

Clinical characteristics of arytenoid dislocation in patients undergoing bariatric/metabolic surgery

A STROBE-complaint retrospective study

Kuo-Chuan Hung, MD^{a,*}, Yi-Ting Chen, MD^b, Jen-Yin Chen, MD, PhD^{a,c}, Chuan-Yi Kuo, MD^d, Shao-Chun Wu, MD^e, Min-Hsien Chiang, MD^e, Kuo-Mao Lan, MD^a, Li-Kai Wang, MD, MSc^a, Cheuk-Kwan Sun, MD, PhD^f

Abstract

Tracheal intubation and the use of a large-bore calibrating orogastric (OG) tube have been reported to increase the incidence of arytenoid dislocation (AD) in patients undergoing bariatric/metabolic surgery. This study aimed at identifying the clinical characteristics of this patient subgroup.

We retrospectively examined the clinical characteristics of 14 patients with AD (study group) who received tracheal intubation and OG insertion for bariatric/metabolic surgery between 2011 and 2016. For comparison, another group of 19 patients with postoperative AD collected from published literature and 3 patients from the authors' institute served as controls in whom only tracheal intubation was performed. Information on patient characteristics, anesthetic time, symptoms, time of symptom onset, intervention, and postinterventional impact on vocalization of the 2 groups were collected and compared.

Patients in the study group were younger than those in the control group (38 [25–60] vs 54.5 [19–88] years, $P = .03$). Compared with the control group, anesthetic time (282.5 [155–360] vs 225 [25–480] minutes, $P = .041$) was longer and symptom onset (1.0 [0–6] vs 1.0 [0–6] days, $P = .018$) was more delayed in the study group. After closed reduction, the frequency of voice recovery was comparable in both groups in a time interval of 12 weeks (84.6% vs 92.9%, $P = .59$).

Our report demonstrates that the clinical characteristics of patients with AD who received tracheal intubation and OG insertion for bariatric/metabolic surgery were different from those with postoperative AD receiving only tracheal intubation, highlighting the importance of implementing individualized strategies for AD prevention in this patient population.

Abbreviations: AD = arytenoid dislocation, CAJ = cricoarytenoid joint, GERD = gastroesophageal reflux disease, OG = calibrating orogastric, POD = postoperative day.

Keywords: arytenoid dislocation, bariatric surgery, hoarseness, orogastric tube

1. Introduction

Arytenoid dislocation (AD), which is a rare complication associated with tracheal intubation, external blunt trauma, or insertion of

medical devices into the larynx or esophagus,^[1–4] may result in severe vocal disability (eg, hoarseness) or airway obstruction. Delay identification and treatment of AD have been reported to contribute to prolonged voice impairment^[1,2] and adversely affect postoperative patient satisfaction. As hoarseness is a common postoperative complaint after tracheal intubation with an incidence as high as 14.4% and 50%,^[5–7] the occurrence of postoperative AD may be ignored. In addition, despite advances in intubation techniques and devices, it seems that patients remain at risk of AD.^[8] To recognize the clinical characteristics of AD is important for the clinician to provide patient counseling and implement strategies to optimize patient safety and postoperative care.

Our previous reports demonstrated that the perioperative use of a large-bore calibrating orogastric (OG) tube (36 French) may increase the risk of AD in intubated patients undergoing bariatric/metabolic surgery under general anesthesia.^[9,10] At our institute, patients who undergo bariatric/metabolic surgery are often obese, relatively young, and associated with multiple comorbidities (eg, diabetes). In addition, the mechanism of AD in this patient subgroup may be related to multiple trauma from tracheal intubation and the use of OG tubes.^[11] We hypothesized that the clinical characteristics of AD in this patient subgroup may be different from those in the general population with postoperative AD. To test our hypothesis, we compared the clinical characteristics of this patient subgroup with those of the reported patients with postoperative AD in whom only tracheal intubation was performed.

Editor: Naila Akhtar.

K-CH and C-KS contributed equally to this study.

The authors have no funding and conflicts of interest to disclose.

^aDepartment of Anaesthesiology, Chi Mei Medical Center, Tainan, ^bDepartment of Anaesthesiology, Chang Gung Memorial Hospital, Chia-Yi, ^cDepartment of the Senior Citizen Service Management, Chia Nan University of Pharmacy and Science, Tainan, ^dDepartment of Anaesthesiology, E-Da Hospital, I-Shou University, ^eDepartment of Anaesthesiology, Kaohsiung Chang Gung Memorial Hospital, Chang Gung University and College of Medicine, ^fDepartment of Emergency Medicine, E-Da Hospital, School of Medicine for International Students, I-Shou University, Kaohsiung, Taiwan.

* Correspondence: Kuo-Chuan Hung, Chi Mei Medical Center, No. 901, Chung-Hwa Road, Yung-Kung Dist., Tainan 71004, Taiwan, R.O.C. (e-mail: ed102605@gmail.com).

Copyright © 2019 the Author(s). Published by Wolters Kluwer Health, Inc. This is an open access article distributed under the terms of the Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 (CCBY-NC-ND), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

Medicine (2019) 98:17(e15318)

Received: 26 May 2018 / Received in final form: 20 March 2019 / Accepted: 23 March 2019

<http://dx.doi.org/10.1097/MD.00000000000015318>

2. Patients and methods

2.1. Patient population

After approval from the institutional review board (EMRP-106-029), we retrospectively reviewed the data of patients with AD between 2011 and 2016 from the anesthesia database of a tertiary referral hospital. The study group comprised patients with postoperative AD who underwent weight loss (bariatric surgery) or diabetes control (metabolic surgery) surgeries with tracheal intubation and calibrating OG tube insertion during general anesthesia. Patients were excluded for a positive history of laryngeal trauma, postoperative admission to the intensive care unit (ICU) for ventilator support, or requirement for a second surgery during the same hospitalization (eg, reoperation for complications associated with the first procedure). Under these conditions, it may be difficult to determine the clinical characteristics or course of AD. To determine the clinical characteristics of this patient subgroup who underwent bariatric/metabolic surgery (study group), a control group of patients receiving only tracheal intubation with postoperative AD from published reports and additional patients with AD from the authors' institute was used for comparison.

2.2. Equipment, procedures, and diagnostic criteria

The calibrating OG tube (36 F gauge; Obtech Medical Sàrl, Le Locle, Switzerland), which allows precise calibration of the residual gastric volume, was routinely inserted blindly through the esophagus into the stomach for gastric pouch formation after tracheal intubation. This device was inserted, left in situ throughout the operation and removed after completion of surgery. The diagnosis of AD was confirmed by surgical history, findings from flexible fiberoptic laryngoscopy or stroboscopy examinations as well as intraoperative arytenoid palpation.^[2]

2.3. Literature search

The PubMed database was systematically searched to identify relevant case reports and case series from 1974 to 2017 using the following keywords: "arytenoid dislocation," "cricoarytenoid subluxation," "surgery," "postoperative," "anaesthesia," and "tracheal intubation." The selection criteria for articles were:

- (1) cases in which the details about intubation process, onset of symptom, and other characteristics of AD could be obtained,

- (2) a causal relationship between tracheal intubation and development of AD.

The exclusion criteria for cases were:

- (1) articles published in non-English languages,
- (2) AD was not caused by tracheal intubation (eg, laryngeal mask airway),
- (3) cases with age less than 18 years,
- (4) cases with prolonged tracheal intubation for more than 24 hours,
- (5) cases undergoing cardiovascular surgery.

Additional cases were collected from 2011 to 2016 at the authors' institute.

2.4. Study parameters

Information on patient characteristics, co-morbidities, the clinical characteristics of AD including symptoms and onset time (expressed as postoperative day [POD]), the interval between endolaryngeal manipulation and intervention of AD, intubation attempts, and voice outcome were collected in the study group and the control group.

2.5. Statistical analysis

Categorical variables presented as numbers and percentages were compared using Fisher exact test. Non-normally distributed continuous variables expressed as median and range were compared with Mann-Whitney *U* test. Statistical significance was indicated by $P < .05$. All analyses were performed using SPSS 19.0 statistical software (SPSS Inc, Chicago, IL).

3. Results

3.1. Medical record review

There were 1735 bariatric/metabolic surgeries performed during the study period at our institute. From the anesthesia database, we identified 14 patients with postoperative AD who met the inclusion criteria, giving an AD incidence of 0.8% (14/1735) in patients undergoing bariatric/metabolic surgeries. No patient was excluded from the present study. Patients' characteristics, co-morbidities, and initial procedures are shown in Table 1. The

Table 1
Characteristics of patients undergoing bariatric/metabolic surgery with postoperative arytenoid dislocation (N = 14).

Case	Age, yr/sex	BW, kg	BMI, kg/m ²	Procedure	Comorbidity
1	25/F	136	54.5	LGB	Nil
2	37/M	121	37.8	Sleeve	Hypertension, hyperlipidemia, obstructive sleep apnea, asthma, old stroke
3	34/F	88	32.3	LAGBP	Hyperlipidemia
4	41/F	84	31.6	LAGBP	Hyperlipidemia
5	39/M	128	39.5	LGB	Hypertension, diabetes, hyperlipidemia, GERD
6	35/F	62	23.6	Sleeve + LGB	Diabetes, hyperlipidemia
7	37/M	79	29.4	LDJBSG	Diabetes, hyperlipidemia, GERD
8	59/F	77	27.9	LGB	Hyperlipidemia, GERD, asthma
9	45/F	77	26.0	LDJBSG	Diabetes
10	46/F	99	40.7	LDJBSG	Diabetes, hyperlipidemia, GERD
11	60/F	52	23.4	LGB	Diabetes, hyperlipidemia
12	28/M	140	50.2	LGB	Nil
13	27/M	133	40.5	Sleeve	Hypertension, Diabetes, hyperlipidemia, GERD
14	47/M	102	34.7	Sleeve	Hypertension, hyperlipidemia,

BMI = body-mass index, BW = body weight, GERD = gastroesophageal reflux disease, LAGBP = laparoscopic adjustable gastric banded plication, LDJBSG = sleeve gastrectomy with loop duodenojejunal bypass, LGB = laparoscopic gastric bypass surgery, Sleeve = sleeve gastrectomy.

Table 2**Intubation-related information, presentations, and outcomes of patients undergoing bariatric/metabolic surgery with postoperative arytenoid dislocation (N = 14).**

Case	IT, min	Tube size, mm	Intubation attempt	Symptoms	Side	Symptom onset, d	Interval, d	Outcomes
1	230	7.5	1	Hoarseness	Left	2	5	Fully recovered
2	185	7.5	1	Hoarseness, dysphagia, sore throat	Left	4	7	Fully recovered
3	300	7.5	1	Hoarseness	Left	2	7	Fully recovered
4	270	7.0	1	Hoarseness, voice fatigue	Left	2	5	Fully recovered
5	270	7.5	1	Hoarseness, voice fatigue, sore throat	Left	1	SR	Fully recovered
6	240	7.0	1	Hoarseness, dysphagia, choking	Left	1	2	Fully recovered
7	345	7.5	1	Hoarseness, dysphagia	Left	1	2	Not improved
8	240	7.0	1	Hoarseness	Left	0	2	Fully recovered
9	330	7.0	1	Hoarseness	Left	1	12	Fully recovered
10	360	7.5	1	Hoarseness	Left	6	16	Fully recovered
11	300	7.0	1	Hoarseness	Left	1	36	Not improved
12	335	7.5	1	Hoarseness, breathing voice	Left	1	3	Fully recovered
13	295	8.0	1	Hoarseness, breathing voice	Right	1	3	Fully recovered
14	155	7.5	1	Hoarseness, breathing voice, dysphagia	Left	2	6	Fully recovered

Interval period from first surgery to close reduction, Outcome recovery of voice quality during patients' 12-week follow-up. IT=intubation time, SR=spontaneous recovery.

study population comprised 6 males (42.9%) and 8 females (57.1%) in the age range of 25 to 60 years. Among them, hyperlipidemia (n=11; 78.6%) and diabetes (n=7; 50%) were the top 2 co-morbidities. Their anesthesia time, number of intubation attempts, clinical characteristics (eg, symptoms of AD, side of dislocation, time of symptom onset) and voice outcomes are shown in Table 2. Tracheal intubation was successful on the first attempt in all patients and patients' anesthetic records showed no evidence of difficulties encountered during airway manipulation or OG tube insertion. Their anesthesia times ranged from 155 to 360 minutes, and the leading symptom was hoarseness. Spontaneous voice recovery was noted in 1 patient. After a time interval of 12 weeks, voice recovery to preinjury quality was noted in 84.6% (11/13) of patients who underwent closed reduction.

3.2. Literature review

Nineteen cases were identified through PubMed search (8, 12–26). The search strategy is shown in Figure 1. After the addition of 3 cases at our institute, totally 22 cases were included in the control group for analysis (Table 3). There were 14 (63.6%) males and 8 (36.4%) females (range of age: 19–88 years). Among the 22 patients, diabetes mellitus was the top co-morbidity (6/22; 27.3%) while another 3 patients were also associated with other co-morbidities. Tracheal intubation was successful at first attempt in 19 patients (86.4%). The anesthetic time was reported in 18 patients (81.8%), with a median time of 225 (range, 25–480) minutes. Spontaneous voice recovery occurred in 8 patients (36.4%), and it took an average of 6.7 ± 3.5 weeks (range, 2–12 weeks) to achieve full voice recovery. In those patients who underwent close reduction (n=14), 92.9% (n=12) had voice recovery within a time interval of 12 weeks.

3.3. Comparison between characteristics of patients with and without bariatric/metabolic surgeries

Comparisons of demographic and clinical characteristics between the study group and the control group are shown in Table 4. Patients in the study group were younger than those in the control group (38 [25–60] vs 54.5 [19–88] years, respectively,

$P=.03$). The anesthetic time was longer (282.5 [155–360] vs 225 [25–480] minutes, $P=.041$) and the time of symptom onset was more delayed (1.0 [0–6] vs 1.0 [0–6] days, $P=.018$) in the study group compared with those in the control group. After closed reduction, the frequency of voice recovery was comparable in the study and control groups in a time interval of 12 weeks (84.6% vs 92.9%, respectively, $P=.59$).

4. Discussion

One of the major findings of this report is that the incidence of AD was about 0.8% despite uneventful endolaryngeal manipulation in patients undergoing bariatric/metabolic surgery (ie, study group). Compared with the general population with postoperative AD (ie, control group), patients in the study group were younger with longer anesthetic time and more delayed symptom onset compared with those in the control group. To the best of our knowledge, the present study is the first to compare the clinical characteristics of AD in patients receiving tracheal intubation and OG tube insertion with those in patients with AD-related to tracheal intubation.

Previous cadaveric studies have demonstrated that significant force is required to disrupt the major support structures (eg, the cricoarytenoid and vocal ligaments) of the cricoarytenoid joint (CAJ) and cause AD in a normal larynx.^[27,28] However, in patients aged more than 40 years, the incidence of osteoarthritic changes in the CAJ has been reported to be up to 50%,^[29] suggesting that degenerative changes may predispose to intubation trauma.^[29,30] In the control group (n=22) of the present study, the median age of the AD cases was 54.5 (range, 19–88) years, which supported the findings in the previous studies.^[29,30] Accordingly, the younger age of the study group (ie, 38; range, 25–60) compared to that in the control group in the present study implies that the insertion of a large-bore calibrating OG tube may impair the integrity or aggravate the pre-existing degenerative change of the supporting structures, thereby predisposing to the development of AD. Gastroesophageal reflux disease (GERD), which is common in obese patients,^[31,32] may cause contact ulcers of the larynx, leading to erythematous and oedematous changes over the vocal cord or arytenoid cartilages.^[33] It remains unknown whether the presence of GERD in this patient subgroup

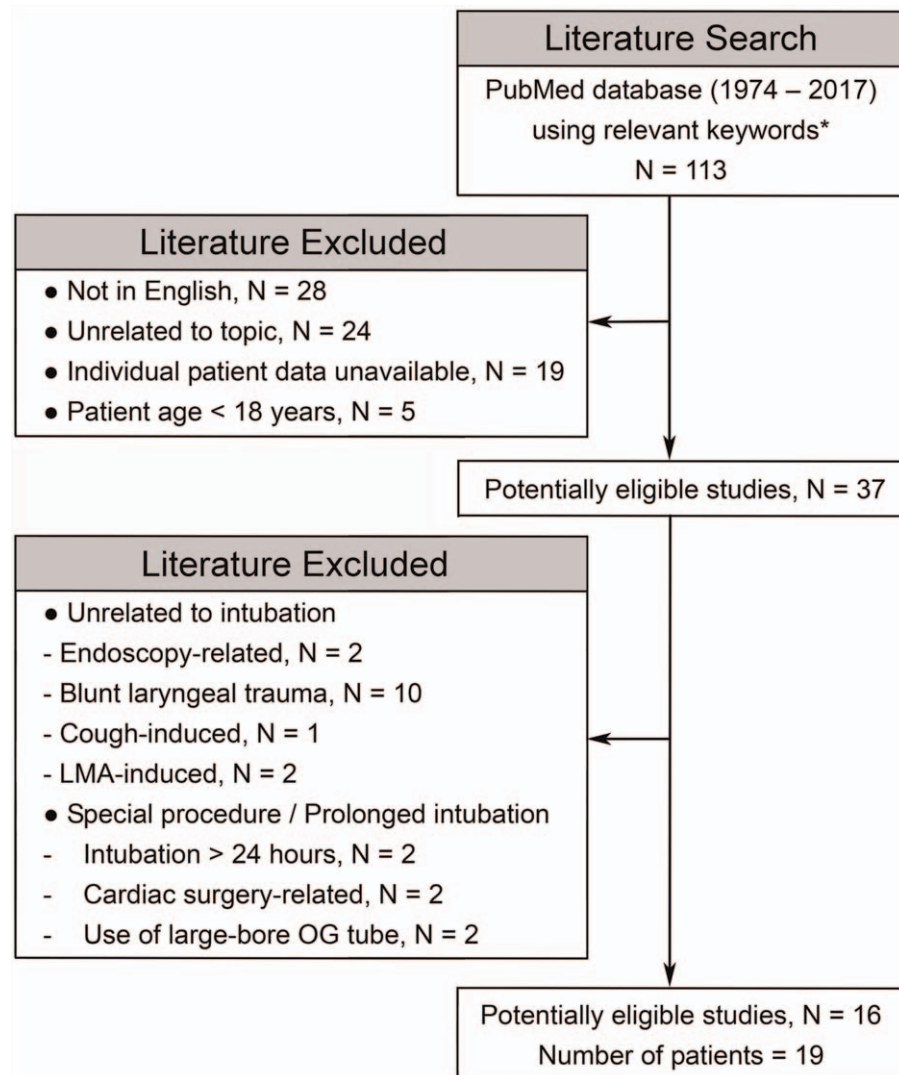


Figure 1. Strategy of literature search. OG tube, orogastric tube. *Keywords used for literature search including “arytenoid dislocation,” “cricoidarytenoid subluxation,” “surgery,” “postoperative,” “anaesthesia,” and “tracheal intubation.” LMA=laryngeal mask airway, N=number of studies.

had a significant impact on the integrity of major support structures of the CAJ, thereby predisposing this patient subgroup to intubation trauma even after uneventful endolaryngeal manipulation.

In general, the causes of AD following endolaryngeal manipulation were commonly thought to be inadvertent trauma generated by tracheal intubation or during the blind insertion of medical devices (eg, OG tubes). Previously, we assumed that traumatic AD may occur with prolonged mechanical compression of the CAJ between the convex curvature of the endotracheal tube anteriorly and body of the calibrating OG tube posteriorly.^[10,11] The proposal was based on a previous study in which the body of the tracheal tube was demonstrated to exert force against the medial side of the arytenoid cartilages in a cadaveric study.^[34] Compared with the control group, the anesthetic time was longer in the study group in the present study, supporting that the mechanical compression theory may play an important role.

Another noteworthy finding of the present study is that the study population had delayed presentation of AD symptoms compared with that in the control group. In contrast with joint

subluxation or joint dislocation that is likely to cause immediate symptoms of AD, it has been reported that serosynovitis or joint cavity hemorrhage from mechanical trauma may contribute to the delayed development of AD.^[27,30] After the serosynovitis subsided or hemarthrosis is absorbed, adhesion of articular surfaces or periarticular structures may follow, fixing the arytenoid in an abnormal position.^[30] Therefore, we suggest that serosynovitis or hemarthrosis of the CAJ caused by prolonged mechanical compression may be a possible pathologic mechanism in our study group, leading to a delayed presentation of symptoms. In contrast, joint subluxation or dislocation may be caused by inadvertent trauma generated by tracheal intubation in the control group, accounting for the early onset of symptoms. Considering that the fast-track protocol is commonly applied to bariatric/metabolic surgeries to shorten the duration of hospitalization,^[35,36] clinicians must remain vigilant for potential AD and its delayed presentation, even when endolaryngeal manipulation was uneventful.

The incidence of AD remained unclear in the current literature. A large retrospective study found 4 cases of AD in 13,698

Table 3
Intubation-related and clinical information of patients with postoperative arytenoid dislocation without bariatric/metabolic surgery (N = 22).

Authors	Age/ sex	Side	Intubation attempt	C-L	Tube size, mm	IT	Airway obstructive symptoms	Symptom onset	Interval, d	Recovery, wk	Co-morbidities
Senoglu et al ^[12]	19/M	L	1	2	8	240	No	POD 0	9	6	No systemic disease
Tan and Seevanayagam ^[13]	88/M	R	1	3	8	NA	Yes	Immediately	SR	2	DM
Goz et al ^[14]	39/F	NA	1	NA	NA	90	No	POD 1	SR	8	No systemic disease
	39/M	NA	1	NA	NA	NA	No	Immediately	SR	6	No systemic disease
Oh et al ^[15]	48/F	L	1	1	7	240	No	POD 1	6	4	No systemic disease
Sim et al ^[16]	65/M	R	1	2	7.5	150	No	POD 1	7	8	HTN, Af
Zhong et al ^[17]	64/M	R	1	NA	NA	120	No	Immediately	NA	6	DM
Chun et al ^[8]	70/M	Bilateral	1	1	7.5	25	Yes	Immediately	1	6	No systemic disease
Kurihara et al ^[18]	64/F	R	1	NA	35F	NA	No	POD 1	>120	24	No systemic disease
Mikuni et al ^[19]	52/M	L	2	2	39F	260	No	Immediately	SR	10	No systemic disease
Usui et al ^[20]	26/M	L	3	3	7.5	360	No	POD 1	SR	4	No systemic disease
Szigeti et al ^[21]	57/M	L	1	NA	8	240	No	POD 6	SR	5	DM, HTM, liver disease
Gauss et al ^[22]	60/M	L	1	3	8.5	720	No	POD 1	SR	NA	No systemic disease
Castella et al ^[23]	77/F	Bilateral	1	NA	8	180	Yes	Immediately	SR	12	No systemic disease
Frink and Pattison ^[24]	49/F	L	1	NA	7	480	No	POD 3	3	1	No systemic disease
Quick and Merwin ^[25]	31/M	L	1	NA	NA	180	No	Immediately	13	2 days	DM, ESRD
	31/F	L	5	NA	NA	270	No	POD 1	12	2 days	DM, ESRD
	30/F	L	1	NA	7.5	255	No	POD 1	13	20 days	DM, ESRD
Faries and Martella ^[26]	71/F	L	1	NA	8	210	Yes	POD 2	NA	4	No systemic disease
Authors' institute	40/M	L	1	2	7.5	305	No	POD 1	11	12	No systemic disease
	85/M	L	1	1	7.5	185	No	Immediately	23	12	HTN, liver disease
	80/M	L	1	1	7.5	185	No	POD 1	22	8	Heart disease, HTN

Interval period from first surgery to close reduction, immediately defined as events occurring within 6h after surgery or in the postanesthesia care unit. Af = atrial fibrillation, C-L = Cormack-Lehane classification system, DM = diabetes mellitus, ESRD = end-stage renal disease, HTN = hypertension, IT = intubation time, NA = not available, POD = postoperative day, SR = spontaneous recovery.

tracheal intubations, suggesting an incidence of 0.029%.^[21] Previously, we reported an AD incidence of 0.014% in a total of 21,634 intubations in the general population.^[9] As AD may be misidentified as recurrent laryngeal nerve paralysis^[11] and spontaneous recovery from AD is possible, the reported incidences^[9,21] are likely to be underestimated. This is supported by the findings of a prospective study by Yamanaka et al who reported an AD incidence of as high as 0.1% in the general population (n=3093).^[37] Although our data were collected retrospectively, we believed that all AD cases were identified because we routinely consult otolaryngologists when hoarseness occurred postoperatively in this patient subgroup since the first case of AD observed in this patient population.^[10] In the study group, the incidence of AD was 0.8% (n=1735), which

demonstrated appropriately an 8-fold increase compared with that in the study by Yamanaka et al (ie, 0.1%).^[37] This finding, therefore, is consistent with that of our previous report showing that the use of OG may increase the risk of AD.^[9]

Spontaneous voice recovery of AD may occur. Lee et al reported an incidence of 4.5% spontaneous recovery in a case series of 22 patients.^[2] We found that the frequency of spontaneous recovery was 36.4% in the control group and 7.1% in the study group (P=.062). In the control group, it took an average of 6.7 ± 3.5 weeks (range, 2–12 weeks, n=8) to attain spontaneous voice recovery. Direct laryngoscopy with closed reduction remains the treatment of choice for patients with AD.^[1,2] Lee et al reported that good recovery of arytenoid motion can be achieved in 86% of patient after closed reduction and recommended that closed reduction should be performed within 21 days of the presumed dislocation event for optimal recovery.^[2] In the study group, most closed reductions (n=12; 92.3%) were performed within 21 days and 84.6% of patients achieved voice recovery after a follow-up of 12 weeks. This finding suggested that although there were different clinical presentations or pathologic mechanisms of AD in the subgroup, the response to surgical intervention may be similar to those in the general population. These findings corroborate existing evidence in support of the importance of early surgical intervention.^[1,2] Besides, according to the finding of a study by Rubin et al,^[11] approximately 40% (n=25) of their patients with AD exhibited abnormalities on laryngeal electromyography. Therefore, failure in voice recovery in 2 patients after a 12-week follow-up in the present study may be due to concomitant nerve injuries.

Although early surgical intervention may lead to favorable clinical outcomes, routine consultation with otolaryngologists whenever postoperative hoarseness occurred may not be

Table 4
Comparison of clinical characteristics between patients with postoperative arytenoid dislocation (AD) with and without bariatric/metabolic surgeries.

Variables	Study group (N=14)	Control group (N=22)	P-value*
Age, yr	38 (25–60)	54.5 (19–88)	.030
Sex (male)	6 (42.9)	14 (63.6)	.307
Anesthetic time, min	282.5 (155–360)	225 (25–480)	.041
Time of symptoms onset (POD)	1.0 (0–6)	1.0 (0–6)	.018
Spontaneous recovery	1 (7.1)	8 (36.4)	.062
Diabetes mellitus	7 (50.0)	6 (27.3)	.286

Data presented as medians and ranges as well as numbers and percentages. POD = postoperative day. * Significance of difference determined by Fisher exact test for categorical variables and Mann–Whitney U test for continuous variable.

costeffective, considering the rarity of this laryngeal morbidity. Yamanaka et al reported that postoperative hoarseness was observed in 49% of patients on the day of surgery with reduction to 11% and 0.8% on the third and seventh PODs, respectively.^[37] As closed reduction within 21 days of the presumed dislocation is acceptable, we suggest that if postoperative hoarseness did not subside after a follow-up of 7 days, otolaryngologists should be consulted in high-risk patients (eg, old age, multiple intubation attempts). In addition, if the patients had a previous history of OG tube insertion and an unusual presentation of postoperative hoarseness (eg, delayed hoarseness), a high index of suspicion for this rare complication is required.

This study is subject to the limitations of any retrospective study. Additionally, because the occurrence of AD may be mistaken for recurrent laryngeal nerve paralysis and spontaneous recovery of AD is possible, patients who met the inclusion criteria may have been missed during our search of the anesthesia database. Also, our investigation focused on the clinical characteristics and outcomes of patients in whom the occurrence of AD was associated with airway manipulation and OG tube insertion, so that the analysis of other confounding factors is unavailable in this report. In addition, although prolonged intubation may be associated with AD, critical information on clinical course and the onset of symptoms is often not readily available in patients in the ICUs due to their accompanying conditions such as consciousness disturbance and complicated clinical courses (eg, repeated tracheal intubations and tracheostomy). To avoid these uncertainties that would introduce bias into the present study, the ICU patients were excluded. Therefore, our data cannot be extrapolated to the critically ill patients. Lastly, this study was conducted at a single institution, hindering its generalizability to other settings.

In conclusion, our report demonstrates that there may be difference in characteristics of AD between patient subgroups, highlighting the importance of implementing individualized strategies to improve patient safety. Given the increasing adoption of fast-track recovery programmes involving a shorter hospital stay for bariatric/metabolic surgeries, a high index of suspicion for this complication in the intubated patients requiring OG tube insertion is required on encountering prolonged postoperative hoarseness (ie, more than 7 days) especially in patients with long anaesthetic time and delayed onset of hoarseness.

Author contributions

HKC, CYT, CJY, LKM, and WLK made contributions in study design and manuscript writing. HKC, KCY, WSC, CMH, and SCK made vast contributions in literature review, and data analysis. HKC and SCK made substantial contributions to manuscript composition and was responsible for the final product. All authors read and approved the final manuscript.

Conceptualization: Kuo-Chuan Hung, Yi-Ting Chen, Jen-Yin Chen, Shao-Chun Wu, Li-Kai Wang.

Data curation: Shao-Chun Wu.

Formal analysis: Kuo-Chuan Hung, Jen-Yin Chen, Chuan-Yi Kuo.

Investigation: Jen-Yin Chen, Chuan-Yi Kuo, Shao-Chun Wu, Min-Hsien Chiang, Li-Kai Wang.

Methodology: Yi-Ting Chen, Jen-Yin Chen, Shao-Chun Wu, Min-Hsien Chiang, Kuo-Mao Lan, Li-Kai Wang.

Software: Kuo-Mao Lan, Li-Kai Wang.

Supervision: Cheuk-Kwan Sun.

Validation: Cheuk-Kwan Sun.

Writing – original draft: Yi-Ting Chen, Jen-Yin Chen, Min-Hsien Chiang.

Writing – review and editing: Kuo-Chuan Hung, Kuo-Mao Lan, Cheuk-Kwan Sun.

References

- [1] Rubin AD, Hawkshaw MJ, Moyer CA, et al. Arytenoid cartilage dislocation: a 20-year experience. *J Voice* 2005;19:687–701.
- [2] Lee SW, Park KN, Welham NV. Clinical features and surgical outcomes following closed reduction of arytenoid dislocation. *JAMA Otolaryngol Head Neck Surg* 2014;140:1045–50.
- [3] Lee DH, Yoon TM, Lee JK, et al. Treatment outcomes of closed reduction of arytenoid dislocation. *Acta Otolaryngol* 2013;133:518–22.
- [4] Lee DH, Yoon TM, Lee JK, et al. Clinical characteristics of arytenoid dislocation after endotracheal intubation. *J Craniofac Surg* 2015;26:1358–60.
- [5] Stout DM, Bishop MJ, Dwersteg JF, et al. Correlation of endotracheal tube size with sore throat and hoarseness following general anesthesia. *Anesthesiology* 1987;67:419–21.
- [6] Jones MW, Catling S, Evans E, et al. Hoarseness after tracheal intubation. *Anaesthesia* 1992;47:213–6.
- [7] Wu CL, Berenholtz SM, Pronovost PJ, et al. Systematic review and analysis of postdischarge symptoms after outpatient surgery. *Anesthesiology* 2002;96:994–1003.
- [8] Chun EH, Baik HJ, Chung RK, et al. Arytenoid cartilage dislocation mimicking bilateral vocal cord paralysis: a case report. *Medicine (Baltimore)* 2017;96:e8514.
- [9] Tan PH, Hung KC, Hsieh SW, et al. Large-bore calibrating orogastric tube and arytenoid dislocation: a retrospective study. *Br J Anaesth* 2016;116:296–8.
- [10] Hung KC. Arytenoid cartilage dislocation after laparoscopic surgery for treatment of diabetes. *A A Case Rep* 2013;1:34–6.
- [11] Hung KC, Hsieh SW. Potential mechanism of arytenoid dislocation following insertion of a calibrating orogastric tube. *J Clin Anesth* 2016;31:173–4.
- [12] Senoglu N, Oksuz H, Ugur N, et al. Arytenoid dislocation related to an uneventful endotracheal intubation: a case report. *Cases J* 2008;1:251.
- [13] Tan V, Seevanayagam S. Arytenoid subluxation after a difficult intubation treated successfully with voice therapy. *Anaesth Intensive Care* 2009;37:843–6.
- [14] Goz V, Qureshi S, Hecht AC. Arytenoid dislocation as a cause of prolonged hoarseness after cervical discectomy and fusion. *Global Spine J* 2013;3:47–50.
- [15] Oh TK, Yun JY, Ryu CH, et al. Arytenoid dislocation after uneventful endotracheal intubation: a case report. *Korean J Anesthesiol* 2016;69:93–6.
- [16] Sim YH, Choi JH, Kim MK. Arytenoid cartilage dislocation after reversed total shoulder replacement surgery in the beach chair position: a case report. *Korean J Anesthesiol* 2016;69:382–5.
- [17] Zhong Z, Hu J, Wu N, et al. Prolonged hoarseness caused by arytenoid dislocation after anterior cervical corpectomy and fusion. *Spine (Phila Pa 1976)* 2016;41:E174–7.
- [18] Kurihara N, Imai K, Minamiya Y, et al. Hoarseness caused by arytenoid dislocation after surgery for lung cancer. *Gen Thorac Cardiovasc Surg* 2014;62:730–3.
- [19] Mikuni I, Suzuki A, Takahata O, et al. Arytenoid cartilage dislocation caused by a double-lumen endobronchial tube. *Br J Anaesth* 2006;96:136–8.
- [20] Usui T, Saito S, Goto F. Arytenoid dislocation while using a McCoy laryngoscope. *Anesth Analg* 2001;92:1347–8.
- [21] Szigeti CL, Baeuerle JJ, Mongan PD. Arytenoid dislocation with lighted stylet intubation: case report and retrospective review. *Anesth Analg* 1994;78:185–6.
- [22] Gauss A, Treiber HS, Haehnel J, et al. Spontaneous reposition of a dislocated arytenoid cartilage. *Br J Anaesth* 1993;70:591–2.
- [23] Castella X, Gilabert J, Perez C. Arytenoid dislocation after tracheal intubation: an unusual cause of acute respiratory failure? *Anesthesiology* 1991;74:613–5.
- [24] Frink EJ, Pattison BD. Posterior arytenoid dislocation following uneventful endotracheal intubation and anesthesia. *Anesthesiology* 1989;70:358–60.

- [25] Quick CA, Merwin GE. Arytenoid dislocation. *Arch Otolaryngol* 1978;104:267–70.
- [26] Faries PL, Martella AT. Arytenoid dislocation. *Otolaryngol Head Neck Surg* 1996;115:160–2.
- [27] Paulsen FP, Rudert HH, Tillmann BN. New insights into the pathomechanism of postintubation arytenoid subluxation. *Anesthesiology* 1999;91:659–66.
- [28] Wang RC. Three-dimensional analysis of cricoarytenoid joint motion. *Laryngoscope* 1998;108:1–7.
- [29] Paulsen FP, Tillmann BN. Degenerative changes in the human cricoarytenoid joint. *Arch Otolaryngol Head Neck Surg* 1998;124:903–6.
- [30] Paulsen FP, Jungmann K, Tillmann BN. The cricoarytenoid joint capsule and its relevance to endotracheal intubation. *Anesth Analg* 2000;90:180–5.
- [31] Suter M, Dorta G, Giusti V, et al. Gastro-esophageal reflux and esophageal motility disorders in morbidly obese patients. *Obes Surg* 2004;14:959–66.
- [32] Hong D, Khajanchee YS, Pereira N, et al. Manometric abnormalities and gastroesophageal reflux disease in the morbidly obese. *Obes Surg* 2004;14:744–9.
- [33] Vaezi MF, Hicks DM, Abelson TI, et al. Laryngeal signs and symptoms and gastroesophageal reflux disease (GERD): a critical assessment of cause and effect association. *Clin Gastroenterol Hepatol* 2003;1:333–44.
- [34] Randestad A, Lindholm CE, Fabian P. Dimensions of the cricoid cartilage and the trachea. *Laryngoscope* 2000;110:1957–61.
- [35] Bamgbade OA, Adeogun BO, Abbas K. Fast-track laparoscopic gastric bypass surgery: outcomes and lessons from a bariatric surgery service in the United Kingdom. *Obes Surg* 2012;22:398–402.
- [36] Dogan K, Kraaij L, Aarts EO, et al. Fast-track bariatric surgery improves perioperative care and logistics compared to conventional care. *Obes Surg* 2015;25:28–35.
- [37] Yamanaka H, Hayashi Y, Watanabe Y, et al. Prolonged hoarseness and arytenoid cartilage dislocation after tracheal intubation. *Br J Anaesth* 2009;103:452–5.