Article

Endotracheal Tube Cuff Deflation Methods Reduce Stress Response and Incidence of Postoperative Pharyngeal Complications in Patients Treated with Gynecological Laparoscopic Surgery

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AIM: This study aims to explore the impact of endotracheal tube cuff deflation methods on extubation stress responses and postoperative pharyngeal complications in patients treated with gynecological laparoscopic surgery.
METHODS: In this study, retrospective clinical data of 94 patients treated with gynecological laparoscopic surgery under general anesthesia in Northwest Women's and Children's Hospital from June 2023 to June 2024 were collected and analyzed. Patients were assigned into two groups based on the cuff deflation methods used after anesthesia: Group A (45 patients) adopted a one-time deflation method, while Group B (49 patients) employed a gradual deflation method. Surgery-associated indicators were recorded, with heart rate (HR), mean arterial pressure (MAP), rate pressure product (RPP), epinephrine (E), norepinephrine (NE), and cortisol (Cor) levels monitored at selected time points: before cuff (T0), immediately after extubation (T1), 1 minute post-extubation (T2), 5 minutes post-extubation (T3), and 10 minutes post-extubation (T4). The incidence of pharyngeal complications was also compared between the two groups.
RESULTS: Compared with Group A, Group B displayed smaller variations in HR, MAP, and RPP at T1, T2, and T3 ($p < 0.05$). Group B also showed smaller variations in E, NE, and Cor levels at T2, T3, and T4 in contrast with Group A ($p < 0.05$). The incidence of complications such as coughing, sore throat, and hoarseness was conspicuously attenuated in Group B compared to Group A (6.12% vs 22.22%, $p < 0.05$).
CONCLUSIONS: Gradual deflation of the endotracheal tube cuff dramatically ameliorates extubation stress responses, stabilizes hemodynamics, and alleviates pharyngeal discomfort in patients treated with gynecological laparoscopic surgery.

Keywords: endotracheal tube; cuff; deflation; gynecological laparoscopy; extubation; stress response; pharyngeal complication

Introduction

Gynecological laparoscopic surgery has emerged as a novel surgical technique in recent years, offering advantages such as minimal trauma, reduced disturbance to the internal environment, low blood loss, reduced scars, rapid postoperative recovery, fewer complications, and shorter hospital stays. These benefits have made this approach an attractive option for many patients to treat a range of gynecological diseases and pathologies [1, 2]. The gynecological laparoscopic procedures are performed with general anesthesia, which is common delivered via endotracheal intubation. During mechanical ventilation under general anesthesia, the endotracheal tube is used to ensure efficient ventilation and oxygen supply, preventing reflux and aspiration [3]. Nevertheless, while recovering from the general anesthesia, the patients may experience strong stress responses and multiple complications as a result of mechanical stimulation elicited by the endotracheal tube and cuff on their highly sensitive tracheal mucosa, which contributes to poor patient outcomes. Some of the common airway complications include sore throat, hoarseness, coughing, tracheoesophageal fistula, and tracheal rupture [4, 5, 6]. Report has pointed out that postoperative sore throat is the most common complication following general anesthesia, with an incidence rate as high as 60%, dramatically increasing treatment costs and severely affecting patient comfort and satisfaction [7].

It has been confirmed that the occurrence of iatrogenic complications in the airway such as sore throat, hoarseness, and tracheal stenosis is inextricably correlated with overly high cuff pressure subsequent to intubation [8]. A variety of factors can influence the internal pressure of the endotracheal tube cuff, including the diffusion of anesthetic gases, the volume of gas injected, and the type of cuff adopted [9, 10]. Therefore, managing endotracheal cuff pressure is particularly important in gynecological laparoscopic surgery. For the purpose of attenuating extubation-associated airway complications like airway spasm and negative pressure pulmonary edema, and in order to avoid patient coughing during extubation, a previous study has attempted to harness local anesthetics inside and outside the cuff to alleviate extubation stress responses [11]. Nonetheless, the pressure

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changes caused by cuff deflation have been scarcely investigated. Thus, this research aims to observe the impact of diverse endotracheal tube cuff deflation methods on extubation stress and postoperative pharyngeal complications in patients treated with gynecological laparoscopic surgery.

Materials and Methods

Clinical Data

In this study, we gathered retrospective clinical data from 94 patients who had been treated with gynecological laparoscopic surgery under general anesthesia at Northwest Women and Children Hospital between June 2023 and June 2024.

The inclusion criteria were as follows: (1) patients who underwent hysterectomy; (2) patients who were of the American Society of Anesthesiologists (ASA) grades I–II [12], the Mallampati score levels I–II [13], aged 25–50 years, weighing 45–72 kg, and surgery duration within three hours; and (3) patients with complete clinical data, medical history, and pathology reports.

The exclusion criteria for this study include: (1) patients with preoperative systolic blood pressure (SBP) $\geq$160 mmHg and diastolic blood pressure (DBP) $\geq$110 mmHg; (2) patients with airway hyperreactive diseases such as chronic obstructive pulmonary disease (COPD) and asthma; and (3) patients with a preoperative history of high-risk reflux and aspiration.

The patients were divided into two groups based on the endotracheal tube cuff deflation methods used post-anesthesia: Patients in Group A (n = 45) utilized a one-time deflation method, whereas patients in Group B (n = 49) employed a gradual deflation method. This research was conducted in compliance with the principles outlined in the Declaration of Helsinki, and was approved by the Medical Ethics Committee of Northwest Women and Children's Hospital (No.2023-XBF-024501). The Medical Ethics Committee of Northwest Women and Children's Hospital exempted patients from informed consent.

Anesthesia and Surgical Procedures

All patients went through routine preoperative fasting (no food for 8 hours and no liquids for 4 hours). No premedication was administered. The surgery was performed by the same team, consisting of the chief surgeon, assistant chief physician, attending physician, and anesthesiologist. Upon arrival in the operating room, a venous channel was established, and standard monitoring was initiated, for a range of parameters such as heart rate (HR), pulse oxygen saturation (SpO_2), electrocardiography (ECG), end-tidal carbon dioxide tension ($PetCO_2$), and bispectral index (BIS). Invasive blood pressure (IBP) was monitored by performing radial artery puncture.

To induce anesthesia, the patients were given pure oxygen ventilation via a face mask for 5 minutes. The anesthetic agents used include midazolam (0.05 mg/kg), etomidate (0.2–0.4 mg/kg), sufentanil (0.5–1.0 µg/kg), and cisatracurium (0.15 mg/kg). Endotracheal intubation was implemented when the BIS dropped to below 50 and the train-of-four (TOF) count changed to zero. An experienced anesthesiologist positioned the endotracheal tube tip 2 cm inside the trachea using the scale on the tube as a guide and secured it with tape. Mechanical ventilation was initiated after confirming clear and symmetrical bilateral breath sounds via auscultation, with respiratory parameters adjusted to maintain arterial partial pressure of carbon dioxide ($PaCO_2$) between 35 and 45 mmHg.

Anesthesia was sustained using continuous intravenous pump infusion of propofol (4–8 mg/kg/h) coupled with remifentanil (0.1–0.3 µg/kg/h) to keep BIS in the range of 40–60. Cisatracurium was supplemented every 30–45 minutes at one-fifth to one-third of the induction dose to ensure sustained muscle relaxation. Intraoperative arterial blood gas analysis and other outcomes were referenced to monitor water-electrolyte and acid-base balance, and oral secretions were cleared promptly.

Extubation was performed when spontaneous breathing in patients had restored, tidal volume (TV) reached 8 mL/kg, TOF $\geq$0.9, $PetCO_2$ $<$45 mmHg without showing rising trends, and BIS $>$75. For Group A, the endotracheal tube was removed after the cuff was rapidly deflated using a syringe. For Group B, the cuff was gradually deflated using a 1 mL syringe before removing the endotracheal tube.

Observation Time Points and Indicators

(1) General data of the patients were gathered, including age, body mass index (BMI), educational level, medical history, ASA classification, and Mallampati score level.

(2) Surgery-related parameters were recorded, including surgical duration, pneumoperitoneum time, duration of endotracheal tube placement, cuff inflation volume, intraoperative transfusion volume, and bleeding volume.

(3) HR and mean arterial pressure (MAP) were monitored, while rate pressure product (RPP) was computed at the following time points: before cuff (T0), immediately after extubation (T1), 1 minute post-extubation (T2), 5 minutes post-extubation (T3), and 10 minutes post-extubation (T4).

(4) The levels of epinephrine (E), norepinephrine (NE), and cortisol (Cor) at T0, T1, T2, T3, and T4 were gauged and recorded.

(5) Complications were observed and recorded during extubation in both groups, including coughing, sore throat, and hoarseness.

Statistical Analysis

All data from this research were processed and analyzed using SPSS22.0 software (SPSS Inc., Chicago, IL, USA). Continuous data were analyzed using repeated-measures ANOVA. Tukey HSD post-hoc test was employed to further analyze the differences between the groups. Measurement data that conformed to a normal distribution are expressed

Table 1. Comparison of general data between Groups A and B.

Data		Group A (n = 45)	Group B (n = 49)	χ^2/t	p
Age (years)	-	28.16 ± 3.75	27.94 ± 3.66	0.288	0.774
BMI (kg/m^2)	-	23.42 ± 2.39	23.55 ± 2.71	0.246	0.806
Educational level [n (%)]	Junior high school education or below	16 (35.56)	15 (30.61)	0.259	0.610
	Senior high school education or above	29 (64.44)	34 (69.39)		
Medical history [n (%)]	Diabetes	20 (44.44)	22 (44.90)	0.664	0.717
	Hypertension	13 (28.89)	11 (22.45)		
	Hyperlipidemia	12 (26.67)	16 (32.65)		
ASA classification [n (%)]	I	23 (51.11)	21 (42.86)	0.642	0.423
	II	22 (48.89)	28 (57.14)		
Mallampati score level [n (%)]	I	29 (64.44)	32 (65.31)	0.008	0.930
	II	16 (35.56)	17 (34.69)		

BMI, body mass index; ASA, American Society of Anesthesiologists.

as mean ± standard deviation. Between-group comparisons were conducted using the *t*-test. Categorical data are presented as percentages in this paper and were analyzed using the chi-squared test. A *p*-value of less than 0.05 was regarded as statistically significant.

Results

Comparison of General Data

The average age of the subjects in Group A (n = 45) was 28.16 ± 3.75 years, with an average BMI of 23.42 ± 2.39 kg/m^2. The patients included possessed varying educational levels, with 16 patients having a junior high school education or below, and 29 patients having a senior high school education or above. There were 20 cases of diabetes, 13 cases of hypertension, and 12 cases of hyperlipidemia in Group A. In terms of ASA classification, 23 patients were classified as grade I while the remaining 22 patients as grade II. Twenty-nine patients in the same group were classified as level I and 16 as level II as per the Mallampati score classification. As for Group B, consisting of 49 patients, the subjects had an average age of 27.94 ± 3.66 years and an average BMI of 23.55 ± 2.71 kg/m^2. Fifteen patients had a junior high school education or below, and 34 patients had completed senior high school education or higher-level form of education. In Group B, there were 22 cases of diabetes, 11 cases of hypertension, and 16 cases of hyperlipidemia. According to the ASA classification, 21 patients were classified as level I and 28 as level II. Thirty-two patients were classified as level I and the remaining 17 patients as level II based on the Mallampati score classification. The general data between the two groups, in terms of age, BMI, educational level, medical history, ASA classification, and Mallampati classification, showed no noticeable statistical differences ($p > 0.05$), indicating a balanced and comparable baseline (Table 1).

Comparison of Surgical Conditions

Groups A and B displayed no statistically significant differences in terms of surgical duration, pneumoperitoneum time, cuff inflation volume, intraoperative transfusion volume, and blood loss ($p > 0.05$) (Table 2).

Comparison of Hemodynamic Indicators

Compared to the indicators measured at T0, the HR, MAP, and RPP at T1, T2, and T3 were dramatically heightened in both Groups A and B ($p < 0.05$). As opposed to Group A, Group B exhibited smaller yet statistically significant variations in HR, MAP, and RPP at T1, T2, and T3 ($p < 0.05$). At T0 and T4, there were no remarkable differences in hemodynamic parameters between the groups ($p > 0.05$) (Table 3). These findings demonstrated that gradual cuff deflation during general anesthesia in gynecological laparoscopic surgery resulted in more stable hemodynamics compared with one-time deflation.

Comparison of Stress Response-related Indicators

At T0 and T1, no statistically significant differences in terms of plasma E, NE, and Cor levels were detected between Groups A and B ($p > 0.05$). However, compared with the stress response-related indicators measured at T0, plasma E, NE, and Cor levels were significantly elevated at T2, T3, and T4 in both groups ($p < 0.05$). Compared with Group A, Group B exhibited smaller yet statistically significant fluctuations in E, NE, and Cor levels at T2, T3, and T4 ($p < 0.05$) (Table 4). This indicates that gradual cuff deflation, as opposed to single-time deflation, significantly alleviated stress response during extubation in gynecological laparoscopic surgery performed under general anesthesia.

Comparison of Complication Incidence during Extubation

Coughing, sore throat, and hoarseness are prevalent complications arising during extubation in patients undergoing gynecological laparoscopic surgery under general anesthe-

Table 2. Comparison of surgical conditions between Groups A and B.

Surgical conditions	Group A (n = 45)	Group B (n = 49)	t	p
Surgical duration (min)	104.38 ± 9.26	106.94 ± 8.33	1.411	0.162
Pneumoperitoneum time (min)	95.57 ± 8.41	96.81 ± 6.75	0.791	0.431
Cuff inflation volume (mL)	5.11 ± 0.53	5.07 ± 0.61	0.338	0.736
Intraoperative transfusion volume (mL)	1865.41 ± 86.72	1873.92 ± 75.94	0.507	0.613
Bleeding volume (mL)	53.61 ± 5.33	55.27 ± 5.28	1.516	0.133

Table 3. Comparison of HR, MAP, and RPP at different time points between Groups A and B.

Indicators	Time	Group A (n = 45)	Group B (n = 49)	t	p
HR (beats/min)	T0	80.79 ± 7.41	81.02 ± 9.45	0.131	0.896
	T1	97.56 ± 6.25*	90.23 ± 10.67*	4.018	<0.001
	T2	102.23 ± 10.03*	92.28 ± 9.12*	5.038	<0.001
	T3	96.65 ± 8.98*	91.87 ± 9.08*	2.563	0.012
	T4	84.12 ± 9.25	84.33 ± 8.63	0.114	0.910
F_{column}/p_{column}		3.669/<0.001			
F_{row}/p_{row}		31.700/<0.001			
$F_{interactive}/p_{interactive}$		3.226/<0.001			
MAP (mmHg)	T0	85.62 ± 6.78	85.97 ± 7.75	0.232	0.817
	T1	104.39 ± 9.36*	95.88 ± 8.03*	4.742	<0.001
	T2	106.85 ± 8.99*	96.54 ± 9.88*	5.276	<0.001
	T3	103.41 ± 11.65*	94.46 ± 10.60*	3.900	<0.001
	T4	90.66 ± 8.98	89.93 ± 7.97	0.418	0.677
F_{column}/p_{column}		6.022/<0.001			
F_{row}/p_{row}		29.310/<0.001			
$F_{interactive}/p_{interactive}$		3.838/<0.001			
RPP	T0	9009.86 ± 1046.85	8983.62 ± 1242.01	0.110	0.913
	T1	11,463.38 ± 1398.62*	10,094.13 ± 1253.85*	5.005	<0.001
	T2	12,678.49 ± 976.38*	10,388.67 ± 1395.26*	9.142	<0.001
	T3	12,890.34 ± 1025.53*	11,026.95 ± 899.07*	9.385	<0.001
	T4	9325.11 ± 871.90	9093.42 ± 756.92	1.379	0.171
F_{column}/p_{column}		10.660/<0.001			
F_{row}/p_{row}		45.920/<0.001			
$F_{interactive}/p_{interactive}$		6.317/<0.001			

HR, heart rate; MAP, mean arterial pressure; RPP, rate pressure product; T0, before cuff; T1, immediately after extubation; T2, 1 minute post-extubation; T3, 5 minutes post-extubation; T4, 10 minutes post-extubation. *$p < 0.05$, compared with T0.

sia. The incidence of complications in Group B was significantly lower than that in Group A ($p < 0.05$), as displayed in Table 5. Thus, gradual cuff deflation was notably more efficacious than single-time deflation in preventing the incidence of pharyngeal complications such as coughing, sore throat, and hoarseness in patients.

Discussion

Typically performed under pneumoperitoneum, laparoscopic techniques have become one of the predominant approaches for treating gynecological conditions in recent years [14]. Administering general anesthesia via endotracheal intubation confers optimal surgical conditions, which allow for better management of the patient's breathing and circulation [15], and given these advantages, this approach has seen widespread clinical use. During general anesthesia, cuff inflation in the endotracheal tube is crucial for preventing air leakage from the airway during mechanical ventilation, ensuring effective ventilation, and avoiding the aspiration of oral secretions and gastric contents into the airway [16, 17]. The conclusion of general anesthesia is accompanied by the waning anesthetic effects and the gradual restoration of muscle strength and pharyngeal reflexes, as well as the increasing sensitivity of the airway to mechanical stimuli. This sensitivity, combined with the mechanical stimulation from the endotracheal tube and cuff,

Table 4. Comparison of plasma E, NE, and Cor levels at different time points between Groups A and B.

Indicators	Time	Group A (n = 45)	Group B (n = 49)	t	p
	T0	865.52 ± 91.44	860.33 ± 85.58	0.284	0.777
	T1	858.41 ± 80.66	854.94 ± 90.71	0.195	0.846
E (pmol/L)	T2	1238.95 ± 112.39*	1175.82 ± 105.43*	2.810	0.006
	T3	1435.66 ± 120.73*	1192.46 ± 119.65*	9.802	<0.001
	T4	1190.38 ± 100.88*	897.37 ± 94.97*	14.504	<0.001
F_{column}/p_{column}		7.349/<0.001			
F_{row}/p_{row}		66.270/<0.001			
$F_{interactive}/p_{interactive}$		7.464/<0.001			
	T0	1340.65 ± 125.82	1351.02 ± 117.95	0.412	0.681
	T1	1377.28 ± 131.62	1365.84 ± 128.37	0.426	0.671
NE (pmol/L)	T2	1620.62 ± 188.29*	1406.11 ± 165.41*	5.879	<0.001
	T3	2099.83 ± 226.41*	1681.73 ± 183.97*	9.860	<0.001
	T4	1868.21 ± 194.93*	1467.49 ± 169.76*	10.650	<0.001
F_{column}/p_{column}		12.480/<0.001			
F_{row}/p_{row}		47.730/<0.001			
$F_{interactive}/p_{interactive}$		9.777/<0.001			
	T0	356.85 ± 31.26	359.60 ± 35.50	0.397	0.692
	T1	360.71 ± 32.73	366.42 ± 33.86	0.830	0.409
Cor (pmol/L)	T2	474.50 ± 54.47*	402.28 ± 39.06*	7.432	<0.001
	T3	569.87 ± 50.63*	458.13 ± 41.25*	11.771	<0.001
	T4	485.52 ± 45.07*	396.65 ± 38.98*	10.247	<0.001
F_{column}/p_{column}		11.420/<0.001			
F_{row}/p_{row}		54.140/<0.001			
$F_{interactive}/p_{interactive}$		9.523/<0.001			

E, epinephrine; NE, norepinephrine; Cor, cortisol. $^{*}p < 0.05$, compared with T0.

Table 5. Comparison of complication incidence during extubation between Groups A and B [n (%)].

Complications	Group A (n = 45)	Group B (n = 49)	χ^2/t	p
Coughing	6 (13.33)	2 (4.08)		
Sore throat	2 (4.44)	1 (2.04)		
Hoarseness	2 (4.44)	0 (0)		
Overall incidence	10 (22.22)	3 (6.12)	5.102	0.024

can activate the sympathetic-adrenergic system, triggering a stress response in the body [18] and giving way to a series of pathophysiological alterations.

Coughing, sore throat, and hoarseness are common airway complications following extubation. A study found that the incidence of postoperative sore throat can reach up to 71.8% subsequent to general anesthesia, while hoarseness may occur in up to 50% of cases [19]. To date, there have been numerous studies on preventive or mitigating strategies for these throat complications, including local interventions on the throat or endotracheal tube and systemic intravenous medication regimens [20, 21, 22, 23]. Nevertheless, these approaches have limitations and often fail to achieve optimal results. Recently, it has been suggested that continuous and appropriate control of endotracheal cuff pressure during surgery can lower the incidence of postoperative sore throat, coughing, blood-streaked sputum, and hoarseness [24]. This prompted us to investigate the effects of two different cuff deflation management strategies—single-time deflation versus gradual deflation—on the stress response and pharyngeal complications during extubation in patients undergoing gynecological laparoscopic surgery.

Given the outcomes, there were no statistically significant variations in terms of surgery time, pneumoperitoneum duration, cuff inflation volume, intraoperative transfusion volume, or blood loss between the two groups. Nonetheless, compared with single-time deflation, gradual deflation of the endotracheal cuff culminated in smaller variations in hemodynamic parameters—HR, MAP, and RPP—immediately after extubation, 1 minute after extubation, and 5 minutes after extubation. Additionally, stress indicators, such as E, NE, and Cor, showed smaller variations

1 minute, 5 minutes, and 10 minutes after extubation with gradual deflation. The incidence of pharyngeal complications such as coughing, sore throat, and hoarseness was only 6.12% in the gradual deflation group, notably lower than in the single-time deflation group. Our findings underscored that for patients undergoing gynecological laparoscopic surgery with general anesthesia, gradual deflation of the endotracheal cuff was more efficacious in sustaining hemodynamic stability, attenuating stress responses during extubation, and lowering the incidence of pharyngeal complications—features that highlight the reliability of this technique.

Zhu *et al*. [25] discovered that vigorous usage of automatic cuff pressure controller monitoring system could reduce the incidence and severity of hoarseness, coughing, and sore throat post-intubation. Similarly, Wang *et al*. [26] noted a substantial difference in cough reflex incidence between patients using single-time endotracheal tube cuff deflation and those using gradual cuff manometer deflation, with the latter showing markedly mitigating cough reflexes during extubation, thus minimizing hemodynamic fluctuations and airway complications. The findings of the current study closely concur with previous research focusing on reducing airway complications and alleviating hemodynamic fluctuations [26]. Additionally, our research showed that a gradual, stepwise deflation method can more effectively attenuate the overall postoperative stress response by reducing levels of E, NE, and Cor following deflation in patients undergoing gynecological laparoscopic surgery under general anesthesia. The fundamental reason for these findings may lie in the mode of cuff volume change. Rapid single-time deflation causes a swift alteration in cuff volume, resulting in stronger mechanical stimulation of the airway and a greater likelihood of triggering a cough reflex due to the dense nerve distribution in the throat [27]. In contrast, gradual pressure release allows the throat to undergo a pre-adaptation process, evidently reducing nerve impulses from mechanoreceptors in the tracheal mucosa compared with single-time deflation. Thus, this helps with effectively ameliorating stress responses and pharyngeal complications during extubation through the E, NE, and Cor hormone surge, the reduction of stress reflex response, and the weakening of airway stimulation caused by cuff deflation, thereby alleviating hemodynamic disturbances and decreasing the incidence of pharyngeal complications [28]. It is worth noting that gradual, stepwise deflation method is not recommended in time-sensitive situations, such as elevated airway pressure during general anesthesia (especially in cases nearing the critical value) and poor patient condition; instead, a one-time rapid deflation should be performed to quickly relieve the airway pressure.

However, this study has certain limitations. First, as a retrospective study, it is inevitably subject to confounding factors and biases. Second, due to ethical considerations, patients' tracheal mucosa was not biopsied for conducting pathological studies, posing restrictions in assessing the extent of tracheal mucosal damage. Future research will aim to address these shortcomings to further validate the findings of this study.

Conclusions

In conclusion, as opposed to the one-time deflation method, the gradual, stepwise deflation of the endotracheal cuff conspicuously alleviates the stress response during extubation in patients treated with gynecological laparoscopic surgery. This approach boasts the benefits in stabilizing hemodynamic status and mitigating pharyngeal discomfort, thereby leading to improved patient outcomes, which are crucial for facilitating a smoother perioperative course and guaranteeing a faster postoperative recovery.

Availability of Data and Materials

The datasets used or analysed during the current study are available from the corresponding author upon reasonable request.

Author Contributions

YL and JS designed the research study; YL, JS, KDC and JJL performed the research; JS, KDC, and LC collected and analyzed the data. YL, JS, KDC and LC have been involved in drafting the manuscript and all authors have been involved in revising it critically for important intellectual content. All authors give final approval of the version to be published. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

This study has been approved by the Medical Ethics Committee of Northwest Women and Children's Hospital (No.2023-XBF-024501). This research was conducted in compliance with the principles outlined in the Declaration of Helsinki. The Medical Ethics Committee of Northwest Women and Children's Hospital exempted patients from informed consent.

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Conflict of Interest

The authors declare no conflict of interest.

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