoptic intubation (AFOI)

According to ASA guidelines, awake fiberoptic intubation (AFOI) is a safe option when we expect a difficult airway *(5)*. AFOI provides the possibility of securing the airway under the control of optics with the benefit of sustained spontaneous ventilation of the patient. As it requires a longer learning curve path to master the technique and learn, unlike videolaryngoscopy, which is similar to conventional laryngoscopy, awake videolaryngoscopy is offered as an option for accessing a difficult airway. It is clear if the insertion of a videolaryngoscope blade into the oral cavity is possible. AFOI is not pleasant for the patient. It requires techniques of applying local anesthetic according to the principle of "spray as you go", and conscious sedation with oxygenation techniques.

Surgical airway

We should not forget that the "cannot intubate, cannot oxygenate" (CICO) situation is a rare but life-threatening event. In such cases, front of neck airway (FONA) management becomes essential, involving emergency surgical techniques to establish an airway when standard methods fail. According to DAS guidelines, the scalpel-bougie-tube technique is preferred over needle cricothyroidotomy, and a tracheostomy should be considered if cricothyroidotomy fails. *(37)*. FONA is considered the last resort in airway management, but its timely execution is crucial for patient survival in airway emergencies.

Principles of drug dosing

Finally, it should not be ignored that the pharmacodynamics and pharmacokinetics of anesthetics and neuromuscular relaxants in obese patients are altered, which can further compromise both hemodynamic stability and airway. Whenever possible, preference should be given to regional anesthesia and opioid-sparing anesthesia *(9)*.

Accurate drug dosing is crucial: for most anesthetic agents, analgesics, and local anesthetics, lean body weight is the recommended guide for dosing, with the exception of non-depolarizing neuromuscular blockers (which are based on ideal body weight) and succinylcholine and sugammadex (which are dosed according to actual body weight *(38)*.

Documentation

The documentation of medical observations is unquestionable. „AIRWAY ALERT“ from the Difficult Airway Society (DAS) is designed to identify and document patients with difficult airways to enhance safety in future procedures. This involves recording past airway issues, ensuring communication between medical teams, and planning alternative intubation strategies. The focus is on sharing information to reduce the risk of airway complications in future cases *(37)*.

At the end, as technology continues to advance, there is growing interest in the potential role of artificial intelligence (AI) in managing airway in obese patients. While AI shows promise in improving airway assessment, prediction, and intervention strategies, further research is needed to confirm its effectiveness in enhancing patient outcomes.

CONCLUSION

When ensuring the airway of obese patients, timely objectification of risks with an individual plan for each patient is of utmost importance. All team members involved in the management of the airway in obese people must be familiar with the plan. Choosing the appropriate respiratory maintenance technique in accordance with current guidelines leads to a favorable outcome with an acceptable risk. Given the specific anatomical and pathophysiological changes of obese people, guidelines for airway management directed towards this population are necessary.

REFERENCES

1. World Health Organization. Obesity and overweight [Internet]. Geneva: WHO; 2021 [cited 2021 Sep 27]. Available from: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight
2. PAGE MJ, McKENZIE JE, BOSSUYT PM, BOUTRON I, HOFFMANN TC, MULROW CD, MOHER D, LARDETTE R, TELLEZ D, CHOWDHURY M, MCKENNA J, TURNER L, SHAMSIDDINI A, RICHARDSON WS, CAMPBELL P, ALFARO V, STEWART LA 2021 The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ 372:n71. https://doi.org/10.1136/bmj.n71
3. JOFFE AM, AZIZ MF, POSNER KL, DUGGAN LV, MINCER SL, DOMINO KB 2019 Management of Difficult Tracheal Intubation: A Closed Claims Analysis. Anesthesiology 131: 818–29. https://doi.org/10.1097/ALN.0000000000002815
4. APFELBAUM JL, HAGBERG CA, CAPLAN RA, BLITT CD, CONNIS RT, NICKINOVICH DG, CAPLAN RA, BENUMOF JL, BERRY FA, BLITT CD, BODE RH, CHENEY FW, CONNIS RT, GUIDRY OF, OVASSAPIAN A 2013 Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Anesthesiology 118(2): 251–70. https://doi.org/10.1097/ALN.0b013e31827773b2
5. APFELBAUM JL, HAGBERG CA, CONNIS RT, ABDELMALAK BB, AGARKAR M, DUTTON RP, FIADJOE JE, GREIF R, KLOCK PA, MERCIER D, MYATRA SN, O SULLIVAN EP, ROSENBLATT WH, SORBELLO M, TUNG A 2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway. Anesthesiology 136: 31–81. https://doi.org/10.1097/ALN.0000000000004002
6. SHIGA T, WAJIMA Z, INOUE T, SAKAMOTO A 2005 Predicting difficult intubation in apparently normal patients: a meta-

analysis of bedside screening test performance. Anesthesiology 103: 429–437. https://doi.org/10.1097/00000542-200508000-000

7. COOK TM, WOODALL N, FRERK C 2011 Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 1: anaesthesia. Br J Anaesth 106: 617–631. https://doi.org/10.1093/bja/aer058
8. HORNER RL, MOHIADDIN RH, LOWELL DG, SHEA SA, BURMAN ED, LONGMORE DB, GUZ A 1989 Sites and sizes of fat deposits around the pharynx in obese patients with obstructive sleep apnoea and weight-matched controls. Eur Respir J 2: 613–22. https://doi.org/10.1183/09031936.93.02070613
9. PRATHEP S, JITPAKDEE W, WORAATHASIN W, OOFUVONG M 2022 Predicting difficult laryngoscopy in morbidly obese Thai patients by ultrasound measurement of distance from skin to epiglottis: a prospective observational study. BMC Anesthesiol 22: 145. https://doi.org/10.1186/s12871-022-01685-7
10. MOON TS, VAN DE PUTTE P, DE BAERDEMAEKER L, SCHUMANN R 2021 The Obese Patient: Facts, Fables, and Best Practices. Anesth Analg 132(1): 53–64. https://doi.org/10.1213/ane.0000000000004772
11. AHMED A, SHAIKH SH, IQBAL H, ESSARANI RS, AZAM HM, ASHRAF M 2024 Relationship between diabetes and temporomandibular joint disorder. J Popul Ther Clin Pharmacol 31(7): 633–644. https://doi.org/10.53555/jptcp.v31i7.7042
12. DETSKY ME, JIVRAJ N, ADHIKARI NK, FRIEDRICH JO, PINTO R, SIMEL DL, WIJEYSUNDERA DM, SCALES DC 2019 Will This Patient Be Difficult to Intubate?: The Rational Clinical Examination Systematic Review. JAMA 321: 493–503. https://doi.org/10.1001/jama.2018.21413
13. KINDEL TL, WANG AY, WADHWA A, SCHULMAN AR, SHARAIHA RZ, KROH M, GHANEM OM, LEVY S, JOSHI GP, LAMASTERS TL 2024 Multisociety clinical practice guidance for the safe use of glucagon-like peptide-1 receptor agonists in the perioperative period. Surg Obes Relat Dis 20(12): 1183–1186. https://doi.org/10.1016/j.soard.2024.08.033
14. JOSHI GP, ABDELMALAK BB, WEIGEL WA, SORIANO SG, HARBELL MW, KUO CI, STRICKER PA, DOMINO KB 2023 American Society of Anesthesiologists consensus-based guidance on preoperative management of patients (adults and children) on glucagon-like peptide-1 (GLP-1) receptor agonists [Internet]. Schaumburg (IL): American Society of Anesthesiologists; https://www.asahq.org/about-asa/newsroom/news-releases/2023/06/glp1-guidance
15. SEET E, CHUNG F, WANG CY, TAM S, KUMAR CM, UBEYNARAYANA CU, YIM CC, CHEW EFF, LAM CKM, CHENG BCP, CHAN MTV 2021 Association of Obstructive Sleep Apnea With Difficult Intubation: Prospective Multicenter Observational Cohort Study. Anesth Analg 133(1): 196–204. https://doi.org/10.1213/ane.0000000000005479
16. XIA M, MA W, ZUO M, DENG X, XUE F, BATTAGLINI D, AGGARWAL V, VARRASSI G, CERNY V, DI GIACINTO I, CATALDO R, MA D, YAMAMOTO T, REKATSINA M, DE CASSAI A, CARSETTI A, CHANG MG, SEET E, DAVIS DP, IRWIN MG, HUANG Y, JIANG H 2023 Expert consensus on difficult airway assessment. Hepatobiliary Surg Nutr 12(4): 545–566. https://doi.org/10.21037/hbsn-23-46
17. EL-GANZOURI AR, MCCARTHY RJ, TUMAN KJ, TANCK EN, IVANKOVICH AD 1996 Preoperative airway assessment: predictive value of a multivariate risk index. Anesth Analg 82(6): 1197–204. https://doi.org/10.1097/00000539-199606000-00017
18. SINHA A, JAYARAMAN L, PUNHANI D 2020 Predictors of difficult airway in the obese are closely related to safe apnea time! J Anaesthesiol Clin Pharmacol 36(1): 25–30. https://doi.org/10.4103/joacp.JOACP_164_19
19. THOTA B, JAN KM, OH MW, MOON TS 2022 Airway management in patients with obesity. Saudi J Anaesth 16: 76–81. https://doi.org/10.1186/s12871-022-01685-7
20. KAYA C, BILGIN S, CEBECI GC, TOMAK L 2019 Anaesthetic Management of Patients Undergoing Bariatric Surgery. J Coll Physicians Surg Pak 29(8): 757–762. https://doi.org/10.29271/jcpsp.2019.08.757
21. SALOME CM, KING GG, BEREND N 2010 Physiology of obesity and effects on lung function. J Appl Physiol (1985) 108(1): 206–11. https://doi.org/10.1152/japplphysiol.00694.2009
22. PRAKASH S, MULLICK P, BHANDARI S, KUMAR A, GOGIA AR, SINGH R 2017 Sternomental distance and sternomental displacement as predictors of difficult laryngoscopy and intubation in adult patients. Saudi J Anaesth 11(3): 273–278. https://doi.org/10.4103/1658-354X.206798
23. GORGY A, AHMED A, ATEF M, MEKAWY N, SAMI W, NAGY H 2023 Sternomental displacement and neck circumference: a new look for the neck as a difficult airway predictor in obese surgical patients—a cohort study. Ain-Shams J Anesthesiol 15: 58. https://doi.org/10.1186/s42077-023-00355-1
24. RAJU VEGESNA AR, AL-ANEE KN, BASHAH MMM, FARAJ JH 2020 Airway management in bariatric surgery patients, our experience in Qatar: A prospective observational cohort study. Qatar Med J 2020(1): 2. https://doi.org/10.5339/qmj.2020.2
25. SHARMA V, YADAV HP, PRAKASH A, YADAV N, KUMAR M, ABBAS H 2024 Assessment of Different Indices as Predictors of Difficult Airway in Obese Patients. Cureus 16(2): e55005. https://doi.org/10.7759/cureus.55005
26. JAIN S, KACHRU N, YADAV R 2021 Evaluation of Ultrasound Guided Measurement of Anterior Neck Soft Tissue Thickness in Predicting Difficult Laryngoscopy in Obese Patients. Arch Anesth Crit Care 7(4): 216–222. https://doi.org/10.18502/aacc.v7i4.7627
27. JUNG H 2023 A comprehensive review of difficult airway management strategies for patient safety. Anesth Pain Med (Seoul) 18(4): 331–339. https://doi.org/10.17085/apm.23123
28. COLLINS JS, LEMMENS HJ, BRODSKY JB, BROCK-UTNE JG, LEVITAN RM 2004 Laryngoscopy and morbid obesity: a comparison of the "sniff" and "ramped" positions. Obes Surg 14(9): 1171–5. https://doi.org/10.1381/0960892042386869
29. JENSE HG, DUBIN SA, SILVERSTEIN PI, O'LEARY-ESCOLAS U 1991 Effect of obesity on safe duration of apnea in anesthetized humans. Anesth Analg 72(1): 89–93. https://doi.org/10.1213/00000539-199101000-00016
30. MOON TS, TAI K, KIM A, GONZALES MX, LU R, PAK T, SMITH K, CHEN JL, MINHAJUDDIN AT, NNAMANI N, FOX PE, OGUNNAIKE B 2019 Apneic Oxygenation During Prolonged Laryngoscopy in Obese Patients: a Randomized, Double-Blinded, Controlled Trial. Obes Surg 29(12): 3992–3999. https://doi.org/10.1007/s11695-019-04077-y
31. WONG DT, DALLAIRE A, SINGH KP, MADHUSUDAN P, JACKSON T, SINGH M, WONG J, CHUNG F 2019 High-Flow Nasal Oxygen Improves Safe Apnea Time in Morbidly Obese Patients. Anesth Analg 129(4): 1130–1136. https://doi.org/10.1213/ANE.0000000000003966
32. HAMP T, PRAGER G, BARON-STEFANIAK J, MÜLLER J, BICHLER C, PLÖCHL W 2021 Duration of safe apnea in patients with morbid obesity during passive oxygenation using high-flow nasal insufflation versus regular flow nasal insufflation a randomized trial. Surg Obes Relat Dis 17: 347–355. https://doi.org/10.1016/j.soard.2020.09.027
33. GANDER S, FRASCAROLO P, SUTER M, SPAHN DR, MAGNUSSON L 2005 Positive end-expiratory pressure during induction of general anesthesia increases duration of nonhypoxic apnea in morbidly obese patients. Anesth Analg 100: 580–584. https://doi.org/10.1213/01.ANE.0000143339.40385.1B

34. SINHA A, JAYARAMAN L, PUNHANI D 2019 The supraglottic airway device as first line of management in anticipated difficult mask ventilation in the morbidly obese. J Anaesthesiol Clin Pharmacol 35: 540–545 https://doi.org/10.4103/joacp.joacp_159_19

35. LIEW WJ, NEGAR A, SINGH PA 2022 Airway management in patients suffering from morbid obesity. Saudi J Anaesth 16: 314–321. https://doi.org/10.4103/sja.sja_90_22

36. CHAUDERY H, HAMEED H, SHARIF Z, ASINGER S, MCKECHNIE A 2024 Comparative efficacy of videolaryngoscopy and direct laryngoscopy in patients living with obesity a meta-analysis. Cureus 16: e76558. https://doi.org/10.7759/cureus.76558

37. FRERK C, MITCHELL VS, MCNARRY AF, MENDONCA C, BHAGRATH R, PATEL A, O'SULLIVAN EP, WOODALL NM, AHMAD I 2015 Difficult Airway Society 2015 guidelines for management of unanticipated difficult intubation in adults. Br J Anaesth 115: 827–848. https://doi.org/10.1093/bja/aev371

38. CARRON M, SAFAEE FAKHR B, IEPPARIELLO G, FOLETTO M 2020 Perioperative care of the obese patient. Br J Surg 107: e39–e55. https://doi.org/10.1002/bjs.11447