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Risk Factors for Fentanyl-Induced Cough Following General Anesthesia in Adults: A Retrospective Study from a Single Center in China

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Background: Fentanyl-induced cough (FIC) during general anesthesia induction and postoperative nausea and vomiting are common complications, yet the risk factors for FIC remain controversial. This retrospective study was conducted at a single center in China and aimed to investigate the risk factors for fentanyl-induced cough following general anesthesia in adults.


Material/Methods: A total of 601 adult patients undergoing elective surgery were enrolled, and the incidence of FIC during general anesthesia induction and postoperative adverse events were recorded. The risk factors for FIC during general anesthesia induction and postoperative nausea and vomiting were assessed using multivariate logistic regression analysis.

Results: The incidence of FIC, nausea, and vomiting were 21.8%, 6.3%, and 4.5%, respectively. The results of multivariate logistic regression analysis indicated that pharyngitis history was associated with an increased risk of FIC during general anesthesia induction (odds ratio [OR]: 2.852; 95% confidence interval [CI]: 1.698-4.792; $P < 0.001$), whereas use of lidocaine could protect against FIC risk (OR: 0.649; 95% CI: 0.557-0.757; $P < 0.001$). However, the characteristics of patients were not associated with the risk of postoperative nausea and vomiting.

Conclusions: The findings from this study showed that a history of pharyngitis increased the risk of FIC, while the use of lidocaine was associated with a reduced risk of FIC. The risk of postoperative nausea and vomiting was not affected by fentanyl use or patient characteristics.

Keywords: Anesthesia, General • Cough • Postoperative Complications

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Background

There remain gaps in the assessment, prevention, and treatment of pain in critically ill adults [1-4]. Opioids are widely used for analgesia and premedication. The advantages of opioids include perioperative analgesia, attenuation of the hemodynamic response, and reduction in the requirement of inhalational agents during general anesthesia. Currently, several short-acting opioids, including alfentanil, fentanyl, and sufentanil, are often used as intravenous boluses, which is associated with faster onset and recovery and high potency, with few adverse effects. Fentanyl is one of the widely used opioids for perioperative analgesia due to its rapid onset, short duration, intense analgesia, and low histamine release [5-8]. However, fentanyl-induced coughing (FIC) is a common adverse reaction occurring in 28-65% of patients, which always occurs within 2 min after fentanyl injection [9]. Although FIC in most patients is benign, transient, and self-limiting, it can be spasmodic or explosive and life-threatening, needing immediate intervention, especially for neurosurgical and ophthalmic procedures [10,11]. A previous study indicated FIC and postoperative nausea and vomiting share some common mechanisms, and FIC is associated with an increased risk of postoperative nausea and vomiting [12].

Numerous studies have already illustrated the role of pharmacological and nonpharmacological treatment strategies in the progression of FIC [13-25]. However, whether the incidence of FIC during general anesthesia induction and postoperative adverse events are associated with patient characteristics of remains controversial. Clarifying the risk factors for preventing FIC and postoperative adverse events is particularly important in patients undergoing general anesthesia induction, as it has not been definitively determined. Therefore, this retrospective study aimed to investigate the risk factors for FIC following general anesthesia in adults at a single center in China.

Material and Methods

Patients

This study was approved by the Ethics Committee of our hospital. The purpose and procedures of the study were carefully explained and written informed consent was obtained from all participants. A total of 601 patients undergoing general anesthesia induction were enrolled in this study between January 2015 and October 2018. All the included patients underwent general anesthesia induction and were ≥ 18.0 years of age. The exclusion criteria of this study were age < 18.0 years, absence of preanesthetic anxiolytic drugs, administration of lidocaine or antitussive agents within the previous week, and persistent symptomatic coughing that would make it difficult

to identify FIC. All patients were fasting for 8 h before the operation, and no anesthesia was used before the operation. The venous access of the upper limb was opened in the pre-anesthesia room, and the sodium lactate Ringer's solution was supplemented according to the preoperative loss. The monitor was connected, and the electrocardiogram, noninvasive blood pressure, and pulse oxygen saturation of upper limb were routinely monitored.

Data Collection

The baseline characteristics of the enrolled patients were collected using a pre-structured questionnaire and medical records, and all patients received physical examinations and systemic examination for chronic disease. The collected information included gender, age, type of surgery, operative time, body mass index (BMI), intraoperative blood loss, smoking status, alcohol intake, pharyngitis, history of gastroesophageal reflux, other digestive tract diseases, hypertension, diabetes mellitus, history of asthma, psychiatric history, history of respiratory infection (within 2 months), history of surgery, lidocaine, and use of midazolam, dexmedetomidine, sufentanil, propofol, and rocuronium bromide.

Anesthesia Induction

After 3 min of pure oxygen mask ventilation, patients received intravenous injection of lidocaine 0.04 ml/kg (2% concentration), midazolam 0.02-0.03 mg/kg, intravenous infusion of sufentanil 18 $\mu\text{g}/\text{kg}/\text{h}$ for 1 min, propofol 120 mg/kg/h for 1 min, and injection of rocuronium 0.8 mg/kg after the loss of consciousness. Then, endotracheal intubation was applied after 120 s, and mechanical ventilation was used for inhalation of 60% concentration of oxygen. The respiratory parameters were adjusted as follows: tidal volume: 8-10 ml/kg, respiratory rate: 10-15 times/min, inhalation/respiration ratio: 1: 1.5. End-tidal carbon dioxide partial pressure was maintained at 35-45 mmHg during the whole course. Sevoflurane (0.8-1.2 mac) was inhaled and rocuronium and sufentanil were injected as needed to maintain anesthesia. The above ventilation mode was maintained until the end of the operation.

Outcomes

The primary outcome of this study was the incidence of FIC during general anesthesia induction, and the secondary outcomes were postoperative nausea, vomiting, tongue falling back, laryngospasm, and anoxia. An episode of coughing within 2 min after fentanyl administration was defined as FIC, and the severity of FIC was divided into mild (1 or 2 coughs), moderate (3 or 4 coughs), and severe (≥ 5 coughs) [21]. The timing of the cough from drug administration was recorded in each enrolled patient. Postoperative adverse events were assessed,

and the incidence of specific adverse events were recorded by a trained nurse. Specific adverse events were defined as any degree of nausea, vomiting, tongue falling back, laryngospasm, or anoxia within 24 h after surgery.

Statistical Analysis

The characteristics of patients are presented as medians and quartiles or as event rates. Comparisons of continuous variables between FIC and non-FIC patients were calculated using Kruskal-Wallis tests due to the non-normal distributions, while the frequencies of data between these 2 groups were calculated using chi-squared tests. Multivariate logistic regression analyses were used to explore the potential association between patient and clinical characteristics and FIC during general anesthesia induction and postoperative nausea, vomiting, tongue falling back, laryngospasm, and anoxia. All reported *P* values are 2-sided, and *P* values <0.05 were considered statistically significant. The data were analyzed using International Business Machines Corporation Statistical Product and Service Solutions Statistics for Windows, version 19.0 (SPSS 19.0).

Results

The baseline characteristics of the recruited patients are shown in **Table 1**. Overall, 601 patients (131 FIC and 470 non-FIC patients) undergoing general anesthesia induction were enrolled in this retrospective cohort study. There were significant differences between the FIC and non-FIC groups in pharyngitis history (*P*<0.001), the use of lidocaine (*P*<0.001), and the use of propofol (*P*=0.021), while no significant differences were observed between these 2 groups for gender, age, type of surgery, operative time, BMI, intraoperative blood loss, smoking status, alcohol intake, history of gastroesophageal reflux, other digestive tract diseases, hypertension, diabetes mellitus, history of asthma, psychiatric history, history of respiratory infection (within 2 months), history of surgery, the use of midazolam and dexmedetomidine, sufentanil dosing, and rocuronium bromide, and the use of sufentanil.

Table 2 summarizes the potential association of patient and clinical characteristics with the incidence of FIC during general anesthesia induction. The results of multivariate logistic regression analysis suggested that patients with pharyngitis had an increased risk of FIC during general anesthesia induction (odds ratio [OR]: 2.852; 95% confidence interval [CI]: 1.698-4.792; *P*<0.001), while use of lidocaine was associated with lower incidence of FIC during general anesthesia induction (OR: 0.649; 95% CI: 0.557-0.757; *P*<0.001). Moreover, there were no significant differences between the FIC group and non-FIC group for gender (*P*=0.764), age (*P*=0.597), type of surgery (*P*=0.054), operative time (*P*=0.719), BMI (*P*=0.910),

intraoperative blood loss (*P*=0.397), smoking status (*P*=0.099), alcohol intake (*P*=0.273), history of gastroesophageal reflux (*P*=0.409), other digestive tract diseases (*P*=0.463), hypertension (*P*=0.134), diabetes mellitus (*P*=0.108), history of asthma (*P*=0.262), psychiatric history (*P*=0.343), history of respiratory infection (within 2 months) (*P*=0.552), history of surgery (*P*=0.199), palliative (dexmedetomidine versus midazolam) (*P*=0.124), sufentanil (*P*=0.214), propofol (*P*=0.729), and rocuronium bromide (*P*=0.253).

Table 3 summarizes the potential association of patient and clinical characteristics with the incidence of postoperative nausea. Overall, no significant differences were observed in gender (*P*=0.233), age (*P*=0.982), type of surgery (*P*=0.302), operative time (*P*=0.926), BMI (*P*=0.060), intraoperative blood loss (*P*=0.549), smoking status (*P*=0.161), alcohol intake (*P*=0.951), pharyngitis history (*P*=0.431), history of gastroesophageal reflux (*P*=0.470), other digestive tract diseases (*P*=0.501), hypertension (*P*=0.762), diabetes mellitus (*P*=0.969), history of asthma (*P*=0.781), psychiatric history (*P*=0.985), history of respiratory infection (within 2 months) (*P*=0.986), history of surgery (*P*=0.709), lidocaine (*P*=0.656), palliative (dexmedetomidine versus midazolam) (*P*=0.994), sufentanil (*P*=0.411), propofol (*P*=0.374), and rocuronium bromide (*P*=0.123) on the risk of postoperative nausea.

Table 4 summarizes the potential association of patient and clinical characteristics with the incidence of postoperative vomiting. We found that gender (*P*=0.300), age (*P*=0.405), type of surgery (*P*=0.928), operative time (*P*=0.879), BMI (*P*=0.981), intraoperative blood loss (*P*=0.563), smoking status (*P*=0.884), alcohol intake (*P*=0.667), pharyngitis history (*P*=0.617), history of gastroesophageal reflux (*P*=0.434), other digestive tract diseases (*P*=0.919), hypertension (*P*=0.745), diabetes mellitus (*P*=0.399), history of asthma (*P*=0.689), psychiatric history (*P*=0.959), history of respiratory infection (within 2 months) (*P*=0.957), history of surgery (*P*=0.792), lidocaine (*P*=0.647), palliative (dexmedetomidine versus midazolam) (*P*=0.349), sufentanil (*P*=0.803), propofol (*P*=0.377), and rocuronium bromide (*P*=0.990) were not associated with the incidence of postoperative vomiting.

The incidences of tongue falling back, laryngospasm, and anoxia within 24 h after surgery were 13/601, 2/601, and 3/601, respectively. Overall, BMI (OR: 2.271; 95% CI: 1.557-3.312; *P*<0.001), psychiatric history (OR: 24.481; 95% CI: 1.187-505.120; *P*=0.038), history of respiratory infection (within 2 months) (OR: 56.553; 95% CI: 1.568-2040.079; *P*=0.027), and the use of sufentanil (OR: 0.872; 95% CI: 0.762-0.998; *P*=0.047) were significantly correlated with the risk of the tongue falling back postoperatively. Moreover, none of the patient characteristics were associated with the risk of postoperative

Table 1. Baseline characteristics of included patients.

Variable	Non-FIC (n=470)		FIC (n=131)		P value
Gender					
Male	230	(48.94%)	62	(47.33%)	0.745
Female	240	(51.06%)	69	(52.67%)	
Age (years)	49.00	(36.00, 61.00)	52.00	(38.00, 66.00)	0.086
Type of surgery					
Orthopedics	110	(23.40%)	31	(23.66%)	0.951
Abdominal	360	(76.60%)	100	(76.34%)	
Operative time (min)	85.00	(50.00, 145.00)	100.00	(50.00, 155.00)	0.302
BMI	23.58	(20.98, 26.30)	24.21	(20.31, 25.86)	0.431
Intraoperative blood loss (ml)	200.00	(100.00, 300.00)	200.00	(100.00, 350.00)	0.106
Smoking status					
Never	405	(86.17%)	105	(80.15%)	0.089
Current or former	65	(13.83%)	26	(19.85%)	
Alcohol intake					
Never	434	(92.34%)	116	(88.55%)	0.169
Yes	36	(7.66%)	15	(11.45%)	
Pharyngitis					
Never	402	(85.53%)	93	(70.99%)	<0.001
Yes	68	(14.47%)	38	(29.01%)	
History of gastroesophageal reflux					
Never	450	(95.74%)	122	(93.13%)	0.217
Yes	20	(4.26%)	9	(6.87%)	
Other digestive tract diseases					
Never	447	(95.11%)	121	(92.37%)	0.223
Yes	23	(4.89%)	10	(7.63%)	
Hypertension					
Never	382	(81.28%)	97	(74.05%)	0.069
Yes	88	(18.72%)	34	(25.95%)	
Diabetes mellitus					
Never	412	(87.66%)	115	(87.79%)	0.969
Yes	58	(12.34%)	16	(12.21%)	
History of asthma					
Never	448	(95.32%)	126	(96.18%)	0.673
Yes	22	(4.68%)	5	(3.82%)	

Table 1 conitnued. Baseline characteristics of included patients.

Variable	Non-FIC (n=470)		FIC (n=131)		P value
Psychiatric history					
Never	460	(97.87%)	129	(98.47%)	0.935
Yes	10	(2.13%)	2	(1.53%)	
History of respiratory infection (within 2 months)					
Never	461	(98.09%)	129	(98.47%)	1.000
Yes	9	(1.91%)	2	(1.53%)	
History of surgery					
Never	453	(96.38%)	123	(93.89%)	0.207
Yes	17	(3.62%)	8	(6.11%)	
Lidocaine (2% ml)	3.00	(2.45, 3.50)	2.55	(0.00, 3.30)	<0.001
Palliative					
Midazolam	337	(71.70%)	87	(66.41%)	0.240
Dexmedetomidine	133	(28.30%)	44	(33.59%)	
Sufentanil (ug)					
10	9	(1.91%)	1	(0.76%)	0.256
15	152	(32.34%)	53	(40.46%)	
20	309	(65.74%)	77	(58.78%)	
Propofol (mg)	100.00	(100.00, 100.00)	100.00	(90.00, 100.00)	0.021
Rocuronium bromide	50.00	(40.00, 50.00)	50.00	(40.00, 50.00)	0.052
Sufentanil	10.00	(10.00, 30.00)	10.00	(10.00, 30.00)	0.534

BMI – body mass index; FIC – fentanyl-induced cough.

laryngospasm. Similarly, no patient characteristics were correlated with the risk of postoperative anoxia (data not shown).

Discussion

FIC and postoperative adverse events can affect patient mobility, prolong discharge from the postanesthesia care unit, and increase care cost, which are the most common postoperative problems [26-29]. The present retrospective cohort study enrolled 601 patients undergoing general anesthesia induction across wide range of patient characteristics. The multiple adjusted results indicated patients with pharyngitis are more likely to have FIC, whereas use of lidocaine was associated with a reduced risk of FIC during general anesthesia induction. Moreover, the risk of postoperative tongue falling back was associated with BMI, psychiatric history, history of respiratory infection (within 2 months), and the use of sufentanil. No

other risk factors were identified for FIC during general anesthesia induction and postoperative nausea, vomiting, tongue falling back, laryngospasm, and anoxia.

Numerous studies have assessed the incidence of FIC, whereas the potential association of patient characteristics and anesthetic technique with the incidence of FIC has only been reported in 1 study [30]. This study suggested aging, cigarette smoking, prior epidural injection of lidocaine, or a priming dose of vecuronium are significantly associated with the risk of FIC in patients undergoing elective surgery under general anesthesia. First, they point out aging was associated with a reduced risk of FIC, which could be due to the decreased number of rapidly adapting stretch receptors in aging [31]. However, this significant difference was not observed in this retrospective cohort study, and is consistent with another previous study, which suggested the capsaicin cough thresholds are similar among various age groups in the same sex [32]. Second, a

Table 2. The risk factors for the incidence of fentanyl-induced cough by multivariate logistic regression analysis.

Variables	β value	SD	Wald chi-square	OR (95% CI)	P value
Intercept	0.529	1.639	0.104		0.747
Gender	0.080	0.266	0.090	1.083 (0.643-1.822)	0.764
Age (years)	0.004	0.008	0.280	1.004 (0.989-1.020)	0.597
Type of surgery	-0.533	0.277	3.717	0.587 (0.341-1.009)	0.054
Operative time (min)	0.001	0.003	0.130	1.001 (0.996-1.006)	0.719
BMI	0.005	0.043	0.013	1.005 (0.923-1.094)	0.910
Intraoperative blood loss (ml)	0.000	0.001	0.718	1.000 (0.999-1.002)	0.397
Smoking status	0.516	0.312	2.728	1.675 (0.908-3.089)	0.099
Alcohol intake	0.420	0.383	1.202	1.521 (0.719-3.222)	0.273
Pharyngitis	1.048	0.265	15.685	2.852 (1.698-4.792)	<0.001
History of gastroesophageal reflux	0.384	0.465	0.682	1.468 (0.590-3.651)	0.409
Other digestive tract diseases	0.350	0.477	0.539	1.420 (0.557-3.615)	0.463
Hypertension	0.438	0.292	2.251	1.549 (0.875-2.743)	0.134
Diabetes mellitus	-0.584	0.363	2.582	0.558 (0.274-1.137)	0.108
History of asthma	-0.617	0.550	1.261	0.539 (0.184-1.585)	0.262
Psychiatric history	-0.792	0.834	0.901	0.453 (0.088-2.324)	0.343
History of respiratory infection (within 2 months)	-0.508	0.854	0.354	0.602 (0.113-3.208)	0.552
History of surgery	0.638	0.497	1.647	1.893 (0.714-5.019)	0.199
Lidocaine (2%ml)	-0.432	0.078	30.591	0.649 (0.557-0.757)	<0.001
Palliative (Dexmedetomidinevs midazolam)	0.385	0.250	2.363	1.469 (0.900-2.400)	0.124
Sufentanil (ug)					.
10	–	–	–	Ref	.
15	0.701	1.231	0.324	2.016 (0.181-22.520)	0.569
20	0.765	1.366	0.313	2.148 (0.148-31.227)	0.576
Propofol (mg)	-0.005	0.013	0.120	0.995 (0.970-1.022)	0.729
Rocuronium bromide	-0.030	0.026	1.309	0.971 (0.923-1.021)	0.253
Sufentanil	-0.022	0.018	1.544	0.978 (0.945-1.013)	0.214

BMI – body mass index; CI – confidence interval; OR – odds ratio; SD – standard deviation.

previous study indicated absence of smoking was associated with an increased risk of FIC, which could be due to an increase capsaicin cough threshold in smokers [33]. However, the present study indicated current smoker status was associated with a non-significant increased incidence of FIC, which could be because lung function is affected by smoking [34]. Third, prior epidural injection of lidocaine was not associated with a reduced risk of FIC, and this antitussive effect could

be attributed to the systemic effects of this local anesthetic [35,36]. However, our study found the use of lidocaine was associated with a reduced risk of FIC owing to the arrhythmogenic effects of lidocaine. An appropriate dose of lidocaine can reduce the risk of FIC [37], and the prophylactic effect of intravenous lidocaine on the risk of opioid-induced cough has already demonstrated [38,39]. Fourth, the use of vecuronium can affect histamine release, which is involved in the onset

Table 3. The risk factors for the incidence of nausea by multivariate logistic regression analysis.

Variables	β value	SD	Wald chi-square	OR (95% CI)	P value
Intercept	-6.473	2.871	5.082		0.024
Gender	-0.498	0.418	1.425	0.607 (0.268-1.377)	0.233
Age (years)	0.000	0.014	0.001	1.000 (0.974-1.028)	0.982
Type of surgery	0.517	0.500	1.066	1.676 (0.629-4.468)	0.302
Operative time (min)	0.000	0.004	0.009	1.000 (0.993-1.008)	0.926
BMI	0.136	0.073	3.539	1.146 (0.994-1.321)	0.060
Intraoperative blood loss (ml)	-0.001	0.001	0.359	0.999 (0.997-1.001)	0.549
Smoking status	-0.925	0.660	1.964	0.397 (0.109-1.446)	0.161
Alcohol intake	0.040	0.659	0.004	1.041 (0.286-3.789)	0.951
Pharyngitis	-0.417	0.530	0.621	0.659 (0.233-1.860)	0.431
History of gastroesophageal reflux	0.513	0.710	0.522	1.671 (0.415-6.720)	0.470
Other digestive tract diseases	0.478	0.711	0.453	1.614 (0.401-6.496)	0.501
Hypertension	0.145	0.478	0.092	1.155 (0.453-2.947)	0.762
Diabetes mellitus	-0.023	0.584	0.002	0.977 (0.311-3.073)	0.969
History of asthma	0.226	0.814	0.077	1.254 (0.254-6.182)	0.781
Psychiatric history	-13.224	688.726	0.000	0.000 (0.000-1)	0.985
History of respiratory infection (within 2 months)	-12.747	706.969	0.000	0.000 (0.000-1)	0.986
History of surgery	-0.411	1.101	0.139	0.663 (0.077-5.736)	0.709
Lidocaine (2%ml)	-0.053	0.120	0.198	0.948 (0.749-1.199)	0.656
Palliative (Dexmedetomidinevs midazolam)	0.003	0.405	0.000	1.003 (0.454-2.217)	0.994
Sufentanil (ug)					.
10	-	-	-	Ref	.
15	-1.103	1.679	0.432	0.332 (0.012-8.907)	0.511
20	-3.045	2.074	2.156	0.048 (0.001-2.773)	0.142
Propofol (mg)	-0.024	0.027	0.789	0.976 (0.926-1.029)	0.374
Rocuronium bromide	0.106	0.069	2.385	1.112 (0.972-1.272)	0.123
Sufentanil	0.024	0.029	0.677	1.024 (0.968-1.084)	0.411

BMI – body mass index; CI – confidence interval; OR – odds ratio; SD – standard deviation.

of FIC [40]. The lack of a significant association in the present study could be because the number of patients in each category of vecuronium was not balanced, which affected the power to detect the association of vecuronium and the onset of FIC. Finally, we found that patients with pharyngitis history had an increased risk of FIC during general anesthesia induction. The reason for this could be that pharyngitis-induced cough can cause overestimation of FIC.

The results of the present study showed no association of patient and clinical characteristics with postoperative nausea and vomiting. The reason for this could be the lower incidence of postoperative nausea and vomiting, which always has broad confidence intervals, meaning there is no statistically significant difference. A similar reason could explain the lack of significant risk factors for the onset of postoperative laryngospasm and apnea. Finally, although the incidence of postoperative

Table 4. The risk factors for the incidence of vomiting by multivariate logistic regression analysis.

Variables	β value	SD	Wald chi-square	OR (95% CI)	P value
Intercept	-14.354	222.465	0.004		0.949
Gender	0.549	0.530	1.075	1.732 (0.613-4.891)	0.300
Age (years)	-0.013	0.016	0.694	0.987 (0.956-1.018)	0.405
Type of surgery	0.048	0.530	0.008	1.049 (0.371-2.962)	0.928
Operative time (min)	-0.001	0.006	0.023	0.999 (0.988-1.011)	0.879
BMI	0.002	0.085	0.001	1.002 (0.849-1.183)	0.981
Intraoperative blood loss (ml)	-0.001	0.002	0.334	0.999 (0.996-1.002)	0.563
Smoking status	-0.101	0.694	0.021	0.904 (0.232-3.521)	0.884
Alcohol intake	0.350	0.812	0.186	1.419 (0.289-6.972)	0.667
Pharyngitis	0.260	0.519	0.251	1.297 (0.469-3.585)	0.617
History of gastroesophageal reflux	0.682	0.871	0.613	1.977 (0.359-10.901)	0.434
Other digestive tract diseases	-0.114	1.122	0.010	0.892 (0.099-8.044)	0.919
Hypertension	-0.228	0.700	0.106	0.796 (0.202-3.138)	0.745
Diabetes mellitus	-0.923	1.095	0.710	0.397 (0.046-3.399)	0.399
History of asthma	-0.438	1.095	0.160	0.645 (0.075-5.519)	0.689
Psychiatric history	-10.009	194.335	0.003	0.000 (0.000-1.18E161)	0.959
History of respiratory infection (within 2 months)	-9.857	181.488	0.003	0.000 (0.000-1.59E150)	0.957
History of surgery	0.289	1.096	0.070	1.335 (0.156-11.436)	0.792
Lidocaine (2%ml)	-0.068	0.149	0.210	0.934 (0.698-1.250)	0.647
Palliative (Dexmedetomidinevs midazolam)	-0.488	0.521	0.876	0.614 (0.221-1.706)	0.349
Sufentanil (ug)					.
10	-	-	-	Ref	.
15	9.906	222.455	0.002	20048.52 (0.000-4.53E193)	0.965
20	9.886	222.459	0.002	19651.67 (0.000-4.47E193)	0.965
Propofol (mg)	0.020	0.023	0.782	1.021 (0.975-1.068)	0.377
Rocuronium bromide	-0.001	0.060	0.000	0.999 (0.888-1.125)	0.990
Sufentanil	0.009	0.037	0.062	1.009 (0.939-1.084)	0.803

BMI – body mass index; CI – confidence interval; OR – odds ratio; SD – standard deviation.

tongue falling back was lower, BMI, psychiatric history, history of respiratory infection (within 2 months), and the use of sufentanil were significantly associated with the risk of postoperative tongue falling back. However, these results were not stable and need to be verified by a larger prospective study.

This study has several limitations. First, stratified results were not conducted due to all of patients' characteristics entered the logistic model, which prevented us from exploring the risk factor on FIC during general anesthesia induction and postoperative nausea, vomiting, tongue falling back, laryngospasm,

and anoxia in patients with specific characteristics. Second, this was a retrospective cohort study, with inherent risk of bias due to lack of control of confounding variables. Third, the sequence for drugs administration, and timing for the use of fentanyl could affect the progression of FIC [41,42], which were not addressed in our study owing to this study designed as retrospective cohort. Fourth, the analysis of this study based on the frequent of FIC incidence, while the frequency and severity scoring system for FIC were not combined [43]. Fifth, the severity of FIC during general anesthesia induction and postoperative nausea, vomiting, tongue falling back, laryngospasm, and anoxia were not addressed in this study. Finally, other limitations of this study, including small sample size, the use of a single center, and any study bias.

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Conclusions

The results of this study indicated that a history of pharyngitis increased the risk of FIC, while the use of lidocaine was associated with a reduced risk of FIC. However, fentanyl use and the characteristics of patients were not associated with the risk of postoperative nausea and vomiting. However, these results are based on a retrospective cohort analysis, and further large-scale prospective cohort studies are needed to identify potential risk factors for FIC during general anesthesia induction, as well as to explore the possible associations with postoperative nausea, vomiting, tongue falling back, laryngospasm, and anoxia in patients with specific characteristics.

Conflict of Interests

None.

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