Retrospective Study of Postoperative Pulmonary Complications in Patients with Cervical Spine Pathology

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Abstract

Background Postoperative pulmonary complication (PPC) after cervical spine surgery is known to increase patient morbidity and mortality as well as the hospital and intensive care unit (ICU) stay. However, studies addressing this issue are scarce in the current literature. The aim of this study was to find out the incidence and various factors associated with PPC in patients undergoing cervical spine surgeries.

Materials and Methods It is a retrospective study in a tertiary care hospital. Two hundred and seven patients who underwent different cervical spinal surgeries were included in this study. Various perioperative data including demography, history of smoking, associated systemic illness, type and site of lesion, preoperative respiratory status, and signs of involvement of lower cranial nerves were collected. The incidence and the risk factors for PPC were found out. Statistical analysis was done using chi-square/Fisher's exact test/Student's *t*-test, followed by univariate and multiple logistic regression analysis.

Results The incidence of PPC in our study was 39.6%. Various pulmonary complications observed were difficulty in breathing requiring some intervention (19.3%), pneumonia (5.3%), tracheobronchitis (3.9%), arterial desaturation (3.4%), reintubation (3.4%), atelectasis (1.3%), pleural effusion (0.97%), pneumothorax (0.97%), and acute respiratory distress syndrome (ARDS) (0.97%). Preoperative respiratory abnormality, cervical laminectomy and instrumentation surgery and postoperative mechanical ventilation of > 24 hours duration were found to be independent risk factors for occurrence of PPC.

Conclusions The patients with cervical spinal cord pathology are at increased risk for PPC. Preoperative respiratory abnormality, postoperative mechanical ventilation of > 24-hour duration, and cervical laminectomy and instrumentation surgery are independent risk factors for PPC.

Keywords
- cervical spine
- complications
- pulmonary
- risk factors

Introduction

Patients with cervical spine pathology can have respiratory system dysfunction due to weakness of respiratory muscles/diaphragm or involvement of the respiratory center and lower cranial nerves secondary to medullary compression.[1,2] Pulmonary aspiration, atelectasis, poor respiratory function, and inadequate cough mechanism secondary to diaphragm or respiratory muscle involvement can lead to preoperative respiratory abnormalities in patients with cervical spine pathology that might get exaggerated in the postoperative period because of various anesthetic and surgical causes.[3–5] Prolonged tracheal intubation/tracheostomy in the postoperative period further can increase the incidence of pulmonary

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complications.[6,7] However, studies addressing pulmonary complications in patients specifically with cervical spine pathology are scarce. Therefore, the objective of the study was to find out the incidence of postoperative pulmonary complication (PPC) in patient undergoing cervical spine surgeries and to identify the factors associated with PPC in these patients.

Materials and Methods

After approval of institute ethics committee, records of the patients who underwent surgery for different cervical spinal cord/vertebral pathology within a stipulated 2-year-duration were reviewed. Patients who underwent surgery for craniovertebral junction (CVJ) anomaly were excluded from the study.

Demographic data and data regarding associated systemic illness, type and site of pathology, preoperative respiratory status, and signs of involvement of lower cranial nerves were collected. If there were documented positive signs or symptoms of respiratory abnormality, need for airway or respiratory support, abnormal sounds on chest auscultation, or presence of abnormal chest X-ray, the patient was considered to have preoperative respiratory system abnormality. Data about anesthetic technique, intubation techniques, surgical procedure, levels of the cervical vertebra operated, duration of surgery and anesthesia, amount of blood loss, amount of intravenous fluid used, amount of blood, and blood component transfused were noted.

Postoperative data were reviewed for the presence of PPC, need for reintubation/other airway intervention, need and duration of postoperative mechanical ventilation, blood and blood component transfusion, other complications, need for reexploration, postoperative use of methyl prednisolone, nasogastric tube (NGT) insertion, and duration of intensive care unit (ICU) and hospital stay.

Presence of any one or more of the following was considered as PPC: hypoventilation, hyperventilation, presence of abnormal signs or symptoms of pulmonary system, difficulty in breathing requiring intervention (i.e., intubation, airway insertion, nebulization, maneuvers to keep airway patent, etc.) arterial oxygen saturation < 90% needing oxygen supplementation, atelectasis, pneumothorax, pleural effusion, hemothorax, abnormal chest auscultatory findings, pneumonia, tracheobronchitis, or acute respiratory distress syndrome (ARDS).

The statistical analysis was performed using Stata 11.0 (College Stations, Texas, United States). Data were presented as number (%)/mean ± standard deviation (SD)/median (range). Demographic and clinical characteristics of the patients were compared using chi-square/Fisher's exact test (for categorical variables) and Student's *t*-test (for continuous variables). The risk factors for PPC were found out using univariate analysis followed by multiple logistic regression analysis. The results were shown as odds ratio (OR) (95% confidence interval [CI]). *p*-Value < 0.05 was considered as significant.

Results

Data of 207 patients (160 [80.7%] males) were analyzed in this study. Different demographic characteristics of the patients are shown in ►**Table 1**. The median age of the patients was 49 years (3 months–86 years), and most of the patients were of ASA (American Society of Anesthesiologists) class I (54.1%) and II (44.9%). Perioperative characteristics of the patients are shown in ►**Table 2**. Forty-four (21.3%) patients were smokers and 34 (16.4%) had preoperative respiratory abnormality. Majority of the patients had prolapsed intervertebral disc (39.7%), and 28.5% of patients had involvement of multiple cervical levels. Majority of our patients underwent anterior cervical discectomy and fusion (ACDF) (39.7%) and cervical laminoplasty (39.1%) surgery. The surgical approach was anterior in 50.7% patients and posterior in 48.3% patients. The mean durations of surgery and anesthesia were 201.2 ± 91 minutes and 260.4 ± 98.1 minutes, respectively. Forty-five (27.8%) patients required mechanical ventilation in the postoperative period, and the mean duration of mechanical ventilation was 13.1 ± 60.7 hours. Five (2.4%) patients required tracheostomy. Methyl prednisolone was

Table 1 Demographic characteristics of the patients (n = 207)[a]

Parameter	Frequency
Age (y)[b]	49 (3 mo–86 y)
Weight (kg)[b]	60 (5–105)
ASA status	
I	112 (54.1)
II	93 (44.9)
III	2 (1.0)
IV	0
Sex	
Male	160 (80.7)
Female	47 (19.3)

Abbreviation: ASA, American Society of Anesthesiologists.
[a]Data shown as number (%) of patients unless specified.
[b]Data shown as median (range).

Table 2 Perioperative characteristics of the patients (n = 207)[a]

Parameter	Frequency
Smokers	44 (21.3)
Preoperative respiratory system abnormality	34 (16.4)
Diagnosis	
PIVD	82 (39.7)
SOL	31 (14.8)
Myelopathy	37 (17.9)
others	57 (27.6)
Level of injury	
Upper	13 (6.3)
Middle	46 (22.2)
Lower	89 (43)
Multiple	59 (28.5)
Surgery performed	
ACDF	82 (39.7)
Laminoplasty	81 (39.1)
Laminectomy and instrumentation	44 (21.2)
Approach	
Anterior	105 (50.7)
Posterior	100 (48.3)
Combined	2 (1)
Duration of surgery (minutes)[b]	201.2 ± 91
Duration of anesthesia (minutes)[b]	260.4 ± 98.1
Blood loss (mL)[b]	342.9 ± 367.4
Fluid (mL)[b]	2473 ± 964.7
Mechanical ventilation	45 (27.8)
Duration of mechanical ventilation (h)[b]	13.1 ± 60.7
Need for tracheostomy	5 (2.4)
Methyl prednisolone administration	24 (11.6)
ICU stay (h)[b]	36.6 ± 52.3
Hospital stay (d)[b]	5.5 ± 5.1

Abbreviations: ACDF: anterior cervical discectomy and fusion; ASA: American Society of Anesthesiologists; ICU, intensive care unit; PIVD: prolapsed intervertebral disc; SOL, space-occupying lesion.
[a]Data shown as number (%) of patients unless specified.
[b]Data shown as mean (±SD).

administered in 24 (11.6%) patients. The mean ICU stay (ICS) was 36.6 ± 52.3 hours, whereas the mean hospital stay (HOS) was 5.5 ± 5.1 days.

In the postoperative period, 82 (39.6%) patients developed various pulmonary complications (►**Table 3**). The most common pulmonary complication was difficulty in breathing requiring some intervention (19.3%). Based on the presence or absence of PPC, patients were divided into two groups: group P (presence of PPC) and group A (absence of PPC). Comparison of different demographic and perioperative variables is shown in ►**Table 4**. Patients of both the groups were comparable in terms of age, sex distribution, weight, ASA status, and level of pathology. Group P had significantly more number of smokers, more patients with preoperative respiratory abnormality, longer duration of surgery and anesthesia, amount of blood loss intravenous fluid administration, and duration of postoperative mechanical ventilation than group A. Incidence of tracheostomy and methyl prednisolone administration was more in group P than group A. The ICU stay and hospital stay were longer in group P than group A.

The results of univariate analysis are shown in ►**Table 5**. In univariate analysis, age > 60 years, smoking, preoperative respiratory abnormality, posterior approach surgery, cervical laminoplasty and cervical laminectomy and instrumentation surgery, duration of anesthesia > 300 minutes, intraoperative blood loss > 500 mL, intravenous fluid administration of > 2,000 ml, administration of methyl prednisolone, postoperative mechanical ventilation > 24 hours, and neoplastic space-occupying lesions were statistically significant risk factors for PPC.

Table 3 Incidence of different postoperative pulmonary complications (n = 207)[a]

Pulmonary complication	Frequency
Difficulty in breathing requiring intervention	40 (19.3)
Pneumonia	11 (5.3)
Tracheobronchitis	8 (3.9)
Desaturation (Spo_2 < 90%)	7 (3.4)
Reintubation	7 (3.4)
Atelectasis	3 (1.3)
Pleural effusion	2 (0.97)
Pneumothorax	2 (0.97)
ARDS	2 (0.97)

Abbreviation: ARDS, acute respiratory distress syndrome.
[a]Data shown as number (%) of patients.

The results of multivariate analysis are shown in ►**Table 6**. In multivariate analysis, only preoperative respiratory abnormality, cervical laminectomy and instrumentation surgery, and postoperative mechanical ventilation of > 24 hours were found to be independent risk factors for PPC.

Discussion

We conducted this retrospective study to find out the incidences and nature of various pulmonary complications and the associated risk factors in patients who underwent cervical spine surgery. The incidence of PPC in our study was 39.6%. The most common pulmonary complication was difficulty in breathing requiring some intervention (19.3%). The reported incidence of PPC after various procedures varies between 2.5 and 37%.[8–15] This large variation in the incidence of PPCs can be ascribed to differences in different definitions used for pulmonary complications, preoperative patient's conditions, types of surgery, and duration of postoperative follow-up. Our definition of PPC was more inclusive because, in addition to specific pulmonary pathologies, such as pneumonia, atelectasis, and ARDS, it included nonspecific pulmonary conditions such as respiratory distress or hypoxemia that always cannot be attributed to any specific pulmonary pathology and can lead to life-threatening situations and needs urgent intervention. We found a higher incidence of PPCs because of the inclusion of nonspecific pulmonary conditions such as difficulty in breathing requiring intervention.

Preoperative respiratory system abnormality was present in 34 (16.4%) patients in our study, and we found it to be an independent risk factor for PPC (OR, 6.8; 95% CI [2.9, 15.9]; p < 0.0001). Studies have demonstrated preoperative respiratory abnormality to be associated with increased risk of pulmonary complication.[16,17] Chronic obstructive pulmonary disease (COPD) is one of the most important risk factors for PPC. Patients with severe COPD are more likely to have a PPC, and COPD was found to be an independent predictor of increased mortality in patients undergoing cardiac surgeries.[18]

Laminectomy and instrumentation surgery was also an independent risk factor for PPC in our study. This could also be explained on the basis of posterior surgical approach used in these surgeries. Tani et al compared the relative safety of anterior corpectomy (anterior approach surgery) versus laminoplasty (posterior approach) surgery. As compared with laminoplasty, patients treated with a corpectomy were noted to have significantly better functional results and no postoperative neurological complications. Patients treated with a laminoplasty were noted to have significant neurological deterioration.[19] In addition, posterior approach for cervical pathologies is reported to be associated with increased risk for infection, increased postoperative neck pain, and postlaminectomy kyphosis.[20] Postoperative pain may impair patient's ability to cough in the postoperative period, leading to retention of pulmonary secretion causing pulmonary infection. Hence this might have contributed toward an increased incidence of PPC in patients who underwent laminectomy and instrumentation surgery

Duration of postoperative mechanical ventilation of > 24 hours was another independent risk factor for PPC in our study (OR, 43.2; 95% CI [5.5, 337.1]; p < 0.0001). Tracheal tubes are known conduits for lower airway contamination and can lead to chest infection. Greater duration of postoperative mechanical ventilation might have predisposed patients to PPC, leading to higher incidence of PPC in those patients. Volutrauma and barotraumas associated with mechanical ventilation is thought to generate physical damage as well as pulmonary inflammatory response leading to pulmonary dysfunction.[21] Postoperative mechanical ventilation is known to increase the chance of PPC in patients after spine surgery.[22] In our study, patients with PPCs had significantly longer ICU stay than those who did not have PPCs (►**Table 4**). In patients with cervical spinal cord injury, length of hospital stay and hospital costs were reported to increase with the number of respiratory complications experienced during the hospitalization.[23]

The major limitation of our study is that it is a retrospective study. We may have missed many cases because of inadequate data recording. We had no data about the pre- and postoperative pulmonary function tests of the patients, which could have added to our understanding of PPCs. Many of these limitations can be minimized with a prospective

Table 4 Comparison of different variables in patients with and without PPC (n = 207)[a]

Parameter	Group P (n = 82)	Group A (n = 125)	p- Value
Age (y)[b]	47.5 ± 19.4	44.76 ±16.7	0.28
Sex			
Male	66 (80.4)	101 (80.8)	0.95
Female	16 (19.6)	24 (19.2)	
Weight (kg)[b]	58.9 ± 17.3	60.2 ± 17	0.63
ASA status			
I	38 (46.3)	74 (59.2)	0.06
II	42 (51.2)	51 (40.8)	
III	2 (2.5)	0	
IV	0	0	
Smoking	24 (29.2)	20 (16)	0.02
Respiratory abnormality	26 (31.7)	8 (6.4)	0.001
Diagnosis			
PIVD	23 (28)	59 (47.2)	0.005
SOL	18 (21.9)	13 (10.4)	
Myelopathy	12 (14.6)	25 (20)	
others	29 (35.5)	28 (22.4)	
Level			
Upper	8 (9.8)	5 (4)	0.21
Middle	18 (22)	28 (22.4)	
Lower	30 (36.6)	59 (47.2)	
Multiple	26 (31.7)	33 (26.4)	
Approach			
Anterior	32 (39)	73 (58.4)	0.008
Posterior	48 (58.5)	52 (41.6)	
Combined	2 (2.5)	0	
Surgery			
ACDF	18 (21.9)	63 (50.4)	< 0.001
Laminoplasty	38 (46.3)	43 (34.4)	
Laminectomy and instrumentation	26 (31.7)	19 (15.2)	
Duration of surgery (min)[b]	236.8 ± 109.3	177.8 ± 67.6	0.004
Duration of anesthesia (min)[b]	298.1 ± 120.3	235.7 ± 70.6	< 0.001
Blood loss (mL)[b]	462.6 ± 448.6	264.5 ± 277.7	< 0.001
Fluid (mL)[b]	2804.4 ± 1143	2255 ± 756.7	0.004
Tracheostomy			
Yes	5 (6.1)	0	0.005
No	77 (93.9)	125 (100)	
Methyl prednisolone use			
Yes	15 (18.5)	9 (7.2)	0.013
No	67 (81.5)	116 (92.3)	
Mechanical ventilation (h)[b]	32 ± 93.6	0.7 ± 3.64	< 0.001
ICU stay (h)[b]	62.5 ± 75.7	19.5 ± 8.3	< 0.001
Hospital stay (d)[b]	7.6 ± 6.9	4 ± 2.6	< 0.001

Abbreviations: ACDF, anterior cervical discectomy and fusion; ASA, American Society of Anesthesiologists; ICU, intensive care unit; PIVD, prolapsed intervertebral disc; PPC, postoperative pulmonary complication; SOL, space-occupying lesions.
[a]Data shown as number (%) of patients unless specified.
[b]Data shown as mean (±SD).

Table 5 Univariate analysis of relative risk for PPC (n = 207)[a]

Parameters	Group P (n = 82)	Group A (n = 125)	OR		95% CI	p- Value
Age (y)						
≤ 30	19 (23.2)	25 (20.0)	1.0		–	0.006
31–60	39 (47.5)	84 (67.2)	0.61		(0.3, 1.2)	
> 60	24 (29.3)	16 (12.8)	1.97		(0.8, 4.7)	
Smoking						
No	58 (70.8)	105 (84)	1.0			0.02
Yes	24 (29.2)	20 (16)	2.17		(1.1, 4.2)	
Respiratory abnormality						
No	56 (68.3)	117 (93.6)	1.0			< 0.001
Yes	26 (31.7)	8 (6.4)	6.8		(2.9, 15.9)	
Diagnosis						
PIVD	23 (28)	59 (47.2)	1.0		–	0.005
SOL	18 (21.9)	13 (10)	3.55		(1.5, 8.4)	
Myelopathy	12 (14.6)	25 (20)	1.23		(0.5, 2.8)	
Others	29 (35.5)	28 (22.4)	2.65		(1.3, 5.4)	
Approach						
Anterior	32 (39)	73 (58.4)	1.0			0.008
Posterior	48 (58.5)	52 (41.6)	2.1		(1.2, 3.7)	
Combined	2 (2.4)	0	–		–	
Surgery						
ACDF	18 (21.9)	63 (50.4)	1.0		–	< 0.001
Laminoplasty	38 (46.3)	43 (34.4)	3.0		(1.6, 6.1)	
Laminectomy and instrumentation	26 (31.7)	19 (15.2)	4.8		(2.2, 10.5)	
Duration of anesthesia (min)						
≤180 min	8 (9.8)	31 (24.8)	1.0		–	0.007
181–300 min	41 (50)	72 (57.6)	2.2		(0.9, 5.2)	
> 300 min	33 (40.2)	22 (17.6)	5.8		(2.2, 14.9)	
Blood loss						
≤500 mL	61 (74.4)	113 (90.4)	1.0		–	< 0.0001
> 500	21 (25.6)	12 (9.6)	5.4		(2.4, 12.5)	
Intravenous fluid						
≤ 2,000	28 (34.2)	68 (54.4)	1.0		–	0.004
> 2,000	54 (65.8)	51 (45.6)	2.3		(1.3, 4)	
Methyl prednisolone						
No	67 (81.5)	116 (92.8)	1.0		–	0.013
Yes	15 (18.5)	9 (7.2)	2.9		(1.2, 7)	
Mechanical ventilation						
≤ 24 h	25 (30.5)	3 (2.4)	1.0		–	< 0.0001
> 24 h	16 (19.5)	1 (0.8)	43.2		(5.5, 337.1)	

Abbreviations: ACDF, anterior cervical discectomy and fusion; CI, confidence interval; OR, odds ratio; PIVD, prolapsed intervertebral disc; PPC, postoperative pulmonary complication; SOL, space-occupying lesions.
[a]Data shown as number (%).

Table 6 Multivariate analysis of PPC

Parameters	OR	95% CI
Respiratory abnormality	5.4	(1.8,16.6)
Laminectomy and instrumentation	8.35	(1.9,37.3)
Mechanical ventilation (> 24 h)	51.3	(5.4,489)

Abbreviations: CI, confidence interval; OR, odds ratio; PPC, postoperative pulmonary complication.

study. Despite these limitations, our study showed that PPCs are common in patients with cervical spine pathologies, which can prolong the duration of ICU and hospital stay.

Conclusion

Patients with cervical spinal cord pathology are at increased risk for PPCs. There is a strong association between PPCs and preoperative respiratory abnormality, postoperative mechanical ventilation > 24 hours, and cervical laminectomy and instrumentation surgery. Patients with PPC had significantly longer ICU and hospital stay. Future large prospective studies can substantiate our findings and provide more useful information on PPCs in patients with cervical spine pathologies.

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Conflict of Interest
None.

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