The Thai Anesthesia Incidents Study (THAI Study) of Difficult Intubation : A Qualitative Analysis

Thavat Chanchayanon MD*,
Suwannee Suraseranivongse MD**, Waraporn Chau-in MD***

*Songklanagarind Hospital,Faculty of Medicine, Prince of Songkla University, Songkhla,
**Siriraj Hospital, Faculty of Medicine, Mahidol University, Bangkok ,
***Srinakarind Hospital, Khon Kaen University, Khon Kaen,Thailand

Objectives: *To examine the causes, outcomes and contributing factors including suggested corrective strategies associated with difficult intubation*
Material and Method: *Difficult intubation and failed intubation incidents were extracted from the Thai Anesthesia Incidents Study (THAI Study) database conducted between February 1, 2003 to January 31, 2004 and analyzed by using descriptive statistics*
Results: *Two hundred and thirty-four cases of difficult intubation were recorded. Among those, 50 cases (21%) were failed intubation. The most common cause (95%) of incidents was due to patients difficult anatomy. Prediction of events was derived from physical examination (65%) and history taking (50%). Majority of incidents (44%) occurred in Mallampati II and III. Only 3 cases (1.3%) of morbid obesed and 3 cases (1.3%) of pregnant patients were attributed to the events. Most incidents (119 cases, 50.9%) were successfully managed by conventional techniques. The adverse effects included hypoxemia (54 cases, 23.1%), esophageal/ tracheal injury (40 cases, 17.1%) and prolonged ventilatory support (17 cases, 7.3%). One patient died from sepsis.The reported contributing factors included inadequate experience, lack of knowledge including inadequate preoperative evaluation and preparation. Additional training, quality assurance and protocol/ algorithm tended to minimize the incidents.*
Conclusion: *The majority of difficult intubation could be predicted. Proper preoperative evaluation and equipment preparation, appropriate technique including experienced anesthesia personnel could attenuate the morbidity and mortality.*

Keywords: *Difficult intubation, Failed intubation, Anesthesia, Complications, Adverse events*

J Med Assoc Thai 2005; 88 (Suppl 7): S 62-8
Full text. e-Journal: *http://www.medassocthai.org/journal*

Difficult tracheal intubation is a common mechanism of respiratory-related adverse outcome in anaesthetic practice. The incidences of difficult intubation are varied from 0.2 — 8.5%[-3] subjected to definition. Preoperative evaluation is important in the detection of patients at risk for difficult airway management by noting anatomical landmarks and clinical factors associated with a difficult airway. Appropriate plan, proper equipments and experience hands will reduce or eliminate the severity of adverse events.

Correspondence to : Thavat Chanchayanon MD, Songklanagarind Hospital, Prince of Songkla University, Songkhla 90100, Thailand, E-mail:chanchanon@yahoo.com

In Thailand, variation of anaesthetics personnel, intubation and monitoring equipments including clinical guidelines for anaesthetics management may affect the adverse outcome. Incidence of difficult intubation from Thai Anesthesia Incidents Study (THAI Study) was 22.5 per 10,000 (0.23%) and failed intubation was reported as 3.1 per 10,000 (0.03%). In previous study, 0.06% was found to be anesthesia-related and preventable such as predicted difficult intubation from physical examination[1]. With careful preoperative assessment, some patients can be predicted for difficult intubation.

The objective of this study was to evaluate the immediate and long term effects of difficult intuba-

tion, appropriateness of management as well as to search for clinical risk factors, contributing factors and corrective strategies.

Material and Method

Thai Anesthesia Incidents Study (THAI Study) is a multicentered study by a number of hospitals including 7 university-based hospitals, 5 tertiary care hospitals, 4 secondary care hospitals and 4 primary care hospitals across Thailand. The objective of this study is to monitor the incidence of anesthesia-related adverse events from February 1, 2003 until January 31, 2004. This study had been approved by the ethics committee of each hospital. Details regarding preoperative patients data, anesthetic techniques, intraoperative events and postoperative complications taken place within 24 hours postoperatively had been recorded using standardized record forms (form 1, form 2).

An intubation is defined as difficult when a trained anesthesia personnel requires at least 3 attempts or more than 10 minutes to perform a successful endotracheal insertion. Additionally, patients are classified as difficult for intubation when direct laryngoscopy is impossible or when they have to undergo alternative tracheal intubation such as fiberoptic intubation according to a history of difficult conventional intubation. For the latter group, patients are included in the analysis only if anesthetic records contain essential data in terms of the blade(s) used, the number of laryngoscopy attempts and the best view obtained from direct larygoscopy.

Data were recorded by anesthesiologists, nurse anesthetists or a site manager. Records were reviewed by 3 peered reviewers to identify clinical risk factors, contributing factors and strategies for prevention and improvement. Conflicting opinions were reviewed and an agreement was made by all 3 peered reviewers.

Incidence records were analyzed using Microsoft Excel. Demographic data include age, gender, ASA Physical status and concomitant diseases. Records also contained numbers of intubation attempts, successfulness of intubation, predictive factors for difficult intubation from history taking, physical examination and investigations, history of facial injury, preparation of difficult airway equipments, techniques used for successful intubation, immediate and long-term effects associated with difficult intubation, appropriateness of critical management and preventable factors. Risk factors were recorded and these included anesthesia (personnel, knowledge, experience, preoperative preparation, team work communication, and equipments and drugs available), surgery (elective/ emergency surgery, site of operation), patients and other factors. All data were analyzed by using descriptive statistics.

Table 1. patient characteristics (n=234)

	n	%
Sex		
Male	146	62.4
Female	86	36.8
Not stated	2	0.9
Mallampati grading		
Gr 1	24	0.3
Gr 2	59	25.2
Gr 3	44	18.8
Gr 4	27	11.5
Not stated	80	34.2
Laryngoscopic view		
Gr 1	22	9.4
Gr 2	23	9.8
Gr 3	76	32.5
Gr 4	96	41.0
Not stated	17	7.3
ASA		
I	52	22.2
II	129	55.1
III	40	17.1
IV	10	4.3
V	0	0
Not stated	3	1.3
Age		
0-15 yr	27	11.5
16-45 yr	80	34.2
46-65 yr	79	33.8
>65 yr	46	19.7
Not stated	2	0.9
BMI		
< =35	231	98.7
> 35	3	1.3
pregnancy		
yes	3	1.3
no	230	98.3
not stated	1	0.4
maxillofacial trauma	23	9.8

Results

From 243 cases, there were 234 cases of difficult intubation according to operational defition with adequate data.

Demographic data of patients with difficult intubation are shown in Table 1. The majority of patients (62.4%) were male. Mallampati grading varied from grade 1 to 4. Laryngoscopic view was mainly grade 3 and 4 (73.5%). BMI did not exceed 35 in most of patients. Pregnancy accounts for 1.3% of all patients. Maxillofacial trauma took place in 9.8% of patients.

An incidence of difficult intubation was commonly found in university-based hospitals (121, 86, 25 and 2 difficult intubations in university-based, tertiary, secondary and primary care hospitals, respectively). (Table 2) Almost all incidents occurred during induction. Two episodes happened in a recovery room when patients required reintubation. Prediction from history taking, physical examination and investigation contributed 50.4, 65.4 and 4.7 %, respectively, to anticipated difficult intubation.

Available airway equipments during difficult intubation were rigid laryngoscopes with various kinds of blades(94%), endotracheal tubes(97.9%), and stylets (94.9%) were readily prepared (Table 3). End tidal CO2 and laryngeal mask airway (LMA) were also commonly used (66.2 and 63.2% respectively). Fiberoptic bronchoscope (44%) was more popular than cricothyroidotomy (39.3%), combitube (35.5%), Bullard (20.9%), transtracheal jet ventilation (20.5%) and lightwand (14.5%) (table3).

Half of difficult intubations (50.9%) were successfully managed by conventional techniques including changing persons who performed intubation, using smaller endotracheal tube and stylet. Operations were postponed in 6.8% of patients resulting from difficult intubation (Table 4).

Numbers of attempts for successful intuba-

Table 4. Techniques of success intubation

Techniques of success	n	%
Conventional	119	50.9
Mccoy laryngoscope	21	9.0
Tracheostomy	19	8.1
Fiberoptic bronchoscope	17	7.3
Mask awake/cancel	16	6.8
Frova/bougie	12	5.1
LMA	7	3.0
Change nasal/oral ET	6	2.6
Regional	4	1.7
Blind nasal	4	1.7
Cricothyroidotomy	3	1.3
Lightwand	1	0.4
Bullard	1	0.4
Not stated	4	1.7

Table 2 Patients with difficult intubation and failed intubation

	University hospital	**Regional hospital**	**General hospital**	**District hospital**	**Total**
difficult ntubation (n)	121	86	25	2	234
failed intubation (n)	27	18	4	1	50

Table 3. Availability of airway devices

	Yes n (%)	No n (%)	Not stated n (%)
Endotracheal tube	229 (97.9)	0	5 (2.1)
Stylet	222 (94.9)	5 (2.1)	7 (3.0)
Rigid laryngoscope & blade of various size	220 (94.0)	6 (2.6)	8 (3.4)
End tidal CO_2	155 (66.2)	56 (23.9)	23 (9.8)
LMA	148 (63.2)	63 (26.9)	23 (9.8)
FOB	103 (44.0)	113 (48.3)	18 (7.7)
Cricothyroidotomy	92 (39.3)	109 (46.6)	33 (14.1)
Combitube^R	83 (35.5)	126 (53.8)	25 (10.7)
Bullard	49 (20.9)	150 (64.1)	35 (15.0)
TTJ	48 (20.5)	162 (69.2)	24 (10.3)
Lightwand	34 (14.5)	168 (71.8)	32 (13.7)

tion range from 0 (no attempt) to more than 5 attempts. Most of patients (87.2%) were intubated successfully within 5 attempts. (Figure 1)

Immediate adverse effects associated with difficult intubation were desaturation (23.1%) (SPO_2 less than 90%), esophageal/ tracheal injury (17.1%) and 7.3% of patients required ventilator due to respiratory failure. Long term effects were prolonged respiratory support, unplanned ICU admission and death. (Table 5)

Contributing factors for difficult intubation were related to patients (94.9%), anesthetic techniques (65%), cofactors (59.8%), and surgery (2.1%).

Anesthesia-related factors (Table 6) contribute to difficult intubation were lack of experienced personnel (especially attending anesthesiologist or nurse anesthetist), lack of knowledge (lead to inappropriate choice of anesthesia), incomplete preoperative evaluation and preparation (e.g. airway assessment not performed), lack of assistant during anesthetic induction and intubation. Other factors were lack of well communication within a team, lack of equipments and maintenance systems, and no difficult airway guidelines.

According to peer review, preventive strategies were judged as the following; additional training (78.6%), supervising by an expertise person (60.3%), developing a difficult airway guideline and quality assurance (65.4%), more anesthesiologists (21.4%), more ready to use equipments (14.5%), better teamwork communication (9.4%) and good equipments maintenance (6.8%).

Among 234 cases of difficult intubation, 45 patients (19%) were preventable. Strategies to conduct in patients with anticipated difficult intubation were additional training (80%), good supervisor (64%), and using guideline (48.8%). Quality assurance was recommended as to perform adequate preoperative evaluation and select appropriate airway management tech-

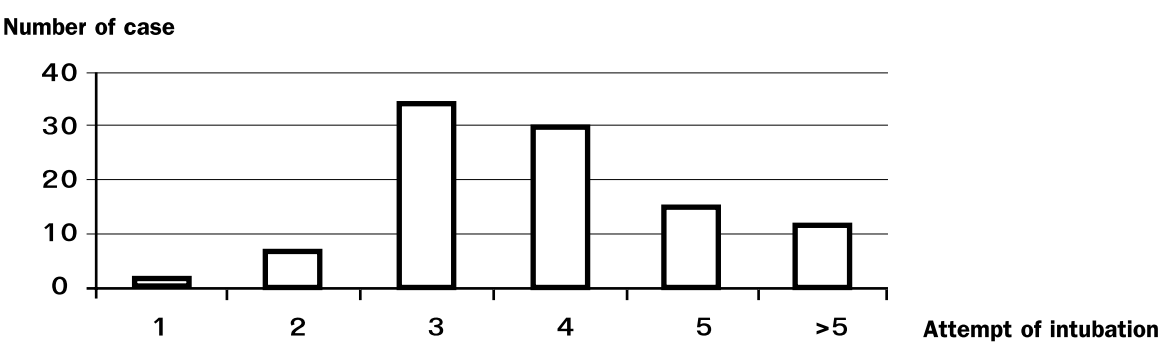

Fig 1. No. of intubation

Table 5. Outcome of incidents

	Immediate, n (%)	Long term, n (%)
Severe hypoxemia (SpO_2 < 90%)	54 (23.1)	-
Esophageal/airway injury	40 (17.1)	-
Respiratory failure need ventilator	17 (7.3)	-
Cancel/postpone surgery	15 (6.4)	-
Minor physiologic change	11 (4.7)	-
Awareness	10 (4.3)	-
Dental injury	8 (3.4)	-
Prolonged emergence/ apnea	4 (1.7)	-
Aspiration	4 (1.7)	-
Cardiac arrest	4 (1.7)	-
Death	1 (0.4)	1 (0.4)
Prolonged ventilatory support	-	13 (5.6)
Brain death	-	1 (0.4)
Unplanned ICU admission	-	3 (1.3)

Table 6. Anesthesia contributing factors (n=234)

	n	%
Human factors		
Presence	18	7.7
Knowledge	41	17.5
Inadequate care		
Inadequate preoperative evaluation	34	14.5
Inexperience	186	79.5
Fatigue	8	3.4
Lack of supervision	92	39.3
Communication failure	17	7.3
Equipment failure		
Presence	28	12.0
Function	10	4.3
Medical failure	2	0.8
Facility failure	0	0
Organization failure		
Inadequate guideline	48	20.5
Inadequate system of consultation	19	8.1
Inadequate referral system	1	0.4

nique (44.4%). Other recommendations are more anesthesiologists (33.3%), better communication between anesthetic team and surgical team (20.0%), adequate equipments available (e.g. stylet 13.3%), equipment maintenance (laryngoscope checking before use, 11.1%). Tracheostomy is performed in a patient with anticipated difficult intubation with no adverse sequelae.

Discussion

Data from THAI Study has shown that difficult intubation and failed intubation were not uncommon. The difficult intubation incidence of 23.67 per 10,000 (0.23%) and failed intubation incidence of 5 per 10,000 (0.05%) were within the range of difficult intubation and failed intubation incidence in the western world.

Its has been suggested that the factors contributed to the likelihood of difficult intubation include obese patient (BMI>=35), obstetric patient, cancerous goiter, size of the tongue, limited jaw movement and Mallampati class III-IV [4-9]. However, results from our study indicated that difficult intubation occurred more frequently in low risk patient groups, mallampati II-III, BMI < 35, non pregnant. Most patients were not obese.

In case of difficult intubation, most of anesthetic personnel preferred conventional techniques followed by fiberoptic bronchoscope and Mccoy laryngoscope. This finding is similar to the survey in the United States using a questionnaire that included four hundred seventy-two anesthesiologists found that direct laryngoscopy and fiberoptic bronchoscope-aided tracheal intubation techniques were chosen for most cases by most anesthesiologists . Anesthesiologists with more than 10 yr of clinical experience and those older than 55 yr of age preferred DL with apneic conditions. Anesthesiologists who had attended workshops within the last 5 yr had greater availability of retrograde guidewire equipment and FOBs. There was little use of newer alternative airway devices [10]. Similar to other studies, the majority of incidents occurred at the induction and intubation periods, a less proportion was presented during PACU.

In this study, the most common immediate outcome after difficult intubation was desaturation and esophageal or airway injury same as the study of Rose et al [9] that patients with difficult tracheal intubation had an increased rate of desaturation (<90%) during induction phase of anesthesia. Esophageal perforation was life threatening complication that may be occurred after endotracheal intubation. The study of Jougon et al [11] found that the patients had esophageal perforation during esophageal intubation usually delayed diagnosis and make the patients death from complications. The study of Hilmi et al [12] reported the two cases of iatrogenic esophageal perforation after endotracheal intubation and confirmed that early diagnosis was as-

sociated with a more favorable outcome. In this study, 17.1% of the patients had esophageal or airway injury but no report of serious sequalae from those injury. However, one patient in our study died after 24 hours in spite of successful airway management due to sepsis from deep neck infection.

Our results are consistent with previous reports [7,8] that human factors contributed to a majority of anesthesia contributing factors. Technical error (fault of technique), knowledge-based error (error of judgment) and rule-based error (inadequate patient evaluation and preparation) were the most common contributing factors identified in this study. Technical errors can be aided by additional training such as the use of simulators, anatomical models and other applied educational models. Knowledge-based errors can be reduced by quality assurance and continuing medical education to improve supervision, while rule-based error can be attenuated by use of protocols and crisis management algorithm. In this study, the majority of incidents occurred in university hospital where there were a lot of trainees; therefore, experience and skill improvement were very important to reduce the risk of difficult and failed intubation. In conclusion, this prospective review of 234 incidents has indicated that perioperative difficult intubation and/or failed intubation is associated with major morbidity. Incidents were infrequent, but associated with high morbidity especially desaturation. Factors to minimize the incidents included additional training, quality assurance, continuing medical education and clinical practice guideline development.

Acknowledgements

This research was accomplished by personal sacrifices and perpetual inspiration of attending anesthesiologists together with all personnel and by guidance of head of departments of all sites in this multicentered study. The Royal College of Anesthesiologists of Thailand and the THAI Study group wish to express deep gratitude to project advisors Professor Chitr Sitthi-Amorn and Associate Professor Joranit Kaewkungwal for their exceptionally wise, encourage criticism and advices. We also wish to thank Professor Pyatat Tatsanavivat, head of Clinical Research Collaborative Network (CRCN) for this continued support, encouragement and helpful suggestions.

The study was financially supported by Health Systems Research Institute (HSRI); Faculty of Medicine of Chiang Mai University, Chulalongkorn University, Khon Kaen University, Mahidol University (Ramathibodi Hospital and Siriraj Hospital), Prince of Songkla University and Thailand Research Fund.

References

1. Fasting S , Gisvold SE. Serious intraoperative problems — a five-year review of 83,844 anesthetics. Can J Anesth 2002; 49 : 545-53.
2. Crosby ET, Cooper RM, Douglas MJ, Doyle DJ, Hung OR, Labrecque P, et al. The unanticipated difficult airway with recommendations for management. Can J Anesth 1998; 45:757-76.
3. Rose DK, Cohen MM. The incidence of airway problems depends on the definition used. Can J Anesth 1996 ; 43 :30-4.
4. Juvin P, Lavaut E, Dupont H, Lefevre P, Demetriou M, Dumoulin JL, et al. Difficult tracheal intubation is more common in obese than in lean patients. Anesth Analg 2003 ; 97: 595-600.
5. Merah NA, Foulkes-Crabbe DJ, Kushimo OT, Ajayi PA. Prediction of difficult laryngoscopy in a population of Nigerian obstetric patients. West Afr J Med 2004 ;23: 38-41.
6. Bouaggad A, Nejmi SE, Bouderka MA, Abbassi O. Prediction of difficult tracheal intubation in thyroid surgery. Anesth Analg 2004 ; 99: 603-6.
7. Cattano D, Panicucci E, Paolicchi A, Forfori F, Giunta F, Hagberg C. Risk factors assessment of the difficult airway: an Italian survey of 1956 patients. Anesth Analg 2004 ; 99: 1774-9.
8. Rose DK, Cohen MM. The airway: problems and predictions in 18,500 patients. Can J Anaesth 1994 ; 41 : 372-83.
9. Voyagis GS, Kyriakis KP, Roussaki-Danou K, Bastounis EA. Evaluating the difficult airway. An epidemiological study. Minerva Anesthesiol 1995 ; 61: 483-9.
10. Rosenblatt WH, Wagner PJ, Ovassapian A, Kain ZN. Practice patterns in managing the difficult airway by anesthesiologists in the United States. Anesth Analg 1998 ;87:153-7.
11. Jougon J, Cantini O, Delcambre F, Minniti A, Velly JF. Esophageal perforation : life threatening complication of endotracheal intubation. Eur J Cardiothoracic Surgery 2001; 20: 7-11.
12. Hilmi IA, Sullivan E, Quinlan J, Shekar S. Esophageal tear: an unusual complication after difficult endotracheal intubation. Anesth Analg 2003; 97:911-4.

การศึกษาอุบัติการณ์ใส่ท่อหายใจยากระหว่างการให้ยาระงับความรู้สึกในประเทศไทย : การวิเคราะห์เชิงคุณภาพ

ธวัช ชาญชญานนท์, สุวรรณี สุรเศรณีวงศ์, วราภรณ์ เชื้ออินทร์

วัตถุประสงค์: *เพื่อศึกษาสาเหตุ, ผลลัพธ์และปัจจัยเกื้อหนุน รวมทั้งวิธีแก้ไขที่เกี่ยวข้องกับภาวะใส่ท่อหายใจยาก*

วัสดุและวิธีการ: *เก็บข้อมูลของผู้ป่วยที่ใส่ท่อหายใจยากจากฐานข้อมูลของ Thai Anesthesia Incidents Study (THAI Study) ของราชวิทยาลัยวิสัญญีแพทย์แห่งประเทศไทย ตั้งแต่ 1 กุมภาพันธ์ พ.ศ. 2546 ถึง 31 มกราคม พ.ศ. 2547 และวิเคราะห์โดยใช้สถิติเชิงพรรณนา*

ผลการศึกษา: *พบผู้ป่วยใส่ท่อหายใจยาก จำนวน 234 ราย โดยใส่ท่อหายใจไม่ได้เลย จำนวน 50 ราย (ร้อยละ 21) สาเหตุที่เกิดส่วนใหญ่ (ร้อยละ 95) เกิดจากกายวิภาคที่ผิดปกติของผู้ป่วย การทำนายว่าใส่ท่อยากสามารถพยากรณ์ได้จากการตรวจร่างกาย (ร้อยละ 65) และการซักประวัติ (ร้อยละ 50) ส่วนใหญ่มี Malliampati II และ III มีผู้ป่วยเพียงส่วนน้อยที่อ้วน 3 ราย (ร้อยละ 1.3) หรือตั้งครรภ์ 3 ราย(ร้อยละ 1.3) ผู้ป่วยส่วนใหญ่ จำนวน 119 ราย (ร้อยละ 50.9) ใส่ท่อสำเร็จโดยวิธี conventional techniques ผลจากภาวะแทรกซ้อน ทำให้มี hypoxemia 54 ราย (ร้อยละ 23.1) esophageal / tracheal injury 40 ราย (ร้อยละ 17.1) และต้องใช้เครื่องช่วยหายใจ จำนวน 17 ราย (ร้อยละ 7.3) ผู้ป่วย 1 รายเสียชีวิตจากการติดเชื้อ ปัจจัยเกื้อหนุน ได้แก่ ประสบการณ์และความรู้ของผู้ให้การ ระงับความรู้สึกไม่เพียงพอ รวมทั้งการประเมินและการเตรียมผู้ป่วยไม่รอบคอบ ควรแก้ไขโดยการฝึกอบรมเพิ่มเติม, ระบบประกันคุณภาพบริการและการจัดทำ protocol / algorithm*

สรุป: *การทำนายภาวะใส่ท่อหายใจยากมักทำได้ล่วงหน้าเป็นส่วนใหญ่ การประเมินผู้ป่วยอย่างรอบคอบ การเตรียมเครื่องมือใส่ท่อหายใจยากที่เหมาะสม ตลอดจนผู้ให้การระงับความรู้สึกที่มีทักษะและประสบการณ์ จะช่วยลดปัญหาจากภาวะแทรกซ้อนนี้*