Original Article

A Retrospective Study of Airway Related Complications in Cervical Spine Surgery

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Objective: The purpose of the present study was to determine the incidences of perioperative airway related complications (failed intubation, remained intubation and reintubation) and related factors for remained intubation in patients undergoing cervical spine surgery.

Materials and Methods: We reviewed records of 253 patients undergoing cervical spine surgery from neurosurgery unit, Siriraj hospital. The data, collected from January 2012 to May 2017, included patients' demographics, perioperative airway management, perioperative data, airway related complications and outcomes.

Results: Total 253 patients were analyzed. The mean age was 57.2±15.6 years, 55% were male; most patients were American Society of Anesthesiologists [ASA] physical status II. The main diagnosis was cervical spondylotic myelopathy and the main operation was anterior cervical discectomy and fusion. The intubations (missing = 11) were all successful with video laryngoscope, fiberoptic bronchoscope, McIntosh direct laryngoscope and others. Remained intubation and reintubation occurred 26.1% and 3.5%, respectively. Independent risk factors (odds ratio [OR]; 95% confidence interval [CI]) for remained intubation were volume of crystalloid given >2,000 ml (OR 2.44; 95% CI 1.15 to 5.20), prolonged anesthetic time >5 hours (OR 3.66; 95% CI 1.71 to 7.87), and finished after official service hours (OR 4.54; 95% CI 2.21 to 9.30). A little more than half of the patients (51.8%) went to neurosurgical intensive care unit. Nine patients (3.5%) required reintubation.

Conclusion: With advanced airway equipment, the intubations were successful in cervical spine patients but postoperative airway complications (remained intubation and reintubation) remained high and could not be neglected.

Keywords: Complications, Airway, Spine, Surgery, Intubation

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According to the individual hospital practice, cervical spine surgery is commonly performed by neurosurgeon in majority. The treatment of various pathologies such as degenerative disease, trauma, tumor, and infection were succeeded with these specific procedures. These procedures generally involve bone removing to decompress the neuronal elements, and fix cervical spines with instrument at one or more levels.

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Most serious adverse events associated with cervical spine surgery are postoperative airway compromise due to airway edema and obstruction which result in dyspnea, hypoxemia and emergent reintubation. The reintubation rate was reported as 0.1 to 6.1%[1-6]. In some high risk patients[6,7], they were kept intubated overnight and examined for readiness for extubation the following day.

Regarding cervical spine pathology, neck movement is limited. It is a challenge for the anesthesiologists taking care of patients' airways. The improper intubation can do some harm to the spinal cord[8,9]. The intubation is not trouble-free, and may end up with unpleasant complications[10]. Various airway equipment such as glidescope[11], McGrath[12,13],

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Pentax AWS[14], Airtraq[14,16], McCoy[14], light wand[16] and intubating laryngeal mask[16,17] had been used successfully to intubate these patients.

In our hospital, there was no available data about intubation success rate, the incidences of airway related complications such as failed intubation, remained intubation and related factors and details of reintubation. The remained intubation might affect postoperative outcome such as the need for mechanical ventilation, prolong intensive care stay or hospital stay. These data would provide necessary information for our quality care improvement.

Materials and Methods

This retrospective study was performed with the approval from the institutional review board (Si. 367/2016). Medical records of patients who underwent cervical spine surgery in neurosurgery unit in Siriraj Hospital, the university hospital in Thailand from January 2012 to May 2017 were extensively reviewed without exclusion. All patients were looked into details from admission to discharge. The collected data were patient characteristics, perioperative data, airway management, airway complications, intra-operative data and outcome.

The airway management information included the intubation method, success rate, intubation attempts, difficulty in airway management and airway related complications were defined as (1) failed intubation after several attempts or methods, or (2) the need for reintubation after extubation in the operating room or in intensive care unit [ICU] or ward, (3) the remained intubation after end of anesthesia. Remained intubated patients were looked in detail and analyzed to identify associated factors. The airway management information was mainly collected from the anesthetic records and reintubation details were retrieved from in-progress note by two researchers. This study included all cases provided from the hospital information system during study period so there were no potential data sources of bias.

The intra-operative cardiovascular complications were retrieved from the treatment from anesthetic records such as atropine for bradycardia, ephedrine or norepinephrine for hypotension and nicardepine or labetalol for hypertension so minor or transient complications were not recorded. The data about other complications found from anesthetic records were also collected. The other interested outcome included ventilator days, ICU stay, hospital stay and patient's final status.

Statistical analysis

The sample size calculation was based on the estimated incidence of remained intubation was 20% (pilot data from our institution) with 5% error and 80% power and the sample size was 246 patients. The interested risk factors on remained intubation would be analyzed by the multiple logistic regression analysis. Most of interested data had less than 5% of missing. All the missing data were examined two times by two researchers to find as much details as possible.

Data analysis was performed using PASW version 18 (Chicago, IL, USA). Qualitative data were presented as number and percentage and compared by using Chi-square or Fisher exact test. For quantitative data were presented as mean and standard deviation [SD] or median, minimum, and maximum and compared by using student t-test or Mann Whitney U test. Univariate predictors of remained intubation were analyzed by Chi-square test and presented as odds ratio [OR] and 95% confidence interval [CI]. The risk factors that produced a point estimate at *p*-value of <0.1 on the univariate analysis were entered into a multivariate regression analysis. Adjusted odds ratio with 95% CI was calculated. A *p*-value <0.05 was considered statistically significant.

Results

A total of 253 patients were included for analysis. Table 1 shows the patients' demographics and diagnosis. The mean age was 57.2±15.6 years. Majority of the cases were classified as American Society of Anesthesiologists [ASA] physical status II, male, and the main diagnosis was cervical spondylotic myelopathy. The intubation methods and their success are shown in Table 2. Table 3 shows intra-operative data which include anesthetic drugs and intra-operative complications. The average anesthetic time was 295±104 minutes or about 5 hours. Majority of the cases used fentanyl, sevoflurane, and muscle relaxant. The average fluid administered was 1,681±934 mL and estimated blood loss was 100 (10, 2,000) mL. The most frequent complication was hypotension (44.7%) and one case with esophageal tear. 51.8% of the cases went to ICU for ventilator support or close observation and mostly stayed less than 24 hours. Median length of stay in the hospital was 6 days. Almost all of the cases could be discharged from the hospital with improved outcome (Table 4).

The pre-operative and intra-operative related factors with the decision for remained intubation were analyzed. Independent risk factors (odds ratio [OR];

Table 1. Patients' data and diagnosis

	Total (n = 253)
Age (year)	57.2±15.6
ASA physical status I/II/III/IV (n = 251, missing = 2)	39/126/85/1
Gender: male	139 (55)
Body weight (kg)	63.8±14.7
Height (cm)	161±11
Underlying disease	
Hypertension	108 (42.7)
Diabetes mellitus	54 (21.3)
Heart disease	22 (8.7)
Systemic disease affecting cervical spine	17 (6.2)
Diagnosis	
Cervical spondylotic myelopathy	134 (53.0)
Fracture	36 (14.2)
Cervical spondylotic radiculopathy	23 (9.1)
Disc herniation	22 (8.7)
Ossification of the posterior longitudinal ligament	9 (3.5)
Tumor	6 (2.3)
Others	23 (9.1)
Number of operative levels 1/2/3/>3	102/66/52/33

The data are presented as mean ± standard deviation or n (% or valid % excluding missing data)
ASA = American Society of Anesthesiologists

Table 2. Airway management and complications

	Total (n = 253)		
	Intubation methods	Successful intubation in first attempt	Missing data
Intubation methods (n = 229, missing = 11, already intubated = 13)			
MacIntosh	58 (25.3)	53/58 (91.3)	0
McCoy	4 (17.5)	4/4 (100)	0
Miller	2 (8.7)	2/2 (100)	0
Light wand	4 (17.5)	2/3 (67)	1
Fiberoptic bronchoscope	72 (31.4)	39/40 (97.5)	32
Video laryngoscope	89 (38.8)	77/84 (91.6)	5
No. of intubation attempts 1/2/3/fail (n = 194, missing = 59)	180 (92.8)/11 (5.7)/3 (1.5)/0		
Easy intubation (rated by operator) (n = 217, missing = 36)	185 (85.3)		
Remained intubation	66 (26.1)		
Extubated ≤24 hr	19 (28.8)		
Extubated >24 hr	28 (42.4)		
No extubation*	19 (28.8)		
Reintubation	9 (3.5)		

The data are presented as n (% or valid % excluding missing data)
* No extubation = tracheostomy or prolonged intubation until death

Table 3. Intraoperative data

	Total (n = 253)
Anesthetic time (min)	295±104
Surgical time (min)	213±98
Fluid (ml)	1,681±934
Estimated blood loss (mL)	100 (10, 2,000)
Anesthetic drugs and others	
Opioids	
Fentanyl only	146 (57.7)
Fentanyl/morphine	79 (31.2)
Others	28 (11.0)
Nonsteriodal anti-inflammatory drugs	16 (6.3)
Dexamethazone	71 (28.1)
Inhalation	
Isoflurane	22 (8.7)
Sevoflurane	123 (48.6)
Desflurane	93 (36.8)
TIVA or combined inhalation and TIVA	15 (5.9)
Intraoperative complications	128 (50.6)
Bradycardia	5 (2.0)
Hypotension	113 (44.7)
Hypertension	14 (5.5)
Other (tear esophagus)	1 (0.4)

The data are presented as mean ± standard deviation or n (% or valid % excluding missing data) or median (min, max).
TIVA = total intravenous anesthesia

Table 4. Postoperative care and outcome

	Total (n = 253)
No. of patients according to ventilator hours (n = 65)	
Ventilator ≤24 hour	31 (47.7)
Ventilator 24 to 48 hour	8 (12.3)
Ventilator ≥48 hour	26 (40)
Intensive care unit [ICU] length of stay (n = 131)	
ICU stay ≤24 hour	64 (48.8)
ICU stay 24 to 48 hour	33 (25.1)
ICU stay ≥48 hour	34 (25.9)
Hospital length of stay (day)	6 (3, 307)
Final outcome	
No changes	8 (3.2)
Improved	242 (95.6)
Worse	1 (0.4)
Death	2 (0.8)

The data are presented as n (%) or median (min, max)

95% confidence interval [CI]) for remained intubation were amount of administered fluid >2,000 mL. (OR 2.44; 95% CI 1.15 to 5.20), anesthetic time >5 hours (OR 3.66; 95% CI 1.71 to 7.87), and case end during out of service hours (OR 4.54; 95% CI 2.21 to 9.30) (Table 5).

Nine patients (3.5%) were re-intubated, three patients had problems with retained secretion, and the others had dyspnea and hypoxemia. All emergent reintubations were successful with attending physicians with some difficulties in 2 cases (Table 6). All patients were improved with respiratory support and were extubated the following days. There were two dead cases, one was diagnosed as advanced stage lung cancer with palliative care, and the other had pneumonia and septic shock.

Discussion

The airway adverse events defined as remained intubation and reintubation occurred 26.1% and 3.5%, respectively. From this study, the administered fluid >2,000 mL (OR 2.44; 95% CI 1.15 to 5.20), anesthetic time >5 hours (OR 3.66; 95% CI 1.71 to 7.87), and case end out of service hours (OR 4.54; 95% CI 2.21 to 9.30) were significant associated factors for remained intubation.

Known B et al kept all patients intubated overnight in combined anterior and posterior decompression and their definition of remained intubation was extubated beyond day 1 and they found related factors were prolonged operative time, large volume of crystalloid and increased in blood loss which was in concordance with the present study[7]. Case end time during out of service hours was highly significant factor for remained intubation because the junior staff or anesthetic resident covered the cases and could not decide for extubation and there were also available ICU beds. Anastasian ZH et al found that case end time was significant factor for remained intubation after multilevel prone spine surgery[18]. They also found that remained intubation had 3 fold higher rate of postoperative pneumonia. Hart RA et al could reduce airway complication with limited fluid management protocol in patients undergoing cervical decompression[19]. From our study, in order to reduce the incidence of remained intubation, we should start and end case in the service hours and limited amount of administered fluid. The anesthetic time (295±104 min) with surgical time (218±100 min) could not be shorter because the operations were complex and undoubtedly related with cervical inflammation and edema.

10.2% of our patients needed prolonged

Table 5. Related factors with remained intubation

	Extubation (n = 187)	Remained intubation (n = 66)	*p*-value	Adjusted OR (95% CI)	*p*-value
Preoperative status					
Age (year)	57.5±14.9	57.0±17.8	0.816		
Male	103 (55)	35 (53)	0.734		
ASA physical status (I/II/III/IV)	32/93/59/0	7/33/25/1	0.194		
BMI (kg/m^2)	24.4±4.6	24.2±5.6	0.844		
Previous surgery	20 (10.7)	9 (13.6)	0.476		
Systemic diseases	10 (5.3)	7 (10.6)	0.146		
Easy intubation (missing = 36)	139 (86.9)	46 (80.7)	0.342		
Spine ≥3 levels	2.0±1.0	2.4±1.8	0.030*	0.82 (0.39 to 1.74)	0.601
Estimated blood loss >300 mL	143±175	368±374	<0.001*	2.02 (0.92 to 4.47)	0.080
Fluid >2,000 mL	1,452±703	2,351±1,129	<0.001*	2.44 (1.15 to 5.20)*	0.021*
Anesthetic time >300 min	264±75	382±124	<0.001*	3.66 (1.71 to 7.87)*	0.001*
Case end out of office hour	31 (16.5%)	39 (59.1%)	<0.001*	4.54 (2.21 to 9.30)*	<0.001*

The data are presented as mean ± standard deviation or n (% or valid % excluding missing data)
OR = odds ratio; CI = confidence interval; ASA = American Society of Anesthesiologists; BMI = body mass index

ventilation (>48 hour) which was much higher compared to the study from Nandyala SV et al which found only 0.62% required prolonged ventilation[5]. In our neurosurgical ICU, attending physicians, mainly neurosurgeons, were reluctant to extubate for fear of reintubation.

Kim M et al found that in protocol group (ASAN extubation protocol), the airway complication rate was significantly lower than non-protocol group[20]. We should develop our airway management protocol regarding remained intubation and extubation and perioperative fluid management to minimize remained intubation and reduce ICU stay.

The emergent reintubation occurred 3.5% was slightly higher than some studies[2-5] but lower than study from Sagi HC et al[6]. We reviewed all kinds of cervical spine surgery patients including cervical spine fractures and some patients had preoperative quadriplegia or severe motor weakness which was related to reintubation[21]. These patients could not cough effectively and some developed postoperative pneumonia.

The limitations of the present study include its retrospective nature and the small number of patients. It is impossible to draw a conclusion about success rate of intubation because some missing data regarding intubation attempts (23.3%), and easiness for intubation (14.2%). There were no descriptive details of intubation, thus the reasons for using advanced airway equipment or intubation performers. Nevertheless there was no report of failed intubation or case cancellation. The reasons for remained intubation were also not documented. The presence or causes of dyspnea may be incomplete or underreported. The number of re-intubated patients was too small to calculate the risk factors, which suggest the need for more samples (multicenter study) in further study. The study took place in single unit (neurosurgery) and in single hospital, so it might not be applicable to other units or other hospitals.

In our hospital, not only does the neurosurgery unit perform cervical spine surgery but the orthopedic department also does the same operations; so it might be interesting to compare airway related complications between two units and this would be our future study.

Conclusion

The intubations were successful in cervical spine patients with various airway equipment. The incidence of remained intubation and prolonged ventilation was high and should be looked in details for improvement. The reintubation rate was slightly higher than previous studies.

What is already known on this topic?

Special airway equipment increases intubation success in patients with cervical spine pathology.

Table 6. Details of reintubations

	P1	P2	P3	P4	P5	P6	P7	P8	P9
Age (yr)	58	75	62	39	87	60	6 month	72	62
Sex	F	F	M	F	M	M	F	M	F
Diagnosis	metastasis	abscess	OPLL	fracture	CSM	fracture	fracture	CSM	CSR
Spine Level	C4-C5	T4-L5, C4-5	C3-C4	C5-C6	C1-C2	C4-T1	C6-C7	C2-C3	C5-C6
Motor power (grade 0-V)	0	0	0	0	III	0	0	V	IV
Anesthetic time (min)	510	545	465	400	570	320	205	555	475
Blood loss	650	400	1,300	1,600	120	200	5	200	50
Fluid (ml)	4,000	4,280	3,600	2,500	2,700	3,100	210	3,450	4,500
Extubation (day)	15	1	1	1	1	3	1	2	0*
Reintubation (day)	15	2	1	2	2	6	2	3	0
Ventilator (day)	16	35	18	7	9	12	8	12	1
ICU stay	16	8**	20	0***	14	15	13	13	2
Hospital stay	17	37	37	32	33	21	29	38	19
Outcome	Death	Improved	Improved	Improved	Improved	Improved	Improved	No changes	Improved

OPLL = Ossification of the posterior longitudinal ligament, CSM = Cervical spondylotic myelopathy, CSR = Cervical spondylotic radiculopathy
* Reintubation in operating room, ** Patient was discharged from ICU and continued using ventilator at ward, ***Intubation and on ventilator at ward

Associated factors with remained intubation are extensive surgery (multiple levels or combined anterior and posterior approach), too much fluid administered, and case end time out of service hours.

What this study adds?

The incidence of remained intubation was too high due to availability of neurosurgical ICU and along with the highly significant factor of case end out of service hours.

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Potential conflicts of interest

The authors declare no conflict of interest.

References

1. Palumbo MA, Aidlen JP, Daniels AH, Bianco A, Caiati JM. Airway compromise due to laryngopharyngeal edema after anterior cervical spine surgery. J Clin Anesth 2013;25:66-72.
2. Nagoshi N, Fehlings MG, Nakashima H, Tetreault L, Gum JL, Smith ZA, et al. Prevalence and outcomes in patients undergoing reintubation after anterior cervical spine surgery: Results from the AO Spine North America Multicenter Study on 8887 Patients. Global Spine J 2017;7(1 Suppl):96S-102S.
3. Marquez-Lara A, Nandyala SV, Fineberg SJ, Singh K. Incidence, outcomes, and mortality of reintubation after anterior cervical fusion. Spine (Phila Pa 1976) 2014;39:134-9.
4. Schroeder J, Salzmann SN, Hughes AP, Beckman JD, Shue J, Girardi FP. Emergent reintubation following elective cervical surgery: A case series. World J Orthop 2017;8:465-70.
5. Nandyala SV, Marquez-Lara A, Park DK, Hassanzadeh H, Sankaranarayanan S, Noureldin M, et al. Incidence, risk factors, and outcomes of postoperative airway management after cervical spine surgery. Spine (Phila Pa 1976) 2014;39:E557-

63.
6. Sagi HC, Beutler W, Carroll E, Connolly PJ. Airway complications associated with surgery on the anterior cervical spine. Spine (Phila Pa 1976) 2002;27:949-53.
7. Kwon B, Yoo JU, Furey CG, Rowbottom J, Emery SE. Risk factors for delayed extubation after single-stage, multi-level anterior cervical decompression and posterior fusion. J Spinal Disord Tech 2006;19: 389-93.
8. Martini RP, Larson DM. Clinical evaluation and airway management for adults with cervical spine instability. Anesthesiol Clin 2015;33:315-27.
9. Farag E. Airway management for cervical spine surgery. Best Pract Res Clin Anaesthesiol 2016; 30:13-25.
10. Tantry TP, Karanth H, Shetty P, Adappa KK. Eventful anaesthesia: can we prevent it? J Clin Diagn Res 2015;9:UD05-7.
11. Kill C, Risse J, Wallot P, Seidl P, Steinfeldt T, Wulf H. Videolaryngoscopy with glidescope reduces cervical spine movement in patients with unsecured cervical spine. J Emerg Med 2013;44:750-6.
12. Foulds LT, McGuire BE, Shippey BJ. A randomised cross-over trial comparing the McGrath((R)) Series 5 videolaryngoscope with the Macintosh laryngoscope in patients with cervical spine immobilisation. Anaesthesia 2016;71:437-42.
13. Laosuwan P, Earsakul A, Numkarunarunrote N, Khamjaisai J, Charuluxananan S. Randomized cinefluoroscopic comparison of cervical spine motion using McGrath series 5 and Macintosh laryngoscope for intubation with manual in-line stabilization. J Med Assoc Thai 2015;98 Suppl 1:S63-9.
14. Bogdanski L, Truszewski Z, Kurowski A, Czyzewski L, Zasko P, Adamczyk P, et al. Simulated endotracheal intubation of a patient with cervical spine immobilization during resuscitation: a randomized comparison of the Pentax AWS, the Airtraq, and the McCoy Laryngoscopes. Am J Emerg Med 2015;33:1814-7.
15. Vijayakumar V, Rao S, Shetty N. A Comparison of macintosh and airtraq laryngoscopes for endotracheal intubation in adult patients with cervical spine immobilization using manual in line axial stabilization: A prospective randomized study. J Neurosurg Anesthesiol 2016;28:296-302.
16. Prasarn ML, Conrad B, Rubery PT, Wendling A, Aydog T, Horodyski M, et al. Comparison of 4 airway devices on cervical spine alignment in a cadaver model with global ligamentous instability at C5-C6. Spine (Phila Pa 1976) 2012;37:476-81.
17. Gerstein NS, Braude DA, Hung O, Sanders JC, Murphy MF. The fastrach intubating laryngeal mask airway: an overview and update. Can J Anaesth 2010;57:588-601.
18. Anastasian ZH, Gaudet JG, Levitt LC, Mergeche JL, Heyer EJ, Berman MF. Factors that correlate with the decision to delay extubation after multilevel prone spine surgery. J Neurosurg Anesthesiol 2014; 26:167-71.
19. Hart RA, Dupaix JP, Rusa R, Kane MS, Volpi JD. Reduction of airway complications with fluid management protocol in patients undergoing cervical decompression and fusion across the cervicothoracic junction. Spine (Phila Pa 1976) 2013;38:E1135-40.
20. Kim M, Choi I, Park JH, Jeon SR, Rhim SC, Roh SW. Airway management protocol after anterior cervical spine surgery: analysis of the results of risk factors associated with airway complication. Spine (Phila Pa 1976) 2017;42:E1058-E1066.
21. Emery SE, Smith MD, Bohlman HH. Upper-airway obstruction after multilevel cervical corpectomy for myelopathy. J Bone Joint Surg Am 1991;73:544-51.