

Factors Contributing to Delayed Extubation After Cervical Spine Surgery in Siriraj Hospital

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ABSTRACT

Background: Cervical spine surgery brings up great concerns about post-operative severe complications and morbidities. Anesthesiologists should know contributing factors for the delayed extubation which includes patient factors, surgical factors, and anesthetic factors.

Objective: To study the factors related to delayed extubation for the benefit of anesthetists future decision making and the patients safety.

Methods: Case-controlled study in a retrospective fashion. Patients who undertook cervical spine surgery during 2002-2007 without previous intubation, tracheostomy, and ones with data available to be collected; were identified for the study. Data included age, sex, BMI, ASA classification, smoking history, pre-operative neurological deficit, history of previous C-spine surgery, steroid administration, number of cervical spine surgeries, upper cervical level including, surgical approach, instruments, intubation technique, duration of the operation, total blood loss, and total fluid replacement. All 16 factors were studied and analyzed for their relationship to extubation difficulty.

Results: Of all 140 patients identified in the study, 70 were patients with immediate extubation and 70 were patients with delayed extubation. Factors that are statistically significant in delayed extubation are: advancing age >60 years, ASA classification > class 2, pre-operative neurological deficit, surgery >2 levels of spines, duration of the operation >180 minutes, fiberoptic intubation technique, total fluid administration >4,000 ml during surgery and total blood loss >250 ml. When analyzed with multivariate analysis, factors that related to delayed extubation are advancing age >60 years (odds ratio 4.077, 95% CI 1.562-10.641), neurological deficit (odds ratio 5.719, 95% CI 1.312-24.927), surgery >2 levels of spines (odds ratio 4.108, 95% CI 1.672-10.095), duration of operation >180 minutes (odds ratio 4.538, 95% CI 1.687-12.205), and fiberoptic intubation technique (odds ratio 4.131, 95% CI 1.636-10.433).

Conclusion: There are 5 contributively factors that are related to delayed extubation in patients receiving cervical spine surgery at Siriraj Hospital: advancing age >60 years, neurological deficit, surgery >2 levels of cervical spines, duration of the operation >180 minutes, and fiberoptic intubation technique.

Keywords: Delayed extubation, cervical spine surgery, post-operative airway complication

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Post-operative airway management in patients who undergo cervical spine surgery in Siriraj Hospital has not been extensively investigated before. When anesthesiologists decide to extubate, it can lead to a potentially life-threatening complication which is airway compromise and frank obstruction requiring tracheostomy or reintubation. Post-operative airway obstruction requires timely recognition and reintubation, even though they are rare but potentially catastrophic complications.

Up to now, there has been only a few reports of incidence of airway complication after cervical spine surgery which were quite various.¹⁻³ Brian et al's article shows 0% to 14% incidence of post-operative respiratory compromise after multilevel anterior cervical decompression with or without posterior fusion or posterior fusion alone.¹ Emeryl, et al reviewed seven patients who required reintubation after anterior cervical multilevel corpectomy for myelopathy. The incidence of upper airway obstruction requiring reintubation was 5.2% and two patients died.² Sagi, et al used MEDLINE to find the literatures about anterior surgery of the cervical spine and they found 20 articles which mentioned an airway complication in the peri-operative period, accounting for 40 cases of respiratory distress or insufficiency of a total reviewed population of 1,615 cases.

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The incidence of an airway complication was 2.4% for this group of 20 articles. Finally, a research conducted by Sagi, et al themselves reviewed retrospectively 311 anterior cervical procedures and found 6.1% (19 patients) had airway complication and 1.9% (6 patients) required reintubation.³

There are several causes of a post-operative airway compromised after cervical spine surgery.²⁻⁶ Sagi, et al's literature reviews found the etiologies of the respiratory insufficiency were pharyngeal edema, hematoma, graft dislodgement, sleep apnea, asthma, cerebrospinal fluid leak and pharyngeal laceration. The other potential complications from the surgical approach include transient sore throat, dysphagia, hoarseness, dysphonia, recurrent laryngeal nerve paralysis and esophageal perforation.

Nowadays, there are many patients undergoing a cervical spine operation. This is due to the advancement in medication, methodology and specialized equipment available to correct varieties of diseases^{7,8}, such as cervical spondylosis, cervical disc herniation, cervical spondylo-lysthesia, spinal stenosis, tumor, rheumatoid arthritis and trauma.⁹ Moreover, humans now have longer lives, so an operation to correct degeneration can improve their quality of life.¹⁰ Even though most patients are able to awaken with adequate breathing and successful extubation which is required for effective neurological function after operation, many studies and researches show that these patients still have a high risk of respiratory complications.

Previous studies found that factors increasing the complication rates were obesity, cardiopulmonary diseases, myelopathy, prolonged operative times, multilevel corpectomy, operations that involve the upper cervical spine especially higher than the fourth cervical vertebra, prior cervical spine procedures, increased blood loss, high volume of intravascular fluid and blood replacement, and also a combined anterior and posterior operation.^{1-3,11}

In addition, anesthesiologists and surgeons in Siriraj Hospital always reserve the high dependency unit (HDU) and the intensive care unit (ICU) beds in order to closely observe patients airway post-operatively. Sometimes operational cancellation occurs due to an unavailable ICU bed. Therefore, the aim of this study was to assess variables that predispose to an airway complication after cervical spine surgery in Siriraj Hospital which will benefit patient care, reduce possible complication and reduce unnecessary cancellation as well.

MATERIALS AND METHODS

The research was approved by the Ethics Committee at the Faculty of Medicine Siriraj Hospital, Mahidol University, approval number SI. 052/2009. This is a case-control study conducted in retrospective fashion which was approved by the director general of Siriraj Hospital for reviewing patient information who came for cervical spine surgery from 2005-2007. The controls meant patients in whom immediate extubation could be performed immediate extubation and cases meant patients in whom delayed extubation were performed. Each chart was examined for patient characteristics and pathology, anesthetic parameters and problems, operative procedure, and post-operative airway problems and management. We matched only patients with cervical spine surgery, because we would like to assess every variable even type of operative procedure. Exclusion criteria were patients who had intubation or tracheostomy before their operation and all studies had complete data

available in medical record registration. Everything was kept confidential.

The sample size was calculated by nQuery programme taking into consideration recent existing information of interested variables in previous research reports.¹ Immediate extubation (control group) and delayed extubation (case group) had durations of their operations 8.2 ± 2.2 vs. 10.6 ± 2.0 hrs, total blood loss $1,238 \pm 1,352$ vs. $2,820 \pm 2,340$ ml, total intravenous fluid administration $3,627 \pm 1,174$ vs. $6,218 \pm 2,772$ ml, and blood replacement during operation 0.7 ± 0.9 vs. 3.1 ± 2.9 unit respectively. With type I error 0.05 and power of test equal 90%, the number of samples must be 27, 67, 36 and 46 by each variable respectively, so then we decided to use 70 samples per group. Therefore, the total number of patients are equal to 140.

This study gathered information backdated from 2007 to 2005 until reaching 70 complete samples in each group. The definition of immediate extubation in this study means extubation in the operating theatre and delayed extubation means extubation after the time of moving out of the operating room or having their post extubation airway compromised. Data collected from patients were recorded as follows: patient factors which are sex, age, BMI, ASA classification, smoking history, neurological deficit before operation, previous history of cervical spine surgery, steroid usage; surgical factors which are number of cervical spine surgeries, upper cervical spine including, surgical approach, instrument, operative time and anaesthetic factors which are intubated technique, volume of blood loss during operation and volume of fluid administration during operation.

Univariate analysis was performed in each variable factor between successful group and delayed extubation by Chi-square or Fishers exact test which is reported in p-value. A p-value <0.005 was considered statistically significant. Then multivariate analysis was performed by multiple logistic regression to find out the real factors which are reported in odds ratio and 95% confidence interval. All data are calculated by SPSS version 11.5.

RESULTS

Between 2005-2007, there were 174 cases who underwent cervical spine surgery in Siriraj Hospital. Thirty-four case were excluded from the study because of pre-operative intubation or tracheostomy ($n=13$) and inadequate record ($n=21$). The total of 140 cases were included in this study with the average age of 51.32 ± 16.87 years, BMI of 23.57 ± 4.2 kg/m², 61.1% of male, 32.9% of ASA class 1, 47.1% of ASA class 2, 20% of ASA class 3, and eight emergency cases.

Univariate analysis was used to compare between patients with successful immediate extubation ($n=70$) and patients with delayed extubation after operation ($n=70$). Factors related to individual patients, surgical, and anesthetic factors were shown in table 1-3. Delayed extubation patients were statistically significantly different from successful extubation in the factor of age more than 60 years, ASA classification more than 2, pre-operative neurological deficit, surgery involved more than 2 segmental levels, operative time more than 180 min, fiberoptic assisted intubation, blood loss more than 250 ml, and fluid administration more than 4,000 ml.

All 140 cases underwent cervical spine surgery for an average time of 232 ± 75 min (range between 87-450),

TABLE 1. Patient demographic data compares between the immediate extubation and delayed extubation groups. (The data was displayed in number, percentage and p-value)

| | | Immediate extubation (n=70) | Delayed extubation (n=70) | P-value |
|--------------------------------|---------|------------------------------------|----------------------------------|----------------|
| Gender | Male | 48 (68.6%) | 46 (65.7%) | 0.857 |
| Age group | >60 yrs | 14 (20%) | 32 (45.7%) | 0.002* |
| BMI group (kg/m ²) | >20 | 59 (84.3%) | 55 (78.6%) | 0.515 |
| ASA | 1 | 34 (48.6%) | 12 (17.1%) | < 0.001* |
| | 2 | 30 (42.9%) | 36 (51.4%) | |
| | 3 | 6 (8.6%) | 22 (31.4%) | |
| ASA group | >2 | 6 (8.6%) | 22 (31.4%) | 0.002* |
| Neurological deficit | Yes | 50 (71.4%) | 66 (94.3%) | 0.001* |
| Previous C-spine surgery | Yes | 3 (4.3%) | 9 (12.9%) | 0.131 |
| Smoking history | Yes | 24 (34.3%) | 22 (31.4%) | 0.857 |
| Steroid usage | Yes | 8 (11.4%) | 18 (25.7%) | 0.055 |

*P-value < 0.05 was statistically significant.

received average fluid administration 3,223 ± 564 ml (1,335-8,200) and average blood loss 531 ± 284 ml (75-3,000).

Taking into account every significant factor (p<0.05) from univariate analysis in stepwise multiple logistic regression analysis (Table 4) demonstrated only five factors of statistical significant of p-value lower than 0.005 and odds ratio more than 1 with 95% confidence interval not cover 1. Delayed extubation was significant in patients aged more than 60 years, presence of pre-operative neurological deficits, surgery involved more than 2 segments, operative time longer than 180 minutes and/or fiberoptic assisted intubation were used.

DISCUSSION

Quick recovery of patients from anesthesia and extubation has many advantages, for example, early

TABLE 2. Surgical factors compare between immediate extubation and delayed extubation group. (The data was displayed in number, percentage and p-value)

| | | Immediate extubation (n=70) | Delayed extubation (n=70) | P-value |
|----------------------|-------------|------------------------------------|----------------------------------|----------------|
| Surgical level | >2 levels | 22 (31.4%) | 47 (61.1%) | < 0.001* |
| Upper C (C1-4) | Yes | 52 (74.3%) | 54 (77.1%) | 0.844 |
| Surgical approach | Anterior | 43 (61.4%) | 48 (68.6%) | 0.054 |
| | Posterior | 27 (38.6%) | 19 (27.1%) | |
| | Combined | 0 (0%) | 3 (4.3%) | |
| Instrument | Yes | 42 (60%) | 56 (80%) | 0.061 |
| Operative time (min) | >180 min | 10 (14.3%) | 28 (58.6%) | < 0.001* |
| Diagnosis | Spondylosis | 39 (55.7%) | 32 (45.7%) | 0.086 |
| | HNP | 4 (5.7%) | 1 (1.4%) | |
| | Trauma | 16 (22.9%) | 21 (30%) | |
| | Tumor | 0 (0%) | 5 (7.1%) | |
| | Others | 11 (15.7%) | 11 (15.7%) | |

*P-value < 0.05 was statistically significant, HNP = Herniated nucleus pulposus

evaluation of neurological signs after cervical spine surgery, timely diagnosis and correction of complications¹²⁻¹³, reduction of hemodynamic response during intubation¹⁴, especially for high risk patients such as those with coronary artery syndrome or high blood pressure, effective cough for reducing secretion obstruction¹⁵, especially for patients with lung disease or who are heavy smokers, reducing the cost of treatment, and reducing the usage of HDU or ICU.

A decision to conduct immediate extubation after anesthesia depends on several factors: patient, anesthesia and surgery. Due to the fact that the cervical operation area is in the same area as the gastrointestinal tract and respiratory tract, it can lead to severe complications.^{1-3,11} If we know the factors affecting

delayed extubation, the anesthetists will be more careful before performing extubation and they can make a decision for maintaining a patent airway while pharyngeal swelling subsides which is critical to reduce the potential for postextubation respiratory compromise in this population.

From this research found that patients aged over 60 has more chance to undergo delayed extubation by an odds ratio of 4.078 and 95% CI 1.56-10.64 which differs from Emeryl, et al, Sagi, et al and Epstein, et al who found that age was not be a significant factor in delayed extubation. Because of the fact that being elderly affects the deterioration of internal organs, especially the respiratory and cardiovascular systems, it might explain why anesthetists in Siriraj have concerns that age is an important factor for airway compromise after extubation.¹⁶

Pre-operative neurological deficit is also a factor that leads to delayed extubation, which has an odds ratio of 5.72 and 95% CI 1.31-24.93. This is similar to the study

from Sagi, et al.³ They found the statistical significance of post-operative respiratory complication in the myelopathy group differed from the non-myelopathy group. However, both this study and Sagi, et al did not grade the degree of neurophathy, so this might explain why the confidence interval is so wide in our study (1.31-24.93). In this study, pre-operative neurological deficit varies from motor weakness grade 4/5 to motor weakness grade 0/5 and some patients have weakness only in their lower extremities while others have weakness in both upper and lower extremities. It will be beneficial in the next research if neurological deficit is determined or scored using such as the Kadoya, et al¹⁷ or Nurick scale.¹¹

TABLE 3. Anesthetic factors compare between immediate extubation and delayed extubation group. (The data was displayed in number, percentage and p-value)

| | | Immediate extubation (n=70) | Delayed extubation (n=70) | P-value |
|---------------------------|---------------------|------------------------------------|----------------------------------|----------------|
| Intubation | Direct laryngoscope | 53 (75.7%) | 28 (40%) | <0.001* |
| Technique | Fiberoptic | 17 (24.3%) | 42 (60%) | |
| Fluid administration (ml) | > 4,000 ml | 20 (28.6%) | 41 (58.6%) | 0.001* |
| Blood loss (ml) | > 250 ml | 13 (18.6%) | 32 (45.7%) | 0.001* |

*P-value < 0.05 was statistically significant.

About operative factors, surgery >2 levels of vertebrae is a significant factor which is associated with delayed extubation having an odds ratio of 4.11 (95% CI 1.67-10.09). These findings are the same as the result of Sagi, et al³ and Epstein, et al¹¹. They found that the greater number of cervical spines involved is a positive risk factor for postoperative airway compromise. The reason is more surgical levels involved will result in more tissue trauma and edema which leads to upper airway obstruction after extubation.¹⁸

Another risk factor related to delayed extubation is the operative duration in which we found that more than 180 minutes is significant and had an odds ratio 4.48 (95% CI 1.69-11.84). The reason is a longer operative time is accompanied by a longer period of retraction, an increase in local tissue edema and potentially more post-operative pharyngeal swelling. Emeryl, et al reported that prolonged anaesthetic time predisposed to an airway complication.² Similarly Sagi, et al³ found that an operative time exceeding 5 hours was statistically related to the need for postoperative reintubation while Kwon, et al¹ found total operative time more than 10 hours was significant. In contrast, McAfee, et al reported a mean operative time of 4.5 hours for postoperative reintubation which was shorter than the others¹⁹. There are wide differences between our research and these three researches in which we cannot find their definition for their operative time. However, in our research, we recorded the time from operative start until operative finish which were recorded in the anesthetic record.

In this study, we cannot find the difference between types of operation although there are some studies which found that a combined anterior and posterior procedure is associated with more incidence of upper airway obstruction after cervical spine surgery for example Terao, et al²⁰ and Kwon, et al¹. Combined anterior and posterior cervical spine surgery yielded a very high fusion rate with few graft or plate related complications in comparison with the

TABLE 4. Factors influencing delayed extubation after cervical spine surgery after multiple logistic regression.

| | Odds ratio | 95% confidence interval |
|--------------------------------|-------------------|--------------------------------|
| Age > 60 yrs | 4.08 | 1.56 - 10.64 |
| Fiberoptic assisted intubation | 4.13 | 1.64 - 10.43 |
| Surgery > 2 levels | 4.11 | 1.67 - 10.09 |
| Operative time >180 min | 4.48 | 1.69 - 11.84 |
| Neurological deficit | 5.72 | 1.31 - 24.93 |

anterior approach alone. Unfortunately, this procedure results in an increased surface area of bleeding cancellous bone in comparison with other standard cervical spine surgeries.

Similarly, there were many researches reporting that an anterior procedure is associated with more post-operative airway embarrassment than posterior procedures.¹⁻³ Anterior approaches are performed for many conditions such as degenerative, traumatic, tumorous, and infectious etiologies. During this procedure the

trachea and esophagus are retracted to the contralateral side of the neck to expose the anterior aspect of the cervical spine which results in post-operative airway edema. However, we cannot find any significant difference between these types of operations. All patients undergoing combined anterior and posterior operation were delayed extubation (3 patients) and there were more percentage in the delayed group than the immediate, group undergoing anterior surgery which were 69% and 61% respectively.

Concerning anesthetic factors, the intubation technique with fiberoptic assistance correlates with delayed extubation which had an odds ratio equal to 4.13 with 95% CI (1.64-10.43). Most anesthesiologists who decide to use this technique encounter patients with difficult intubation²⁰ and unstable cervical injury.²¹⁻²² Manninen, et al conducted an observational prospective cohort study in 327 patients, and they found that anesthesiologists prefer to choose awake fiberoptic in myelopathy and unstable or fractured spine while using asleep fiberoptic techniques in patients with radiculopathy symptoms.²² In our research, there were 85% in the total number of patients using awake fiberoptic techniques and only 5 in 59 patients using fiberoptic for intubation were asleep. These reasons, might explain why fiberoptic intubation technique relates significantly with delayed extubation in our study.

In this study, we could not find statistical significance between the amount of received fluid and delayed extubation. However, Brian, et al¹ and Fisher, et al²³ found that airway edema is the major cause of post-operative upper airway obstruction after extubation. If we can collect data in terms of dynamic fluid replacement which is ml/kg/hr, it might be of statistical significance and truly correlate with the outcome.

From these results, it might be useful to conduct research for derivation and validation of a clinical prediction score for safe extubation after cervical spine surgeries. Because until now there is no standard measure using for extubation after cervical spine surgery neither cuff-leak test nor direct fiberoptic examination. Moreover, the time requiring post-operative airway edema and reintubation can vary from 14 to 37 hours post-operatively which creates difficulties for anesthesiologists to decide if it is safe to extubate immediately the operation is finished.

CONCLUSION

One hundred and forty samples were divided into 70 patients in immediate extubation group and 70 patients in delayed extubation group. After multivariate analysis, it was found that advancing age more than 60 years, fiberoptics

assisted intubation technique, surgery which involved at least 3 segments, operative time more than 180 minutes and record of pre-operative neurological deficits are important factors in delayed extubation for cervical spine patients in Siriraj Hospital.

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