Causes of tracheal re-intubation after craniotomy: A prospective study

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ABSTRACT

Background: Re-intubation of neurosurgical patients after a successful tracheal extubation in the operating room is not uncommon. However, no prospective study has ever addressed this concern. This study was aimed at analyzing various risk factors of re-intubation and its effect on patient outcome. **Methods:** Patients aged between 18-60 yrs and of ASA physical status I and II undergoing elective craniotomies over a period of two yrs were included. A standard anesthetic technique using propofol, fentanyl, rocuronium, and isoflurane/sevoflurane was followed, in all these patients. 'Re-intubation' was defined as the necessity of tracheal intubation within 72 hrs of a planned extubation. Data were collected and analyzed employing standard statistical methods. **Results:** One thousand eight hundred and fifty patients underwent elective craniotomy, of which 920 were included in this study. A total of 45 (4.9%) patients required re-intubation. Mean anesthesia duration and time of re-intubation were 6.3±1.8 and 24.6±21.9 hrs, respectively. The causes of re-intubation were neurological deterioration (55.6%), respiratory distress (22.2%), unmanageable respiratory secretion (13.3%), and seizures (8.9%). The most common post-operative radiological (CT scan) finding was residual tumor and edema (68.9%). Seventy-three percent of the re-intubated patients had satisfactory post-operative cough-reflex. The ICU and hospital stay, and Glasgow outcome scale at discharge were not significantly affected by different causes of re-intubation. **Conclusion:** Neurological deterioration is the most common cause of re-intubation following elective craniotomies owing to residual tumor and surrounding edema. A satisfactory cough reflex may not prevent subsequent re-intubation in post-craniotomy patients.

Key words: *Craniotomy, extubation failure, outcome, post-operative, tracheal re-intubation*

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INTRODUCTION

Early tracheal extubation is preferred after an uneventful craniotomy in patients with normal preoperative sensorium.[1] Re-intubation of trachea (unsuccessful extubation) has been reported in 20% of patients within 24 to 72 hrs of planned extubation.[2] It may increase the need for tracheostomy, hospital stay, morbidity, and mortality.[2,3] The causes of extubation failure in patients with neurological impairment has been evaluated in various literature.[3-6] However, these studies included a different set of patients such as the patients who were on mechanical ventilation and extubated subsequently, or those patients with spinal trauma etc. The scenario may differ in patients who undergo elective and uneventful craniotomies after which the trachea is extubated in the operating room (OR). Till date, no prospective study has ever addressed the causes and/or rate of re-intubation after a planned extubation in patients undergoing intracranial surgeries. Hence, this prospective study was aimed at analyzing these aspects.

METHODS

After obtaining institute ethics committee approval and written and informed consent, all patients with ASA physical status I and II undergoing elective craniotomies were included in this prospective observational study carried out between Aug 2008 and July 2010. Patients who were preoperatively intubated, required elective

postoperative ventilation, belonged to ASA class IV and V, underwent emergency surgery, those with preoperative lower cranial nerve involvement, and with neurological or any other systemic disease were excluded from the study. A standard anesthetic technique (using propofol, fentanyl, rocuronium, and isoflurane) and monitoring methods (non invasive and invasive) were used in all patients. At the end of surgery, trachea was extubated after reversal of residual muscle blockade and when the standard extubation criteria were met. The extubation criteria included alert patient obeying to verbal commands, stable vital parameter, and full recovery from neuromuscular blockers as assessed by strong hand grip and tongue protrusion. During emergence, transient hypertension and tachycardia were treated with intravenous labetolol and esmolol, respectively. Then, the patients were shifted to the neurosurgical intensive care unit (ICU), and bed side computed tomographic (CT) scan was carried out. "Re-intubation" was defined as necessity of tracheal intubation (due to any cause) within 72 hrs of a planned OR extubation. Additional CT scans of the patients were obtained immediately following re-intubation. Periodic neurological examination and cough reflex assessment were carried out in these patients (as a part of routine postoperative management) every two hrs after surgery for 12 hrs and as and when necessary. "Neurological deterioration" was defined as decrease in level of consciousness, or a change in the motor response or pupillary changes when metabolic or pharmacotherapy-induced causes were excluded. "Cough reflex" was graded as "satisfactory" (ability to cough out oral secretions voluntarily) or "unsatisfactory" (cough only after oropharyngeal stimulation or no cough even after oropharyngeal stimulation). "Chest infection" was defined as presence of new or progressive localized opacity in on chest radiograph and at least two of the following: Purulent tracheobronchial secretion or temperature >38.5°C or total blood leukocytes count >12000/mm^3. "Respiratory distress" was defined as a condition with any two of the following: Respiratory rate of >25/min, use of accessory muscles of respiration or paradoxical respiration, $PaCO_2$ >50 mmHg, SPO_2 <90% for more than five min or PaO_2 <60 mmHg on room air. "Copious oropharyngeal secretion" was defined as the need for oropharyngeal suctioning more than once every hour. The final patient outcome was expressed as Glasgow outcome scale[7] (GOS) at the time of discharge. The GOS was categorized as unfavorable (GOS of 1, 2, or 3) or favorable (GOS of 4 or 5).

Statistical analysis was carried out using STATA 11.0 (College Station, Texas, USA). Data were presented as number (%) or mean±SD/Median (Range). The difference in proportions was compared using Chi-square/Fisher's exact test. The difference in mean or median was compared using students '*t*' test or wilcoxon's rank sum test. A *P*<0.05 was considered statistically significant.

RESULTS

A total of 1850 patients underwent elective craniotomy during the study period, of which 920 patients (Trachea extubated in OR) included in this study. Forty-five patients (32 male and 13 female) required re-intubation accounting to a tracheal re-intubation rate of 4.9%. The median age and weight of the patients were 32 yrs (range 4-70 yrs) and 60 kg (range 11-100 kg), respectively. Mean duration of anesthesia was 6.3±1.8 hrs, and median interval between extubation and re-intubation was 20 hrs (Range 1-72 hrs). Majority of the patients who required re-intubation had supratentorial tumors (51.1%). Neurological deterioration (55.6%) was the commonest cause of re-intubation [Table 1]. The presence of residual tumor with surrounding edema (68.9%) was the most common finding on CT scan after re-intubation. The patients who were re-intubated following seizures had residual tumor with surrounding edema [Table 2]. Edema was more common in patients with supratentorial tumors (51.6%). Seventy-three percent (33 out of 45) of the re-intubated patients have satisfactory postoperative cough reflex [Table 3]. The frequency of satisfactory cough reflex in patients re-intubated due to neurological deterioration and respiratory distress were 80% and 60%, respectively, as compared to 50% patients with copious oropharyngeal secretion and 100% patients with seizure. The most common cause of re-intubation in patients with a satisfactory cough reflex was neurological deterioration (20 out of 33; 60.6%).

The mean duration of ICU stay and median duration of hospital stay were 8.0±2.2 and 23 days (range 6-62 days),

Table 1: Initial diagnosis and causes of tracheal re-intubation

Diagnosis	Frequency *n* (%)	Causes of re-intubation (no (%))			
		Neurological deterioration	Respiratory distress	Copious oropharyngeal secretion	Seizure
Supratentorial tumors	23 (51.1)	16 (69.6)	3 (13.0)	1 (4.3)	3 (13.0)
Infratentorial tumors	17 (37.8)	7 (41.2)	6 (35.3)	3 (17.6)	1 (5.9)
Vascular lesions	5 (11.1)	2 (40)	1 (20)	2 (40)	0
Total	45 (100)	25 (55.6)	10 (22.2)	6 (13.3)	4 (8.9)

Table 2: Computed tomographic scan finding after tracheal re-intubation

CT scan findings	Frequency n (%)	Causes of tracheal re-intubation [no (%)]			
		Neurological deterioration	Respiratory distress	Copious oropharyngeal secretion	Seizure
Residual tumor with surrounding edema	31 (68.9)	13 (52)	9 (90)	5 (83.3)	4 (100)
Intracerebral hemorrhage	6 (13.3)	5 (20)	1 (10)	0	0
Cerebral infarction	6 (13.3)	5 (20)	0	1 (16.7)	0
Hydrocephalus	1 (2.2)	1 (4)	0	0	0
EDH	1 (2.2)	1 (4)	0	0	0
Total	45 (100)	25 (55.6)	10 (22.2)	6 (13.3)	4 (8.9)

CT – Computed tomographic; EDH – Extradural hematoma

Table 3: Frequency of satisfactory postoperative cough reflex in re-intubated patients

Initial diagnosis (no)	Satisfactory post-operative cough reflex (no (%))
Supratentorial tumors (23)	19 (82.6)
Infratentorial tumors (17)	10 (58.8)
Vascular lesions (5)	4 (80)
Total	33 (73)

Table 4: Glasgow outcome score in relation to the cause of tracheal re-intubation

Etiology of re-intubation (no)	Favorable GOS (no (%))	Unfavorable GOS (no (%))
Neurological deterioration (25)	7 (28)	18 (72)
Respiratory distress (10)	1 (10)	9 (90)
Copious oropharyngeal secretions (6)	0	6 (100)
Seizure (4)	1 (25)	3 (75)

GOS – Glasgow outcome scale

respectively. There was no significant difference of mean ICU stay (P=0.36) and median hospital stay (P=0.12) between the patients re-intubated owing to different causes. Twenty-five of the 45 (55.6%) patients developed chest infection during their hospital stay. The incidence of chest infection was comparable in the patients with or without satisfactory cough reflex (48.5 vs. 75%; P=0.11). Patients who developed chest infection had significantly greater ICU (9±1.9 vs. 6.85±2.0 days; P=0.0006) and hospital stay (35 vs. 16 days; P=0.0006). Twenty-five (55.6%) patients required tracheostomy for prolonged mechanical ventilation. Tracheostomized patients had significantly longer ICU (8.9±2.0 vs. 6.9±1.9 days; P=0.0018) and hospital stay (40 vs. 15 days; P<0.001). The patient with unsatisfactory cough reflex had significantly more incidence of tracheostomy than those with satisfactory cough reflex (91.7 vs. 42.4%; P=0.003). Most of the patients had poor final outcome irrespective of the cause of re-intubation [Table 4]. There was no significant difference in GOS of the patients with and without chest infection (P=0.45) or tracheostomy (P=0.45).

DISCUSSION

'Re-intubation' has been defined as need for tracheal intubation within 24-72 hrs of a planned extubation in various literature.[8,9] It is known to prolong the ICU and hospital stay and cause increased patient morbidity and mortality.[2,3] The rate of re-intubation in neurosurgical patients is found to be between 0.17% and 0.83%.[10-12] Vidotto and colleagues retrospectively studied the outcome of elective craniotomy patients who were re-intubated within 48 hrs of a planned extubation and reported a re-intubation rate of 16%.[3] Patients who were on mechanical ventilation for up to six hrs after surgery were included in this study. Several other studies observed the re-intubation rates of 16-36% in patients with different neurological disorders.[6,13,14] The need of re-intubation in otherwise stable neurosurgical patients who are extubated in the OR after an uneventful craniotomy may be disappointing. The rate of re-intubation in our study was 4.9%. The variance of rates of re-intubation from other studies may be attributable to the difference in the 'patient inclusion criteria.'

In this study, the most common cause of re-intubation was neurological deterioration and residual tumor with surrounding edema [Tables 1 and 2]. Neurological impairment has been suggested as an independent risk factor for extubation failure in previous studies.[6,15,16] Vallverdu and colleagues reported a re-intubation rate of 36% in patients with central nervous system (CNS) impairment.[14] Coplin WM and associates studied brain injured patients and did not found any correlation between Glasgow coma scale (GCS) and the need for re-intubation.[5] However, Namen *et al.* analyzed the predictors of successful extubation in neurosurgical patients and found that a GCS ≥8 had the highest predictive accuracy.[6] In a recent study, GCS ≥10 has been suggested to be a pre-requisite for successful extubation.[16] Chevron *et al.* found that a low consciousness level correlated with unplanned extubation and the need for re-intubation.[17] Currently, a normal level of consciousness is still considered as a main variable for

successful extubation in neurosurgical patients.[3] Hence, a good mentation is invaluable for airway protection in neurosurgical patients, and neurological deterioration is an important reason for re-intubation in these patients. In our study, respiratory distress was the cause of re-intubation in 22.2% cases, which is in variance with the findings of Lee and colleagues,[18] where respiratory complications were implicated to be the most common causes of re-intubation. Our observations reiterate that re-intubation in postoperative craniotomy patients were mainly for airway protection in view of neurological impairment rather than respiratory disorder alone.

Presence of copious oropharyngeal secretion was another common cause of re-intubation, in this study. Secretions in airway may increase due to non-infectious inflammation, upper and lower respiratory tract infections or aspiration of oral secretions.[18] Any of these factors in addition to impaired swallowing may cause copious oropharyngeal secretions. Mokhlesi and colleagues reported that presence of moderate to copious airway secretion to be an important predictor of extubation failure and subsequent reintubation.[16] Khamiees and colleagues reported weak cough and abundant secretions to be an important causes for extubation failure.[19] Most of the re-intubated patients in this study had satisfactory cough reflex. The incidence of intact cough reflex was less in patients who underwent infratentorial craniotomy in comparison to supratentorial craniotomy. This difference could be attributable to lower cranial nerves palsy and laryngeal and pharyngeal muscle dysfunction after infratentorial surgeries secondary to intra-operative ischemia, external compression, or iatrogenic trauma to the brainstem.[10,20] Like other visceral reflexes, 'cough' is also a cortically governed reflex.[21] It may be impaired in patients with altered sensorium secondary to intracranial pathologies. However, in our study, 80% of the patients with neurological deterioration had satisfactory cough reflex. General anesthesia (GA) is known to cause impaired cough reflex.[22] The average duration between planned extubation and re-intubation in our study was 20 hrs. Hence, it is unlikely that the residual effects of the anesthetic drugs could have affected the cough. Cough reflex may be impaired due to respiratory muscles weakness, laryngeal dysfunction, unresolved pulmonary pathology, airway inflammation, and bronchospasm,[23] and one or more of this might have altered the postoperative cough reflex in those patients. Neurological deterioration was the most common cause of re-intubation in patients with satisfactory cough reflex. Coplin and colleagues reported that 82% of the brain injured patients who had weak or absent cough reflex could be successfully extubated.[5] Similarly, Namen *et al.* did not find any relationship of cough reflex and extubation failure in neurosurgical patients. Therefore, it can be inferred that a satisfactory cough reflex may not prevent re-intubation in postoperative neurosurgical patients.

Tracheal tubes are known conduit for lower airway contamination and can lead to chest infection. We found 55.6% patients developed chest infection during their hospital stay. Patients who had chest infection had significantly greater ICU and hospital stay. Tracheal intubation or tracheostomy-related chest infection was found to prolong ICU and hospital stay in our patients. Irrespective of the cause of re-intubation, the GOS of the patients was unfavorable in 80% cases. Re-intubation process being invasive in nature may itself increase morbidity after aspiration of gastric contents and cardiac arrhythmias,[18] although no such problem was encountered. Several hypotheses have been proposed to describe the unfavorable outcome in re-intubated patients. It may reflect a sicker cohort of patients[24] and with re-intubation acting as an additional marker of severity. There were few limitations to this study such as a small sample size, lack of a control group, and absence of a long-term follow-up.

CONCLUSION

The most common cause of re-intubation following elective craniotomies is neurological deterioration mainly due to residual tumor with surrounding edema. A satisfactory cough reflex may not guarantee prevention of extubation failure (re-intubation). Unsatisfactory cough reflex may lead to a higher incidence of tracheostomy. These patients may have longer ICU and hospital stay owing to tracheostomy and/or chest infection. These patients may also have an unfavorable outcome irrespective of the causes of re-intubation.

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