Risk Factors for Airway Management-Related Lip Injuries in Surgery: A Prospective Matched Case-Control Study

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Objective: *To prospectively investigate data specific to 9 risk factors for significant association with airway management-related lip injuries during surgery.*

Material and Method: *Two hundred and seventy patients (90 cases and 180 controls) who underwent surgeries at Siriraj Hospital from September 2015 to July 2016 were enrolled. Ninety patients (injured group) sustained lip injury after surgery. Each case was matched with two cases without lip injury by gender, age, and operation date. One hundred and eighty patients without lip injury were recruited as control group. Data specific to 9 risk factors were evaluated for significant association with airway management-related lip injuries during surgery.*

Results: *Most patients recovered from their lip injury within three days after operation, but 8 patients or 8.4% required as long as 5 days for their lip injury to completely heal. Predisposing factors associated with airway management-related lip injuries in univariate analysis were Mallampati grade >1, dental problems, performed by nurse anesthetist, training duration <3 months and 3 to 6 months, and oral procedure. Significant factors associated with airway management-related lip injuries in multivariate analysis were dental problems (OR 8.9, 95% CI 1.46 to 4.21, p = 0.001), training duration <6 months (OR 16.2, 95% CI 4.2 to 62.5, p<0.001) and oral procedure (OR 19.3, 95% CI 3.5 to 105.8, p = 0.001).*

Conclusion: *Preexisting dental problems, oral procedures, and airway management performed by an operator with less than six month training are risk factors for airway management related injuries. Careful protection and closed observation should be particularly concerned.*

Keywords: *Lip injuries, Anesthesia, Risk factors*

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Airway management is a fundamental practical skill in anesthesiology, emergency and critical care medicine. Serious complications during airway management including failed intubation, esophageal or broncheal intubation, bronchospasm or laryngospasm have been extensively investigated and algorithms have been established to improve airway management processes and outcomes[1,2].

Injuries sustained during airway management included lip or gum lacerations, hematomas, edema, and teeth ablations[3-5]. Dental injuries accounted for 50% of airway management-related injuries[6,7]. The estimated incidence of dental injury is 1 in 4,500 cases[8]. The incidence of lip/tooth injuries varies among studies, but the occurrence of these injuries is the most common complaint against anesthesiologists[8,9]. Most lip injuries result from pressure on the upper lip and maxillary incisors, which are commonly used as a fulcrum during direct laryngoscopy.

In 2014, there were 104 reported cases of lip injury sustained during airway management at Siriraj Hospital (0.52% or 1: 200). The common factors from these 104 cases were difficult airway, dental problems, emergency surgery, full stomach, use of rapid intubation technique, and operation in the prone position. Other proposed factors contributing to lip injuries were airway management experience, duration of training, and operative duration[10-13].

The aim of this prospective matched case-control study was to investigate 9 risk factors for association with airway management-related lip injury

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during surgery.

Material and Method

The protocol for this prospective matched case-control study was approved by the Institutional Review Board (Si 483/2015).

Data were collected on patients aged more than 18 years and underwent surgery at Siriraj Hospital from September 2015 to July 2016 were included. Ninety patients sustained airway management-related lip injuries during surgery (I-gr). Each case in I-gr was matched other two cases who did not have the injuries (C-gr).

In this study, we defined 'Airway management -related lip injuries' as any laceration, edema, wound, bleeding at lip or gum, new loosened tooth, or any tooth injury. For recruitment of study participants, an internal announcement was circulated both verbally and in printto all faculty members asking them to inform our study team if any of their adult patients sustained lip injury. They were requested to report this finding as soon as the injury was detected, whether intraoperative, immediately following surgery, or post-operative period. The research team promptly evaluated the patients for the specific site of injury, severity, management, including the degree of patients' concern. The daily evaluation was carried out until the injury was completely healed. If the patient was discharged from the hospital before the lesion was healed, a daily telephone interview was conducted until the wound was completely resolved.

When lip injury case was reported, the study team identified two control cases (control group, C-gr) that matched the gender, age within ten year range, and were operated on within 30 days of the patient in the I-gr. Written informed consents were obtained from all control patients. Inclusion criteria for C-gr were age >18 years, full consciousness and lucidity at the time of the interview, and a requirement for airway management (either endotracheal intubation or laryngeal mask airway) during surgery. Patients who had difficulty communicating or was unable to understand the purpose of the study were excluded.

Using simple 'rules of thumb' to calculate the minimum sample size, the authors estimated 5 to 10 cases of lip injury for each of 9 evaluated factors. Accordingly, the sample size of 45 to 90 in I-gr was calculated and deemed to be sufficient for multiple logistic regression analysis. Nine factors were tested for significant association with lip injury, as follows: 1) emergency setting; 2) full stomach; 3) dental-related problem: 4) Mallampati grading: 5) first performer: 6) training duration of first performer (duration of each performer training in anesthesia): 7) application of cricoid pressure: 8) operationsite: 9) prone position. In I-gr, time of lip injury detection (intraoperative, immediate postoperative, or postoperative), the observer of lip injury (patient, attending anesthetist, or post-op nurse), degree of injury, and specific injured area, wound management, level of patient concern, and the number of follow-up days were recorded and analyzed.

Statistical analysis

Data were analyzed using PASW Statistics for Windows, 18.0 Chicago: SPSS Inc. Categorical data are presented as number and percentage, and continuous data are presented as mean $\pm$ standard deviation. Demographic data were summarized using descriptive statistics. Univariate analysis was performed to individually evaluate the predictive significance of each factor. Student's t-test was used for normally distributed quantitative variables and Mann-Whitney Utest was used to analyze non-normally distributed quantitative data. Chi-square test was used to evaluate qualitative variables. All risk factors with a *p*-value of less than 0.05 in univariate analysis were included in multiple logistic regression analysis. Findings from univariate and multivariate analysis are presented as odds ratio (OR) with 95% confidence interval (CI), which is defined as the ratio of the odds of having a certain risk factor in a patient with injury.

Results

Patient characteristics

Patient demographic data are shown in Table 1. There were 107 males and 163 females. Mean age was 58$\pm$16.6 years for C-gr and 58.5$\pm$17.5 years for I-gr. I-gr had a higher incidence of emergency and full stomach conditions entailed the increasing use of rapid sequence induction and cricoid pressure. I-gr also showed more difficulty upon preoperative airway evaluation, namely limited neck movement, higher Mallampati grading, shorter thyro-mental distance, and preexisting dental problem. Detailed airway management are presented in Table 2.

Outcome of lip injury

Most patients recovered from their lip injury within three days after operation, but 8 cases or 8.4% required as long as 5 days for their lip injury to completely healed (Table 3). Most of the patients who needed longer healing time expressed the highest level

Table 1. Patient characteristics and airway evaluation

Characteristics	C-group (n = 180)	I-group (n = 90)
Gender, M: F	71:109	36:54
Age range (yrs)	17 to 88	19 to 89
Age (mean ± SD)	58±16.6	58.5±17.5
Underlying disease	118 (65.6)	56 (62.2)
DM/HT/DLP	32/84/3	13/33/7
IHD/arrhythmia	37/1	8/2
Lung disease	5	4
Others	52	31
Emergency	8 (4.4)	8 (8.9)
Full stomach	12 (6.7)	10 (11.1)
Mouth opening <3	1 (0.6)	1 (1.1)
Limited neck movement	0 (0.0)	3 (3.3)

Data presented as number (%)
Abbreviations: M = male; F = female; DM = diabetes mellitus; HT = hypertension; DLP = dyslipidemia; IHD = ischemic heart disease

of concern related to their injuries. Lip injury was detected intraoperatively in almost half of the total cases. The event was usually reported by the attending anesthetist. The most common injury site was the upper lip. Sixty one cases (67.8%) sustained second-degree injury (laceration or open wound), 5 cases had third-degree wound (deep cutting wound). Most injuries resolved spontaneously or with the topical pointment application. Two patients needed suturing of the injury sites, and both cases had difficult airways. In both cases, intubation was attempted more than 2 times and a change of performer was required.

Univariate analysis

Results of univariate analysis are provided in Table 4. Factors that were significantly associated with airway management-related lip injury were: Mallampati grading >1 (OR 2.48, 95% CI 1.46 to 4.21, $p = 0.001$), dental problems (OR 6.13, 95% CI 1.89 to 19.83, $p = 0.001$), intubation by nurse anesthetist/student (OR 7.94, 95% CI 4.17 to 15.13, $p<0.001$), training duration <3 months (OR 24.92, 95% CI 10.35 to 59.99, $p<0.001$), training duration 3 to 6 months (OR 19.94, 95% CI 8.76 to 45.36, $p<0.001$), and oral procedure (OR 4.55, 95% CI 1.77 to 11.73, $p = 0.001$).

Multivariate analysis

Results of multivariate analysis are shown in Table 5. Significant factors associated with airway management-related lip injury included dental problems (OR 8.9, 95% CI 1.9 to 41.6, $p = 0.006$), training duration <3 months (OR 31.5, 95% CI 9.4 to 104.8, $p<0.001$), training duration 3 to 6 months (OR 16.2, 95% CI 4.2 to 62.5, $p<0.001$), and oral procedure (OR 19.3, 95% CI 3.5 to 105.8, $p = 0.001$).

Discussion

This prospective matched case control study described significant predictors of airway management-related lip injury during surgery. Dental related problems, training duration less than 6 months, and oral procedure were all significantly correlated with airway management-related lip injury during surgery according to multivariate analysis. This study was not able to prove degree of mouth opening, limitation of neck movement, and short thyro-mental distance to be predisposing factors for lip injury. It was possibly because of a relatively small sample size. However, these 3 components of difficult airway manipulation must be considered in order to protect the patient from lip injury especially during the teaching process. It is common for trainees and inexperienced personnel to apply excessive pressure on the upper lip and maxillary incisors when attempting to expose the larynx by direct laryngoscopy.

The incidence of lip, gum or dental injury was more frequent in emergency case, full stomach, application of cricoid pressure, use of rapid sequence induction technique. However, the difference between groups did not achieve statistical significance. A similarly high incidence was observed in univariate analysis for prone position and head

Table 2. Airway management data

Characteristics	C-group (n = 180)	I-group (n = 90)
First performer		
Resident	158 (87.8)	36 (40.0)
Nurse	21 (11.7)	38 (42.2)
Medical student	1 (0.5)	16 (17.8)
Performer training duration		
<3 months	8 (4.4)	32 (35.6)
3 to 6 months	10 (5.6)	32 (35.6)
>6 months	162 (90.0)	26 (28.8)
Number of attempts		
1	177 (98.3)	74 (82.3)
2	2 (1.1)	12 (13.3)
3	0 (0.0)	3 (3.3)
4	1 (0.6)	1 (1.1)
Performer >1 person	0 (0.0)	6 (6.7)
Laryngeal view		
Grade 1-2	161 (89.4)	76 (84.4)
Grade 3-4	2 (1.2)	10 (11.2)
Unspecified	17 (9.4)	4 (4.4)
Special technique used	1 (0.6)	8 (8.9)
Rapid sequence induction	9 (0.5)	8 (8.9)
Cricoid pressure used	8 (4.4)	9 (10.0)
Airway equipment		
ETT	155 (86.1)	79 (87.8)
LMA	17 (9.4)	1 (1.1)
Others	8 (4.5)	10 (11.1)
Laryngoscope blade		
Macintosh	161 (89.4)	81 (90.0)
LMA	17 (9.4)	1 (1.1)
Video laryngoscope	1 (0.6)	5 (5.6)
Pentax	0 (0.0)	2 (2.2)
Fiberoptic-assisted	1 (0.6)	1 (1.1)
Difficult airway	1 (0.6)	21 (23.3)
Prone position	6 (3.3)	8 (8.9)
Oral procedure	7 (3.9)	14 (15.6)
Head traction	9 (5.0)	9 (10.0)
Operation time		

Data presented as number (%)
ETT = endotracheal tube; LMA = laryngeal mask airway

traction, nevertheless, there was no statistical significance.

Medical student, number of attempts for intubation, number of performer, use of special technique, and difficult intubation as evaluated by the first performer were all found to be statistically significant in univariate analysis (Table 4). The number of patients in C-gr was too small to include in a multiple logistic regression analysis. We omitted 'performer' from the final analysis due to an overlap between 'performer' and 'training duration'.

Multivariate analysis revealed that dental problems, oral precedure, and training duration less than 6 months were significantly associated with airway management-related lip injury. The incidence of lip injury decreased with longer duration of intubation training, which was similar to several previous studies[4-7]. All of those studies concluded that limited intubation experience contributed to airway management complications. It should be noted that all of those studies were observational, and most of them were conducted in the intensive care and/or

Table 3. Outcomes of lip injury

Characteristics	Details	n (%) (n = 90)
Time of injury detection	Intraoperation	44 (48.9)
	Immediate post-operation	19 (21.1)
	Post-operation	27 (30.0)
Observer of injury	Patient	1 (1.1)
	Attending anesthetist	63 (70.0)
	Post-op nurse	26 (28.9)
Severity of injury	First-degree	24 (26.7)
	Second-degree	61 (67.7)
	Third-degree	5 (5.6)
Site of injury	Upper lip	65 (72.2)
	Lower lip	13 (14.4)
	Gum	4 (4.4)
	Tooth	6 (6.7)
	>1 site	2 (2.2)
Management	Careful observation	44 (48.9)
	Ointment application	44 (48.9)
	Suture	2 (2.2)
Time to completely heal	Day 1	17 (18.8)
	Day 2	33 (36.7)
	Day 3	32 (35.6)
	Day 4	5 (5.6)
	Day 5	3 (3.3)
Level of patient concern	None	5 (5.6)
	Low	35 (38.8)

Data presented as number (%)

emergency departments. Airway management is generally performed in less emergency setting in anesthesia practice compared with emergency departments. There are almost always enough time for good airway preparation; including airway evaluation, patient positioning, drugs and equipment preparation.

In our setting as Thailand's largest medical school and largest national tertiary care hospital, we train people with varying levels of experience and skill which include medical students, anesthesia nurse students, anesthesia residents, and residents rotating from different departments. A high incidence of lip injury during anesthesia can be decreased by modeling careful airway manipulation during the teaching and learning process. All trainees should learn how to avoid lip injury by following the detailed process of mouth opening, applying the blade and carefully exposing the larynx with a minimum pressure on the upper teeth and lip.

Most of the lip injuries in this study were minor with spontaneous recovery, even though a substantial number of injuries were avoidable. A more intensive training process may be able to successfully reduce the incidence of airway management-related lip injury.

Limitations

This study has some limitations. First, when we matched cases and asked for informed consent, both control patients and the anesthetic care team were informed about the study protocol. This might have influenced the performer to be more careful than he or she usually was in a normal practice. However, we had no other way of obtaining written informed consent from the control cohort. This effect caused some of the characteristics C-gr to deviate from normal distribution, especially in the first performer subgroup that was mostly made up of residents and subgroup of training duration. As a result, we were not able to strongly conclude that intubation by nurse or training duration less than 6 month was significantly predictive of lip injury. However, we concluded that the incidence of lip injury was manageable or modifiable by careful practice and a sound training process.

Conclusion

Preexisting dental problems, oral procedures, and airway management performed by an operator with less than six month training are risk factors for airway

Table 4. Univariate analysis of risk factors associated with lip injuries

Risk factors	Number		Univariate analysis	
	C-group (n = 180)	I-group (n = 90)	Crude OR (95% CI)	*p*-value
Emergency case	8 (4.4)	8 (8.9)	2.10 (0.76 to 5.79)	0.15
Full stomach	12 (6.7)	10 (11.1)	1.75 (0.73 to 4.22)	0.21
Cricoid pressure	8 (4.4)	9 (10.0)	2.39 (0.89 to 6.42)	0.08
Rapid sequence induction	9 (0.5)	8 (8.9)	1.85 (0.69 to 4.98)	0.22
Mouth opening <3 cm	1 (0.6)	1 (1.1)	2.01 (0.12 to 32.53)	0.62
Limited neck movement	0 (0.0)	3 (3.3)	-	0.04
Mallampati >grade 1	47 (26.1)	42 (46.7)	2.48 (1.46 to 4.21)	<0.01
Thyromental distance <6 cm	0 (0.0)	4 (4.4)	-	<0.01
Dental problem	4 (2.2)	11 (12.2)	6.13 (1.89 to 19.83)	<0.01
First performer				
Resident	158 (87.8)	36 (40.0)	1	-
Nurse anesthetist/student	21 (11.7)	38 (42.2)	7.94 (4.17 to 15.13)	<0.01
Medical student	1 (0.6)	16 (17.8)	70.22 (9.02 to 546.82)	<0.01
Performer training duration				
>6 months	162 (90.0)	26 (28.9)	1	-
3 to 6 months	10 (5.6)	32 (35.6)	19.94 (8.76 to 45.36)	<0.01
<3 months	8 (4.4)	32 (35.6)	24.92 (10.35 to 59.99)	<0.01
Intubation attempt >1	3 (1.7)	16 (17.8)	12.8 (3.6 to 45.1)	<0.01
Number of performer >1	0 (0.0)	6 (6.7)	-	<0.01
Laryngeal view grade ≥3	2 (1.1)	10 (11.1)	10.59 (2.27 to 49.53)	<0.01
Special technique used	1 (0.6)	8 (8.9)	17.46 (2.15 to 141.93)	<0.01
Difficult airway	1 (0.6)	21 (23.3)	54.48 (7.19 to 412.83)	<0.01
Prone position	6 (3.3)	8 (8.9)	2.83 (0.95 to 8.42)	0.08
Mouth operation	7 (3.9)	14 (15.6)	4.55 (1.77 to 11.73)	<0.01
Head traction	9 (5.0)	9 (10.0)	2.11 (0.81 to 5.52)	0.12
Operation time				
0 to 3 hours	129 (71.7)	63 (70.0)	1	-
>3 to 6 hours	45 (25.0)	20 (22.2)	0.91 (0.50 to 1.67)	0.76
>6 hours	6 (3.3)	7 (7.8)	2.39 (0.77 to 7.41)	0.13

Data presented as number (%) *p*-value <0.05 indicates statistical significance

management related injuries. Careful protection and close observation should be particularly concerned.

What is already known on this topic?

Airway management-related lip injuries in emergency situation are related to limited time for endotracheal intubation in both emergency department and intensive care unit. The performer's experience is suspected as risk factor for the injury.

What this study adds?

The present study showed that, in teaching institute, risk factor for airway management-related lip injuries in surgical setting is primarily related to teaching process. Mostly are preventable by careful preparation trainee, process and equipment.

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Potential conflicts of interest

The authors hereby declare no personal or

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ปัจจัยเสี่ยงต่อการบาดเจ็บของริมฝีปากที่สัมพันธ์กับการจัดการช่องทางเดินอากาศระหว่างการผ่าตัดการศึกษาแบบไปข้างหน้าลักษณะ Matched case-control study

ฐิติมา ชินะโชติ, วิริยา ไหมสาสน์, ธันชุดา สำเภาเงิน

วัตถุประสงค์: การจัดการกับช่องทางเดินอากาศสำหรับการช่วยการหายใจเป็นความสามารถพื้นฐานของวิชาชีพ วิสัญญีวิทยา เวชศาสตร์ฉุกเฉิน และเวชบำบัดวิกฤต ในระหว่างการผ่าตัดจึงมีโอกาสเกิดการบาดเจ็บของริมฝีปาก เหงือก หรือฟัน การศึกษานี้ต้องการประเมินปัจจัยเสี่ยงเก้าประการว่ามีความสัมพันธ์กับอาการบาดเจ็บดังกล่าวอย่างไร

วัสดุและวิธีการ: ดำเนินการศึกษาในผู้ป่วย 270 ราย ที่มารับการผ่าตัดที่โรงพยาบาลศิริราช ระหว่างเดือนกันยายน พ.ศ. 2558 ถึง เดือนกรกฎาคม พ.ศ. 2559 ประกอบด้วยผู้ป่วยที่มีอาการบาดเจ็บของริมฝีปาก หรือเหงือก หรือฟัน จำนวน 90 ราย และคัดเลือกผู้ป่วยกลุ่มควบคุมในสัดส่วน 1: 2 รวมเป็นกลุ่มควบคุม 180 ราย โดยใช้เกณฑ์ เพศ อายุ และวันที่ทำผ่าตัด ประเมินความสัมพันธ์ ของปัจจัยที่ศึกษาเปรียบเทียบระหว่างผู้ป่วยทั้งสองกลุ่ม

ผลการศึกษา: ผู้ป่วยที่มีอาการบาดเจ็บ ส่วนมากอาการหายเป็นปกติในเวลา สามวัน แต่มีผู้ป่วยแปดรายหรือ 8.4 เปอร์เซนต์ ที่ใช้เวลามากถึง 5 วัน ปัจจัยที่สัมพันธ์กับการบาดเจ็บใน univariate analysis ได้แก่ระดับ Mallampati ที่มากกว่า 1 ผู้ป่วยที่มีปัญหาเรื่องฟัน การปฏิบัติการโดยพยาบาลผู้ปฏิบัติการมีระยะเวลาในการฝึกอบรมน้อยกว่า 3 เดือน และ 3 ถึง 6 เดือน การทำหัตถการในช่องปากในการวิเคราะห์โดยใช้ multivariate analysis พบว่าผู้ป่วยที่มีปัญหาเรื่องฟันมีอัตราเสี่ยงต่อการบาดเจ็บที่ OR 8.9, 95% CI 1.46 ถึง 4.21, p = 0.001 ระยะเวลาการฝึกอบรมน้อยกว่าหกเดือน OR 16.2, 95% CI 4.2 ถึง 62.5, p<0.001 และการทำหัตถการในช่องปาก OR 19.3, 95% CI 3.5 ถึง 105.8, p = 0.001

สรุป: ผู้ป่วยที่มีปัญหาเรื่องฟันตั้งแต่ก่อนการผ่าตัดการทำหัตถการในช่องปาก และการปฏิบัติโดยผู้ที่ผ่านการฝึกอบรมน้อยกว่าหกเดือนเป็นปัจจัยเสี่ยงต่อการเกิดอาการบาดเจ็บของริมฝีปาก เหงือก หรือฟัน ในระยะการผ่าตัดผู้ป่วยกลุ่มนี้ ต้องได้รับการป้องกันและเฝ้าสังเกตุการบาดเจ็บระหว่างการผ่าตัดอย่างเหมาะสม