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Risk Factors for Vocal Cord Paralysis and Hoarseness Following Endotracheal Intubation

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Abstract

Background: Hoarseness following endotracheal intubationis a complication that may persist due to recurrent laryngeal nerve palsy, which can impair the quality of life. Here, we evaluated the risk factors for recurrent laryngeal nerve palsy following endotracheal intubation.

Methods: We conducted a single-center retrospective cohort study of all surgical patients who underwent general anesthesia and intubation at St Luke's International Hospital from January 1, 2011, to July 31, 2020. To identify risk factors for recurrent laryngeal nerve palsy following endotracheal intubation, Fisher's exact test and t-test were used for univariate analysis, and logistic regression analysis was used for multivariate analysis.

Results: Of the 46,617 eligible cases, 14 (0.03%) developed vocal cord paralysis. Multivariate analysis revealed a significant association between postoperative hoarseness (OR=42.4, 95%CI=12.8-141.0, p<0.001) and the development of vocal cord paralysis. Sub-analysis with hoarseness as the secondary outcome revealed that hypertension, cuff pressure measurements, and anesthesia time were significantly associated with the development of postoperative hoarseness.

Conclusion: Understanding the risk factors for recurrent laryngeal nerve palsy in surgical patients may help to identify those at high-risk of post-intubation hoarseness and vocal cord paralysis preoperatively and intraoperatively, and allow for more targeted management during intubation.

Introduction

Hoarseness is a potential complication of intubation, and persistent hoarseness may impair the patient's quality of life. The incidence of hoarseness after general anesthesia is 14% to 50% [1]. although post intubation hoarseness usually recovers within 3 days after surgery, symptoms persist for 10 days or more in 12.4% [2] of those affected. Persistent symptoms of hoarseness following intubation may be due to recurrent laryngeal nerve palsy, which occurs with a frequency of 0.1% to 0.15% [3-5].

Previous studies demonstrated that long surgery time and esophageal cancer surgery are risk factors for recurrent laryngeal nerve palsy and hoarseness [6]. Reported risk factors for hoarseness are female, long surgery time, cuff pressure, and the use of an esophageal temperature probe [7,8]. Few studies, however, have collected enough samples to perform a multivariate analysis of recurrent laryngeal nerve palsy [1-3,6,10].

The aims of the present study were to evaluate the risk factors for recurrent laryngeal nerve palsy and hoarseness in a large cohort of surgical patients undergoing intubation.

Methods

This was a single-center retrospective observational study at St. Luke's International Hospital from January 1, 2011, to July 31, 2020, and all patients who underwent general anesthesia for surgery and were intubated at our hospital were included.

Exclusion criteria were recurrent laryngeal nerve palsy before surgery; impaired consciousness; recurrent laryngeal nerve

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damage due to previous surgeries such as thyroid surgery, aortic surgery (excluding percutaneous surgery), and esophageal cancer surgery; age under15 years; and decision not to participate in the study.

The primary endpoint was recurrent laryngeal nerve palsy, and the diagnostic criteria were patients with recurrent laryngeal nerve palsy on postoperative examination in the otolaryngology department. The endpoint for the sub-analysis was hoarseness, and patients experiencing hoarseness during the postoperative examination by the anesthesiology team the day after surgery (which was conducted in all patients who underwent general anesthesia) were selected.

To identify postoperative patients with recurrent laryngeal nerve palsy, we first selected surgical patients (3211 cases) examined by an otolaryngologist using a laryngeal fiberscope. Next, the candidates were those examined by an otolaryngologist at least once after discharge (776 cases) and given a diagnosis of recurrent laryngeal nerve palsy (180 cases, including suspected recurrent laryngeal nerve palsy). Finally, the medical records of the candidate cases were confirmed, and when adiagnosis of recurrent laryngeal nerve palsy was actually made upon examination by an otolaryngologist, the patient was judged to have postoperative recurrent laryngeal nerve palsy. Patients who had recurrent laryngeal nerve palsy or hoarseness before the operation were not judged to have recurrent laryngeal nerve palsy after the operation.

Groups with and without postoperative recurrent laryngeal nerve palsy were analyzed using the statistical software R (version 6.0.2). Each covariate was compared by univariate analysis; a t-test was used for 2-group comparison of continuous variables, and Fisher's exact test was used for 2-group comparison of categorical variables. Multivariate analysis was then performed by logistic regression analysis. A P value was 0.05 or less was considered statistically significant.

This study was approved by the Research Ethics Review Board of our hospital (reference number 20-J00 [9].

Results

Selection of Patients to be Researched and Analyzed

A total of 47735 surgeries performed with endotracheal intubation were performed in our hospital from January 1, 2011, to July 31, 2020, and 46617 surgeries were included in the study. The mean age of the patients was 54 years (range, 15–100 years), 39.6% were male, and the mean anesthesia time was 2.6 h. Recurrent laryngeal nerve palsy developed after surgery in 13 patients 0.03% (Figure 1).The surgery departments for the 47696 cases are shown in (Table 1).

Univariate Analysis

The results of univariate analysis are shown in (Tables 2 & 3). Items with P< 0.05 were anesthesia time and postoperative hoarseness (Table 2).

Multivariate Analysis

Multivariate analysis was performed on items with P<0.05 in the univariate analysis and items considered to be clinically significant (Table 3). The item with P< 0.05 was postoperative hoarseness (Table 3).

Analysis Results for Secondary Outcomes

Cases of recurrent laryngeal nerve palsy after intubation had a significantly higher frequency of postoperative hoarseness. Therefore, we analyzed postoperative hoarseness as the secondary outcome. Of the 46,617 cases analyzed, 460 cases (0.9%) experienced postoperative hoarseness.

Items with P<0.05 in the univariate analysis and multivariate analysis are shown in (Tables 4 & 5).

Breakdown and Outcomes of Patients with Recurrent Laryngeal Nerve Palsy

Breakdown and recovery times of patients with recurrent laryngeal nerve palsy after intubation are shown in (Table 6). Recurrent nerve palsy following intubation occurred in 7 men and 6 women with a mean (standard deviation, SD) age of 56.5 (12.3) years. Two cases (15.3%) developed right-sided recurrent laryngeal nerve palsy and 11 cases (84.6%) developed left-sided recurrent laryngeal nerve palsy. Of these 13 cases, 4 underwent gastrointestinal surgery; 2 each underwent breast, plastic, or urology surgery; and 1 case each underwent respiratory, orthopedic, or gynecologic surgery. The mean (SD) operation time was 239.6 (165.5) minutes.

Regarding the recovery time, none of the13 patients with vocal cord paralysis received active treatment by an otolaryngologist, and all patients were followed up. Follow-up showed improvement in vocal cord paralysis and hoarseness in all cases. The mean (SD) time to improvement was 153 (172) days, ranging from 37 to 629 days.

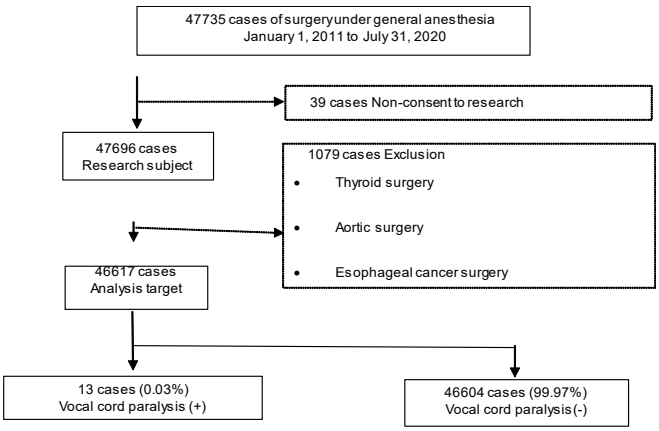

Figure 1: Flowchart of surgical cases to be analyzed

Table 1: Department and number of surgeries included in the study.

Department	Number	%
Breast surgery	8746	18.3
Obstetrics and Gynecology	8761	18.3
Gastrointestinal surgery	7364	15.4
Orthopedic surgery	7284	15.2
Urology	5026	10.5
Cardiovascular surgery	2271	4.7
Plastic surgery	1847	3.8
Neurosurgery	1785	3.7
Otorhinolaryngology	1560	3.2
Respiratory surgery	1106	2.3
Neurosurgery	648	1.3
Others	1298	2.7
Total	47696	100

Table 2: Univariate analysis of risk factors for vocal nerve paralysis, median (range or %).

Factors	Paralysis		
	Yes (N=13)	No (N=46604)	P-value
Age, years	54.8(26-81)	55.5(15-100)	0.889
Body mass index, kg/m^2	22.6(17-23)	20.7(11-72)	0.607
Tube size, cm	7(7-8)	7.4(4-9)	0.987
Tube depth, cm	24(21-25)	22.1(14-59)	0.979
Position changes	0.5(0-2)	0.7(0-7)	0.115
Total anesthesia time, hour	3.0(2.6-10.7)	3.7(0.2-20.4)	0.002
Male	7(53.8)	18468(39.6)	0.396
Diabetes	0(0)	2973(6.4)	1.000
Hypertension	2(13.5)	8601(18.4)	1.000
Gastric tube	4(28.6)	13614(29.2)	1.000
Intubation attempts >2	3(21.4)	4289(9.2)	0.132
Cuff pressure measurement	3(21.4)	9535(20.5)	1.000
Mask ventilation difficulties	0(0)	1116(2.4)	1.000
McGRATH® usage	1(7.1)	622(1.3)	0.172
Fixed left mouthangle	2(14.3)	3488(7.5)	0.282
Mallampati>III	0(0)	5106(10.9)	0.389
Department			0.185
OBGYN, Urology	1(7.6)	13494(28.9)	
Gastrointestinal surgery	6(14.3)	7202(15.5)	
Cardiovascular surgery	0(0)	3257(7.0)	
Orthopedic surgery	1(7.1)	7125(15.3)	
Breast surgery, plastic surgery	4(28.6)	10334(22.2)	
Neurosurgery	0(0)	2383(5.1)	
Intubation by resident	2(15.3)	12950(27,7)	0.536
Position changes	7(53.8)	20393(43.7)	0.579
Postoperative hoarseness	4(30.7)	456(0.9)	<0.001

Table 3: Multivariate logistic regression analysis of risk factors for vocal nerve paralysis.

Factors	OR(95%CI)	P-value
Anesthesia time	1.16(0.92-1.46)	0.21
Hoarseness	42.4(12.8-141.0)	<0.001
Intubation by resident	0.47(0.10-2.14)	0.33
Position changes	1.36(0.45-4.09)	0.58
McGRATH® usage	6.78(0.86-53.4)	0.069

Table 4: Univariate analysis of risk factors for hoarseness, median (range or %).

Factors	Hoarseness		P-value
	Yes (N=460)	No (N=46157)	
Position changes	0.51(0-3)	0.57(0-7)	0.047
Anesthesia time	3.0(0.8-12.3)	3.6(0.1-20.4)	<0.001
Male	134(29.1)	18341(39.7)	<0.001
Mallampati>III	37(8.1)	5096 (10.8)	0.042

Table 5: Multivariate logistic regression analysis of risk factors for hoarseness (N=46617).

Factors	OR(95%CI)	P-value
Male	0.61(0.46-0.80)	<0.001
Hypertension	1.59(1.16-2.19)	0.003
Mallampati> III	0.70(0.50-0.99)	0.045
Cuff pressure measurement	0.45(0.31-0.65)	<0.001
Anesthesia time	1.16(1.09-1.23)	<0.001
Intubation by resident	1.22(0.94-1.59)	0.14

Table 6: Background and outcome of patients with vocal nerve paralysis.

	Sex	Age	Side	Department	Operation (min)	Recovery time (days)
1	M	74	left	Orthopedic	42	196
2	F	45	left	Breast	532	55
3	M	76	left	Respiratory	144	377
4	F	64	left	Gastrointestinal	322	54
5	M	58	right	Gastrointestinal	353	37
6	F	46	left	Breast	165	629
7	F	51	right	Plastic	108	191
8	M	64	left	Gastrointestinal	110	55
9	M	55	left	Urology	197	154
10	M	34	left	Gastrointestinal	141	60
11	F	47	leftleft	OBGYN	135	45
12	M	68	left	Urology	294	51
13	F	53		Plastic	572	93

Discussion

Our findings revealed that postoperative hoarseness was significantly associated with recurrent laryngeal nerve palsy. Previous studies reported that patients with long-duration intubation have a higher frequency of recurrent laryngeal nerve palsy [6], but our results indicated that duration was not a significant contributing factor. This may be due to the small number of cases with recurrent laryngeal nerve palsy in the present study.

Analysis of secondary outcomes revealed that postoperative hoarseness was significantly associated with the absence of cuff pressure measurements, Mallampati classification <III, female, hypertension, and long anesthesia times.

Ischemia of surrounding tissues is reported to occur when the cuff pressure exceeds 30 cmH2O [9], but if the cuff pressure is not measured during surgery, it may exceed this range. Jaensson et al. reported that cuff pressure ranging from 21–30 cmH2O in men and lower than 20 cmH2O in females is a risk factor for postoperative hoarseness [7].

The clinical significance of a Mallampati classification <III is unknown, but more cases had a Mallampati classification of III or IV than of II or lower. The frequency of pressure measurements was significantly higher in cases with Mallampati classification > III (OR = 1.20, 95% CI = 1.12-1.29, P <0.001). Differences in the Mallampati classification indicate intraoral anatomical differences, and further studies are needed to clarify the clinical significance.

In women, high blood pressure and long anesthesia time were significant risk factors for hoarseness, consistent with the results of previous studies [6]. Informing patients preoperatively that these factors are associated with a high risk of hoarse-

ness after surgery will help to prepare patients for the possibility. The risk factors were anatomically small glottis for women, decreased blood flow around the larynx due to arteriosclerosis or hypertension, and long-duration laryngeal compression for anesthesia. At our hospital, the intubation tube used for women is uniformly one size smaller than that for men, but even under such circumstances, there were many cases of hoarseness among women, suggesting that the size of the intubation tube used in women requires further review. Jaensson et al. investigated the relationship between hoarseness/pharyngitis in females with intubation tube size in a randomized controlled trial. They found that a smaller intubation tube was associated with a lower frequency of postoperative sore throat and discomfort, but detected no significant difference in the onset of hoarseness [7].

Intubation by early-stage trainees was not significantly associated with either postoperative recurrent laryngeal nerve palsy or hoarseness, which may be because intubation was always performed under the supervision of an experienced anesthesiologist. Jaensson et al. reported that intubation by trainees with fewer than 3 months experience was a risk factor for postoperative sore throat [8].

Previous studies indicated that the cuff pressure changes significantly during postural changes [9], but we detected no significant difference associated with postural changes. This may be because all patients were treated in the same manner without distinguishing the types of postural changes. Different results may have been obtained by analyzing the patient position (cervical anteflexion, Trendelenburg position, etc.).

In addition, previous studies reported that the use of a laryngeal mask airway reduced the incidence of postoperative hoarseness [10]. No significant difference, however, was detected in the present study.

The outcome of patients with recurrent laryngeal nerve palsy was improved at follow-up in all cases, and the prognosis was very good. Kurokawa et al [6]. reported arecovery time ranging from3 weeks to 2 months, with a mean of 40 days but with large variations depending on the case.

The limitations of this study are that it wasa single-center retrospective study, the number of cases diagnosed with recurrent laryngeal nerve palsy was small, and no adjustments were made for patient background (smoking history, ischemic events, etc.), which may affect the risk of hoarseness.

Recurrent laryngeal nerve palsy and postoperative hoarseness were significantly associated with female sex, hypertension, Mallampati classification <III, absence of cuff pressure measurements, and long anesthesia time. These risk factors may predict those at high risk for postoperative recurrent laryngeal nerve palsy and hoarseness preoperatively and intraoperatively, allowing for more detailed explanations preoperatively and better management during intubation.

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