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Factors influencing difficult and failed intubation in patients undergoing gynecologic oncology surgery: a retrospective cohort study

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ABSTRACT

Objectives: Difficult and unsuccessful intubation is a leading cause of anesthesia-related morbidity and mortality. This study aimed to investigate the incidence and contributing factors of difficult and unsuccessful intubation in patients undergoing gynecologic oncology surgery, particularly those with significant comorbidities and obesity.

Methods: The study included 653 patients over 18 years of age who underwent gynecologic oncology surgery with planned intubation under general anesthesia between January 1 and July 1, 2024. Data collected included demographic information, number of intubation attempts, personnel involved in intubation, auxiliary methods employed, intubation duration, complications, mouth opening, sternomental distance, thyromental distance, neck mobility, upper lip bite test results, presence of retrognathia or micrognathia, obstructive sleep apnea, and mobile dentures.

Results: The incidence of difficult intubation in our cohort was 7.5%, with no cases of failed intubation. Significant factors associated with increased risk of difficult intubation included body mass index (P=0.008), obstructive sleep apnea (P<0.001), Mallampati score (P<0.001), and mouth opening <4 cm (P<0.001). Among patients with difficult intubation, statistically significant differences were observed for age (P=0.001), ASA score (P=0.002), presence of comorbid conditions(P=0.004), Cormack-Lehane score(P<0.001), sternomental distance <12 cm (P<0.001), thyromental distance <6 cm (P<0.001), limited neck mobility (P<0.001), upper lip bite test results (P<0.001), retrognathia/micrognathia (P<0.001), and presence of dentures (P<0.001).

Conclusions: This study demonstrated that preoperative assessments of body mass index, obstructive sleep apnea, Mallampati score, and mouth opening are significant risk factors for difficult intubation. To reduce the risk of airway-related complications, patients undergoing gynecologic oncology surgery should undergo thorough and careful preoperative evaluation.

Keywords: Gynecologic oncology, airway management, difficult intubation, predictive, general anesthesia

Anesthesiologists are equipped with basic airway management tools and adhere to globally accepted guidelines. According to the 2022 guidelines from the American Society of Anesthesiologists (ASA), a situation requiring multiple attempts or in which tracheal intubation fails despite attempts

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is defined as 'difficult or unsuccessful intubation' [1]. With updated guidelines, advances in technology, and auxiliary devices, airway management has become safer, helping to prevent severe complications, including life-threatening events [2].

While managing expected or unexpected difficult intubation is a fundamental skill for all anesthesiologists, a thorough preoperative evaluation of patients remains essential. However, no test offers high sensitivity and specificity for predicting difficult intubation during preoperative assessment [3]. Standard preoperative evaluations alone are insufficient in accurately predicting difficult intubation [4, 5]. The incidence of difficult intubation in general anesthesia ranges from 1% to 13%, with unsuccessful intubation occurring in up to 0.1%-0.2% of cases [4, 6].

The patient population undergoing gynecologic oncology surgery is considered high-risk due to the presence of serious comorbidities, as well as prior exposure to radiotherapy and chemotherapy [7]. While obesity and a high body mass index (BMI) are commonly observed in this population, low BMI can also occur [8]. The combination of obesity and comorbidities may lead to both anticipated and unanticipated airway-related complications. A thorough understanding of the demographic characteristics of this population is essential for managing difficult or unsuccessful intubation, as well as minimizing morbidity and mortality [9]. It is crucial for patient safety that any challenges encountered in airway management are addressed according to current guidelines, with proper preparation and equipment.

This study aimed to determine the incidence of difficult and unsuccessful intubation and the factors influencing these outcomes in patients undergoing gynecologic oncology surgery with significant comorbidities.

METHODS

This retrospective study was conducted at a tertiary education and research hospital and was approved by the Ankara Etlik City Hospital Scientific Research Evaluation and Ethics Committee (AEŞH-BADEK-2024-528). The study adhered to the principles outlined in the Declaration of Helsinki. Patients over the age of 18 who underwent gynecologic oncology surgery with general anesthesia and planned intubation between January 1, 2024, and July 1, 2024, were included. Patients with missing data were excluded from the analysis. Data were collected from the hospital information system, preoperative anesthesia evaluation forms, and operating room observation records. The study examined patients' demographic data, preoperative anesthesia evaluations, previous airway history, first successful oxygenation method, intubation attempts, the number of personnel involved, use of the Back-Up Rightward Pressure (BURP) maneuver, application of assistive methods, Cormack-Lehane score, intubation duration, and complications. Additionally, following routine quality standards in the operating room, we evaluated mouth opening (<4 cm), sternomental distance (<12 cm), thyromental distance (<6 cm), neck mobility, upper lip bite test (-:unable to bite/+:able to bite), presence of retrognathia/micrognathia, obstructive sleep apnea, and mobile dentures. The tertiary health center where the study was conducted is staffed by specialist physicians and anesthesiology residents. The residents have between 1 and 5 years of training and work under the supervision of at least one attending physician as part of a rotational program. In cases of difficult or failed intubation, various adjunct techniques and devices are used following ASA guidelines, depending on the provider's skill and experience. These include a stylet, bougie, video laryngoscope, laryngeal mask airway, fiberoptic bronchoscope, and invasive airway devices (e.g., various tracheostomy sets).

Statistical Analysis

Statistical data were analyzed using SPSS 22.0 (Statistical Package for the Social Sciences) software. The normality of continuous variables was assessed using both visual and analytical methods. Categorical variables are presented as counts and percentages, while continuous variables are expressed as mean±standard deviation or median (range). For comparisons between two groups, the Student's t-test was used for normally distributed continuous variables, and the Mann-Whitney U test was used for non-normally distributed continuous variables. Categorical variables were compared between groups using the Chi-square test or Fisher's exact test. Variables showing statistical significance ($P<0.05$) in pairwise comparisons were further evaluated with confidence intervals using univariate logistic regression analysis. Statistically significant variables (P<0.05) from univariate analysis, which were identified as potential independent risk factors for difficult and unsuccessful intubation, were assessed using a multivariate logistic regression model. Subjective evaluations, which may vary depending on the clinician, and variables with high correlations that could disrupt model compatibility, were excluded from the model. Adjusted odds ratios (adjusted OR) and 95% confidence intervals were calculated. A significance level of P<0.05 was considered statistically significant for this study. Other statistical methods were applied as necessary.

RESULTS

A total of 680 patients met the study criteria between January 1, 2024, and July 1, 2024. Twenty-seven patients were excluded due to missing data, and the data from 653 patients were included in the analysis. Of these, 7.5% (49 patients) experienced difficult intubation, and no patients had unsuccessful intubation (Fig. 1).

The mean age of patients in the difficult intubation group was 57.9±11.5 years, compared to 51.6±13.8 years in the non-difficult intubation group (Table 1). A statistically significant difference in mean age was observed between the groups (P=0.001); however, no significant association was found between age and difficult intubation in the multivariate logistic regression analysis (OR: 0.997, 95% CI: 0.965–1.030, P=0.859) (Table 2). The mean BMI in the difficult intubation group was 38.7±5.8, compared to 29.7±6.5 in the non-difficult intubation group, with a statistically significant difference between the groups (P<0.000) (Table 1). Furthermore, the multivariate logistic regression analysis revealed that a 1-unit increase in BMI was associated with a 1.094-fold increased risk of difficult intubation (OR: 1.094, 95% CI: 1.023-1.169, P=0.008)

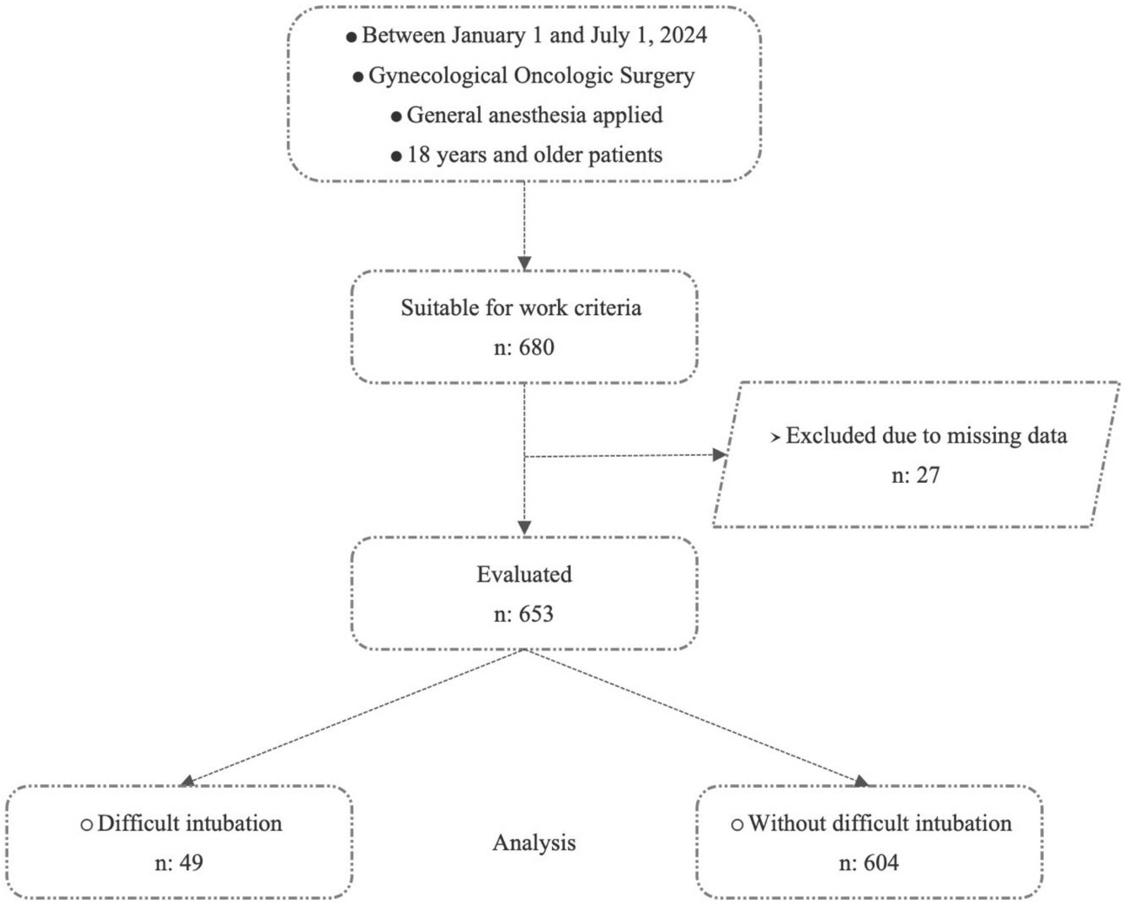

Fig.1. **Flowchart.**

Table 1. Demographic data

	Without difficult intubation (n=604)	Difficult intubation (n=49)	P value
Age (years)	51.6±13.8	57.9±11.5	**0.001**[1]
BMI (kg/m^2)	29.7±6.5	38.7±5.8	**0.008**[1]
ASA Score			
I	61 (10.1)	0	**0.002**
II	331 (54.8)	21 (42.9)	
III	212 (35.1)	28 (57.1)	
Comorbidities	375 (62.1)	41 (83.7)	**0.004**
Hypertension (mmHg)	207 (34.3)	23 (46.9)	0.103
Diabetes	114 (18.9)	16 (32.7)	**0.033**
COPD	59 (9.8)	9 (18.9)	0.098
Hypothyroidism	78 (12.9)	9 (18.4)	0.389
CAD	53 (8.8)	7 (14.3)	0.198
Obstructive sleep apnea	19 (3.1)	13 (26.5)	**<0.001**

Data are shown as mean±standard deviation or n (%) n %).

ASA=ASA Physical status score, BMI=Body mass index, CAD=Coronary artery disease, COPD=Chronic obstructive pulmonary disease

[1]Independent sample t-test

(Table 2). When comparing ASA classifications, no patients in the difficult intubation group were classified as ASA I, and a statistically significant difference was found between the groups (P=0.002) (Table 1).

When patients were compared based on the presence of additional diseases, a statistically significant difference was found (P=0.004) (Table 1). A significant difference was observed in the presence of diabetes and sleep apnea between patients with and without difficult intubation (P=0.033, P<0.001, respectively), whereas no significant difference was found for hypertension, chronic obstructive pulmonary disease (COPD), hypothyroidism, or coronary artery disease (CAD) (Table 1). When examining the relationship between the presence of diabetes and sleep apnea and difficult intubation, the presence of diabetes was not associated with difficult intubation in the multivariate logistic regression analysis (OR: 0.754, 95% CI: 0.333-1.709, P=0.498). However, the presence of sleep apnea was associated with an 8.8-fold increased risk of difficult intubation (OR: 8.826, 95% CI: 3.184-24.465, P<0.001) (Table 2).

Table 2. Multilogistic regression analysis of predictive parameters for difficult intubation.

	OR	95%CI	P value
Age	0.997	0.965-1.030	0.859
BMI	**1.094**	1.023-1.169	**0.008**
Diabetes	0.754	0.333-1.709	0.498
Obstructive sleep apnea	**8.826**	3.184-24.465	**<0.001**
Mallampati	**6.943**	2.650-18.191	**<0.001**
<4 cm Mouth Opening	**8.327**	2.956-23.458	**<0.001**

OR=Odd’s Ratio, BMI=Body mass index.

Table 3. Some parameters evaluated

	Without difficult intubation (n=604)	Difficult intubation (n=49)	P value
Mallampati			
1	228 (37.7)	0	**<0.001**
2	279 (46.2)	11 (22.4)	
3	96 (15.9)	25 (51.0)	
4	1 (0.2)	13 (26.5)	
Cormack Lehane			
1	416 (68.9)	2 (4.2)	**<0.001**
2	147 (24.3)	9 (18.8)	
3	41 (6.8)	28 (58.3)	
4	0	9 (18.8)	
<4 cm mouth opening	35 (5.8)	16 (32.7)	**<0.001**
<12 cm sternomental distance	25 (4.1)	38 (77.6)	**<0.001**
<6 cm thyromental distance	26 (4.3)	37 (75.5)	**<0.001**
Limited neck joint Mmvements	30 (5.0)	16 (32.7)	**<0.001**
Upper lip bite test*	12 (2.0)	31 (63.3)	**<0.001**
Retro/micrognathy	14 (2.3)	23 (46.9)	**<0.001**
Mobile dental prosthesis	96 (15.9)	29 (59.2)	**<0.001**

Data are shown as n %).
*Patients who cannot bite their upper lip

There were no patients with a Mallampati score of 1 in the difficult intubation group, and a statistically significant difference was observed in Mallampati scores between the groups (P<0.001) (Table 3). A Mallampati score of 3-4 was associated with a 6.9-fold increased risk of difficult intubation compared to scores of 1-2 (OR: 6.943, 95% CI: 2.650-18.191, P<0.001) (Table 2). In the difficult intubation group, 32.7% of patients had a mouth opening of less than 4 cm, with a statistically significant difference between the groups (P<0.001) (Table 3). Mouth opening <4 cm was associated with an 8.3-fold increased risk of difficult intubation (OR: 8.327, 95% CI: 2.956–23.458, P<0.001) (Table 2). Significant differences were also found between the groups for Cormack-Lehane score, sternomental distance (<12 cm), thyromental distance (<6 cm), limited neck mobility, upper lip bite test, retrognathia/micrognathia, and presence of mobile dentures (P<0.001) (Table 3).

Only 8.2% of patients with difficult intubation had a history of difficult intubation (Table 4). While 40.8% of patients required 3 or 4 intubation attempts, 79.6% were intubated by a single individual (Table 4). The Back-Up Rightward Pressure (BURP) maneuver was applied in 83.7% of cases, and at least one auxiliary method was used in 91.8% of patients (Table 4). The most commonly used auxiliary methods included stylet (35.6%), videolaryngoscope (VL) with stylet (26.7%), and bougie (20%) (Table 4). The first successful oxygenation method for patients with difficult intubation was mask ventilation, and no cases of unsuccessful intubation were reported. Complications, such as soft tissue injury, were observed in only 3 patients. The mean intubation time for patients with difficult intubation was 5.1±1.73 minutes.

DISCUSSION

This study investigated the incidence and contributing factors of difficult and unsuccessful intubation in a high-comorbidity population undergoing gynecologic

Table 4. Parameters of patients with difficult intubation*

	Difficult intubation (n=49)
History of difficult intubation, n (%)	4 (8.2)
Number of intubation attempts, n (%)	
2	29 (59.2)
3	15 (30.6)
4	5 (10.2)
Number of People who attempted intubation, n (%)	
1	39 (79.6)
2	9 (18.4)
3	1 (2.0)
BURP maneuver, n (%)	41 (83.7)
Use of assisted methods, n (%)	45 (91.8)
Auxiliary method used, n (%)	
Style	16 (35.6)
VL+ Style	12 (26.7)
Bougie	9 (20)
SAD+ Bougie	3 (6.7)
SAD+ Style	2 (4.4)
VL+ Bougie	1 (2.2)
VL+SAD	1 (2.2)
VL	1 (2.2)
Complication, n (%)	3 (6.1)
Intubation time (min)	5.1±1.73 (2.3-10.5)

Data are shown as mean±standard deviation or minimum-maximum or n (%) n %).
BURP=Back UP Rightward Pressure, VL=Videolaryngoscope, SAD=Supraglottic airway device.
*The first successful oxygenation method was Mask ventilation 49 (100%), Intubation success: 100% successful, Complication type: Soft tissue damage in 3 people.

oncologic surgery. The incidence of difficult intubation was 7.2%, with no cases of unsuccessful intubation observed in our cohort. In this high BMI population, factors associated with difficult intubation included BMI, obstructive sleep apnea, Mallampati score, and limited mouth opening.

The incidence of difficult and unsuccessful intubation in patients undergoing general anesthesia ranges from 1.5% to 8.5% [6, 10], while difficult laryngoscopy and intubation rates are reported to be higher among obese patients, ranging from 8.2% to 16.2% [9]. In obese patients, primary concerns for anesthesiologists include intubation difficulty, apnea, hypoxia, and compromised respiratory mechanics. Literature indicates that standard tests used to predict difficult or unsuccessful intubation are insufficient in detecting these major complications [3, 5, 11]. Various airway management societies have established guidelines with predictive tests, measurements, and specialized devices to reduce morbidity and mortality in difficult airway cases, underscoring the vital importance of effective airway management in anesthesia [1, 12, 13]. In our study, the incidence of difficult intubation in a specific high comorbidity population independent of gender was 7.2%, lower than most reported rates in the literature. Previous studies have identified age 40-59 as a risk factor for difficult intubation and noted fewer surgical cases in patients aged 60 and above [3, 14]. In our cohort, mean ages for the two groups were 51.6 and 57.9, and while there was a statistically significant age difference between groups, age was not associated with a higher risk of difficult intubation. This may be due to a lower frequency of surgeries, and thus difficult intubation cases, among patients over 60, potentially resulting in an insufficient sample size. Age, comorbidities, and ASA scores are closely correlated. Schnittker *et al*. also reported that a high ASA score was associated with increased risk for difficult intubation [15]. Consistently, we observed a statistically significant difference between our groups regarding ASA scores and comorbidity presence. We suggest that while age, comorbidities, and high ASA scores may indeed be risk factors for difficult intubation, they are interrelated.

Obesity has been linked to difficult intubation due to increased fat tissue in the oropharyngeal region, altered anatomical planes, and increased neck circumference [8, 10, 15-17]. Although studies report varying degrees of increased risk, with rates ranging from 1.06 to 2.48-fold, some research has suggested that obesity is not a significant risk factor for difficult intubation [15-17]. Obesity is, however, commonly observed in patients undergoing gynecologic oncologic surgery [20]. In our study, the mean BMI in the difficult intubation group was 38.7±5.8 kg/m², with a statistically significant association between BMI and intubation difficulty; a 1 unit increase in BMI corresponded to a 1.094-fold increase in risk. In this female-only population, obesity was prevalent and likely contributed to an elevated risk of difficult intubation, especially given associated conditions like diabetes and obstructive sleep apnea. While both diabetes and obstructive sleep apnea were significantly different between groups, obstructive sleep apnea, in particular, was associated with an 8.8-fold increased risk of difficult intubation. Our findings suggest that obesity is a risk factor for difficult intubation, with undiagnosed obstructive sleep apnea potentially further elevating this risk in obese patients [20].

The Mallampati score, upper lip bite test, mouth opening, sternomental distance, thyromental distance, limitation of neck joint movements, retro/micrognathia, and presence of dentures are among the predictive tests for difficult intubation [11, 21]. However, no single test has shown sufficient sensitivity and specificity to reliably predict difficult intubation [1, 10, 12, 22]. While the reported sensitivity of the Mallampati score varies widely in the literature, from 10% to 90%, our study found that a high Mallampati score (3-4) was associated with a 6.94-fold increased risk of difficult intubation [23]. Our findings are consistent with studies that combine the Mallampati score, thyromental distance, and upper lip bite test as predictive tools [10, 24]. Nonetheless, it is essential to consider potential challenges, such as clinicians' variability in accurately assessing the Mallampati score.

Sternomental and thyromental distances are critical measurements for achieving optimal head and neck alignment in the intubation position, contributing to improved glottic visibility [25]. In our study, these distances showed statistically significant differences between groups. Another key predictor, mouth opening, is a practical bedside anatomical measurement. We found that a mouth opening of less than 4 cm was associated with an 8.32-fold increased risk for difficult intubation, likely due to reduced visibility of glottic structures and increased difficulty in guiding the endotracheal tube. Based on these findings, we recommend incorporating multiple predictive tests in the preoperative evaluation for gynecologic oncologic surgery to improve assessment accuracy.

Although a history of difficult intubation is a strong predictor, as shown in our study, difficult intubation can still occur in patients without such a history [26]. Only 8.2% of our patients had a prior history of difficult intubation, with most cases being unpredictable. This underscores the importance of a thorough preoperative evaluation to mitigate airway-related complications. Masashi *et al*. [27] reported that the BURP maneuver can enhance glottic visibility in difficult intubation cases. In our study, the BURP maneuver was applied to 83.7% of patients with difficult intubation, supporting this finding. We believe that the BURP maneuver improves glottic visibility and intubation success, particularly in high BMI patient populations.

In patients with difficult intubation, using auxiliary methods such as stylet, bougie, videolaryngoscope (VL), and supraglottic airway device (SAD) has been shown to increase intubation success [1, 3, 28].

The choice of auxiliary method often depends on the operator's clinical experience and expertise [1, 13]. Current airway guidelines recommend equipment such as VL as the primary choice in anticipated difficult intubation cases, including maxillofacial trauma, congenital head and neck malformations, and orthognathic surgery. A study by Jaber *et al*. reported that using a stylet reduced intubation time by 30% and decreased unsuccessful intubation rates [29]. Other studies indicate that VL improves field of vision, enhances glottic visibility, and shortens intubation time, particularly when used with the BURP maneuver [22, 30]. In our study, auxiliary methods were used in 91.8% of patients with difficult intubation. Of these patients, 35.6% received a stylet, and 26.7% received both a stylet and VL (Table 3). Consistent with the findings of the literature, we recommend using and combining auxiliary equipment in this high-risk population with elevated BMI and significant comorbidities. Among patients with difficult intubation, 79.6% were intubated by a single operator, and 59.2% required only two attempts, with no failed intubations. Major complications such as hypoxia, arrest, or death were absent in this group, and only three patients experienced soft tissue injury. We attribute our low complication rate to the availability and combined use of auxiliary equipment. In patients with high comorbidities undergoing gynecologic oncologic surgery, auxiliary equipment may help reduce airway-related complications and decrease mortality and morbidity.

Limitations

Our study has several limitations. Firstly, as a retrospective analysis, it relies on data recorded in medical files, which may lead to incomplete or inconsistent entries. Additionally, patients with missing data were excluded, potentially introducing selection bias. Certain values, such as specific measurements, were sometimes recorded only as ‘small’ or ‘large’ without precise quantification, which may affect the accuracy and granularity of our findings. These limitations should be taken into account when interpreting our results and their applicability to broader patient populations. It should also be considered that among the practitioners are anesthesiology residents with varying levels of training (1-5 years) who work as part of a rotational program.

CONCLUSION

In conclusion, patients undergoing gynecologic oncologic surgery represent a high-risk group with considerable comorbidities, high BMI, and histories of chemotherapy and radiotherapy. To minimize complications related to difficult or unsuccessful intubation, we recommend comprehensive preoperative evaluation, thorough preparation of auxiliary airway equipment, and vigilant anesthetic monitoring in this population. While our study, like most in this field, is retrospective, we believe that prospective, controlled clinical studies are needed to further validate these findings and improve airway management strategies in gynecologic oncology patients.

Ethical Statement

This study was approved by the Ankara Etlik City Hospital Scientific Research Evaluation and Ethics Committee (Decision no. AEŞH-BADEK-2024-528, date: 05.06.2024).

Authors’ Contribution

Study Conception: SFK, ZK, DU, AS, SA, JE; Study Design: EK, AG; Supervision: EK, IY; Funding: EK, IY; Materials: EK, AG; Data Collection and/or Processing: EK, BT; Statistical Analysis and/or Data Interpretation: EK, BT; Literature Review: EK, AG; Manuscript Preparation: EK, IY and Critical Review: EK, CA.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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