Early Bronchoalveolar Lavage among Patients with Severe Traumatic Brain Injury and Predicted Macro-Aspiration

Pratyush Nirmal Kusum Chaudhuri[1]

[1] Nirmal Balrugnalaya, Ratnagiri, Maharashtra, India

Indian J Neurotrauma 2015;12:111–116.

Address for correspondence Pratyush Nirmal Kusum Chaudhuri, MCh, Nirmal Balrugnalaya, Salvi Stop, Ratnagiri, Maharashtra 415639, India (e-mail: pratyushchaudhuri@gmail.com).

Abstract

Problems Considered The severity of brain injury and the outcome of therapy have a direct correlation to the presence of aspiration pneumonitis and aspiration pneumonia. Patients often develop macro-aspiration immediately following trauma. This study proposes to evaluate the outcome of check bronchoscopy after severe head injury and develop a scoring system to determine the most likely candidate who would benefit from the procedure.

Method Total 30 patients were prospectively observed after check bronchoscopy for outcome with regard to pneumonia and survival.

Results The procedure could be safely performed in all the 30 patients and the findings were suggestive of significant particulate aspirate. The Predictor of Macro-Aspiration at Trauma site [PMAT] was an effective tool to identify the potential candidates.

Conclusion Check bronchoscopy and lavage may be helpful in decreasing the burden of infection and thereby improve outcome. The PMAT score may be an effective tool to triage the patients who need bronchoscopy.

Keywords
- macro-aspiration
- aspiration pneumonia
- bronchoscopy in neurotrauma

The most common cause of death following severe brain injury is the associated aspiration pneumonitis progressing to pneumonia. All efforts to prevent aspiration and any strategy to minimize aspiration pneumonia in patients with severe brain injury will significantly improve the course of treatment of such patients and decrease the financial burden on limited resources. Management of road traffic–related head-injury patients has several logistic shortcomings and it is rarely possible to prevent aspiration in comatose patients. Hence, the possibility of decreasing the severity of aspiration was contemplated by developing a protocol for early bronchoscopic evaluation and retrieval of the aspirated products. This study presents the observations made during the management of 30 patients with suspected macro-aspiration following severe brain injury among whom bronchoscopy was performed as a part of initial management protocol.

Materials and Methods

This study includes patients with severe brain injury treated in a single institute during the period of 2010 to 2012. All patients were deeply comatose with Glasgow Coma Scale (GCS) of 8 or less either directly brought to the center or primarily managed at another center. The protocol (►**Fig. 1**) involved primary assessment of patients for poly trauma including thoracic injury. Exclusion criteria included those with thoracic injury, age less than 18 years or greater than 60 years, associated diabetes mellitus and chronic obstructive pulmonary (COPD) or other chronic pulmonary illness, and patient not requiring intubation and ventilation (►**Table 1**). Patients who satisfied the inclusion criteria were then screened for presence of maxilla-facial injury, skull base injury, and cerebrospinal fluid (CSF) rhinorrhea. Preadmission triage care was

received
April 27, 2015
accepted
November 5, 2015
published online
December 16, 2015

DOI http://dx.doi.org/10.1055/s-0035-1570094.
ISSN 0973-0508.

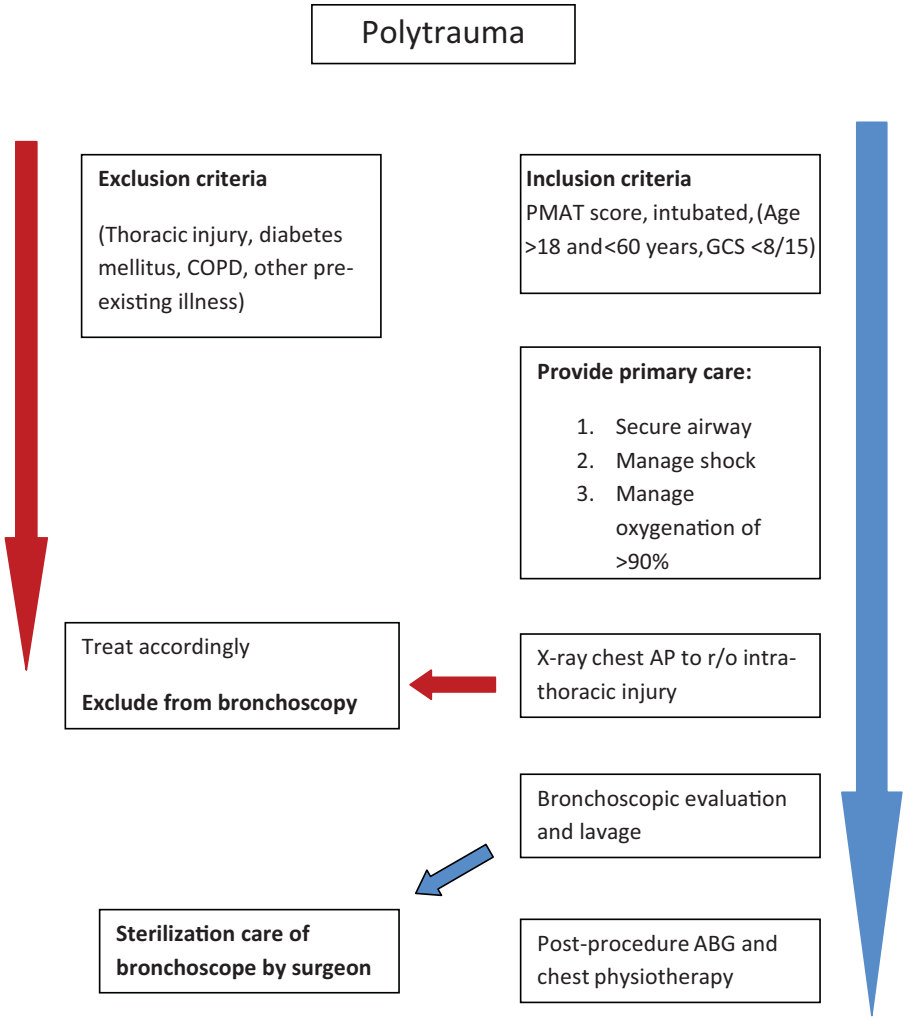

Fig. 1 Protocol for check bronchoscopy after polytrauma.

reviewed with regard to the predictors of macro-aspiration and aspiration pneumonitis, and measures taken for prevention of the same. Considering the available resources in the semirural and rural section of India where this study was based, an attempt to predict the patients who are likely to have macro-aspirated was made by the use of a self-developed scoring system (►**Table 2**). The Predictor of Macro Aspiration at Trauma site [PMAT] score defines multiple parameters that are crucial in airway protection. The score ranged from −3 to 23. The score was conceptualized based on the parameters in favor or against the upper airway safety of patients. Early intubation, transport by trained personnel, and transport by equipped ambulance were given negative scores. All other parameters can be broadly divided into (1) type of brain injury reflecting the immediate loss of consciousness, (2) associated upper airway obstruction and injury such as maxilla-facial injury and CSF rhinorrhea, and (3) those

Table 1 Patient selection criteria

	Inclusion criteria	Exclusion criteria
1	GCS < 8	GCS > 8
2	Altered sensorium due to road traffic injury	Associated thoracic injury.
3	Age > 18 y and < 60 y	Preexisting pulmonary disease (COPD, tuberculosis, etc.)
4	Patients requiring intubation and ventilation	Diabetes mellitus
5	PMAT score > 6	Associated spine injury

Abbreviations: COPD, chronic obstructive pulmonary disease; GCS, Glasgow Coma Scale; PMAT, **P**redictor of Macro-Aspiration at **T**rauma site.

Table 2 Predictors of PMAT

		Allotted score	Patient score
Type of trauma (at least 1)	High velocity (>40 km/h Indian roads)	1	0
	Tangential or rotational injury	1	1
	Thrown out or off vehicle	1	0
GCS	5–8	1	1
	<5	2	0
Extent of injury (at least 1)	Maxilla-facial injury	2	2
	Fracture mandible	2	0
	Decerebrate posturing	2	0
	Quadriplegia	1	0
	CSF rhinorrhea	2	0
	Convulsions	2	0
Primary triage care	Vomiting during transport	2	0
	Suspected aspiration during transport	2	0
	Intubated	−2	−2
	Hypovolemic shock managed	−2	−2
Under the influence of alcohol	Alcohol in vomitus	2	0
Rescue team	Untrained citizen	1	
	Trained citizen	−1	−1
Transport team	Untrained ambulance	1	
	Trained 108 service	−1	−1

Abbreviations: GCS, Glasgow Coma Scale; PMAT, Predictor of Macro-Aspiration at Trauma site.
The greater the score, the higher is the chance of macro-aspiration. Maximum score being 23 and minimum being −3. In the present study, all patients were placed between 6 and 23.

parameters affecting respiration indirectly such as abnormal posturing, seizures, and quadriplegia. All these parameters were found to make a difference in the patient's ability to clear his airway and compound the effect if present together. The distribution of favorable as negative and unfavorable as positive scores was interpreted into a direct proportionality relationship to the expected possibility of macro-aspiration. Hence, the lower the score, the lesser the chance of a macro-aspiration. Score above 6 was considered to have significant bolus of aspiration to warrant a check bronchoscopy. Such a lower limit was purely matter of choice based on the clinical presentation of our study cohort. All patients underwent check bronchoscopy within 6 hours of injury and often after stabilization with ventilator support using an Olympus BF type P10 (Olympus America Inc., Pennsylvania, United States) bronchoscope. The findings were noted with regard to the extent of particulate matter, blood products, and inflammation in the tracheobronchial tree. In all cases, a bronchial lavage with normal saline was given using 15 to 20 mL total lavage volume. End goals of the study were considered with regard to two aspects: (1) at seventh day for presence of evidence of aspiration pneumonia considering available data that aspiration pneumonia incidence peaks between fifth and seventh day posttrauma and (2) survival at 3 weeks to evaluate the overall effect of this intervention on survival. Swabs from endotracheal tube were taken on day 4 from all patients (►**Table 3**). Stringent bronchoscope sterilization procedures were maintained before and after each procedure. Cleaning of the bronchoscope requires recommended enzymatic cleaning with reprocessor (Olympus). This is impractical in most centers. In this study, an alternative low-cost procedure for cleaning bronchoscope was used (►**Table 4**). The bronchoscope was cleaned after changing procedure gloves with cetrimide and chlorhexidine gluconate soapy solution (Savlon) using a gauze pad and the channels using a flexible biopsy forceps for 5 minutes by the clock. Thereafter, the flexible section of the bronchoscope was immersed in the chlorhexidine solution 2 to 3% for 5 minutes and then liberally cleaned with boiled water. The process of drying by holding in hand suspension was important. Thereafter it was wrapped in a sterile polyethylene sheet and stored in the transportation unit. The eye piece and control section in addition to the light guide and universal cord were wiped with soaks of mecetronium metilsulfate in propranolol solution (Sterillium). This procedure cannot be stated to be better than other established automated systems; however; it remained effective as preprocedure swabs taken in two

Table 3 Microbial findings in our patients

Organism[a]	Number of patients (days 3–4 swab) ($n = 21$)	Swab collected on days 7–8 ($n = 30$)
Acinetobacter spp.	0	4
Klebsiella pneumoniae	2	9
Escherichia coli	0	1
Pseudomonas aeruginosa	0	9
Streptococcus	0	1
No growth	19	–

[a]The specimens were collected between the third and fourth day. Culture patterns were different in patients who were diagnosed with VAP.

instances from the initial 10 cm of the scope did not grow bacteria on culture.

Results

Patients sustained injury following high-velocity road traffic accident in 26 of 30 cases. A brief epidemiologic profile of the patients is presented in ►**Table 5**. Most patients were young to middle-aged males who had fallen off their two wheelers. None of the victims were using protective gear such as helmets. Most patients were transferred to the nearest health facility where basic procedure such as intubation could not be done. Unfortunately in most cases, the need for CT scan of the brain was considered more important than securing airway. In 14 of 30 (46.6%) patients, the primary procedure for securing the airway was possible within 60 minutes of injury and 16 of 30 (53.3%) patients were received within an interval of 1 to 4 hours. The most common cause noted was the nonavailability of competent staff, delayed pickup from the site of injury (usually an isolated road), and nonavailability of basic equipment. A total of 23 out of 30 (76.6%) patients had vomited large quantity of gastric content, and 18 of 30 (60%) patients had suffered injury in full stomach and 26 of 30 (86.6%) patients had consumed alcohol prior to the trauma.

Bronchoscopy procedure was successfully completed within 6 hours of the trauma in all patients with the average time of 4.06 hours from the time of injury. The procedure was free of any complications in all the 30 patients. Gross aspiration was noted in 28 of 30 (93.3%) patients with bilateral bronchial contamination with clots, fresh blood, altered blood, and foreign material. Rice particles were aspirated in 5 of 30 (16.6%) patients and vegetable material in 2 of 30 (6.6%) patients, in addition to the altered blood. CSF flooding of the airway was noted in 1 of 30 (3.3%) patients who was intubated in the hospital. Gritstone dust was noted to be present in 1 (3.3%) patient. Gentle normal saline lavage was administered to all the patients.

Outcome assessment after 7 days: A total of 6 out of 30 (18%) patients developed clinical pneumonia and required continued ventilator support because of pulmonary indications. Right lower lobe was affected alone in two of the six patients and bilateral affection was observed in four of six patients. Seven of 30 (23.3%) patients developed ventilator-associated pneumonia (VAP) that was observed after the initial period of 7 days.

Survival at 3 weeks: A total of 5 out of 30 (16.6%) patients died. Three patients died primarily due to the severity of the brain injury. Two patients were diagnosed with VAP required prolonged ventilation. Both patients succumbed to infection. Remaining 25 patients survived this period of 3 weeks at various stages of neurologic recovery.

Bacteriology (►Table 3): In 2 of 21 (9.5%) patients, early samples (within 48 hours and taken by sterile suction tip) were sent and pathologic microorganisms were isolated. Both patients had *Klebsiella* spp. isolated from the tracheal

Table 4 Protocol used for bronchoscope maintenance

Step	Procedure
1	Change procedure gloves
2	Manual scrubbing of the flexible section of the bronchoscope with gauze soaked with Savlon solution for 5 min
3	Soak in 2–3% chlorhexidine solution for 5 min; use available forces to clean the channel
4	Wipe the lens unit and control section, light guide and universal light cable with Sterillium
5	Wash with distill water or boiled water
6	Dry the scope
7	Wrap in sterile disposable polyethylene sheet and preserve

Table 5 Relevant clinical profile of patients included in study

1	Average age	39.6 y
2	Male	28/30 (93%)
3	Female	2/30 (7%)
4	Two-wheeler accidents	23/30 (76.6%)
5	Three-wheeler accidents	2/30 (7%)
6	Four-wheeler accidents	5/30 (16.6%)
7	Primary care at PHC/other hospital	22/30 (73%)
8	Primary care at neurosurgical center	8/30 (26.6%)

Abbreviation: PHC, primary health center.

swab collected on day 3 to 4 of admission. Samples were sent in the cases of 19 other patients and were reported as no growth. The bacteriologic pattern changed on the day 7 to 8 specimens, and *Pseudomonas* spp. and *Klebsiella* spp. were found in 9 of 30 (30%) patients and *Acinetobacter* spp. in 4 of 30 (13.3%) patients.

Bronchoscope hygiene (►Table 4): Cetrimide and chlorhexidine gluconate Savlon solution washing with a gauze wipe by the surgeon for 5 minutes was the most crucial step in cleaning. Immersion in chlorhexidine solution for another 5 minutes and wiping with liberal amounts of normal saline preserved the protective layer of the scope. All three products were easily available and affordable at any surgical unit. Time taken for the cleaning procedure takes on the average approximately 20 minutes accommodated between the writing notes by the surgeon. The bronchoscope needs to be dried and sterile polyethylene sheet was used to wrap the scope before keeping in the transport unit.

Discussion

The guidelines to manage severely traumatized patient with brain injury have been well established.[1–4] The importance attributed to securing of the airway and avoiding hypoxia cannot be overstated. Patients are required to be transported in specific well-defined, pre-hospital procedural code. Yet much of this is not possible in low-resource, rural sectors of the world. Race against time often comes to a complete standstill due to the many reasons stated previously. It has been established that leaving behind particulate aspirated material in the airway is detrimental, especially in the presence of positive pressure ventilation.[5–7] Several inflammatory markers are known to rise immediately following the aspiration of the particulate matter, including tumor necrotic factor-α, macrophage inflammatory protein 2 and cytokine-induced neutrophil chemoattractant-1.[8] A monocytic response peaks at the interval of 48 hours postaspiration. Experiments on mice have confirmed the additive effect of gastric acid and small nonacid particle aspiration to be more severe than the sum of individual events.[9] If so, then an obvious follow-up of this is the question: How do we choose the appropriate candidate for any procedure related to extrication of aspirated particulate material? This observational study proposes to answer such a question. This study proposes that check bronchoscopy and lavage with normal saline among selected patients with neurotrauma predicted to have macro-aspiration can decrease the burden of contaminants and hence prevent or decrease the severity of pneumonia.

Most studies to date comment on the lack of scientific proof for any benefit following routine check bronchoscopy.[1–3] However, systematic literature search does not identify any study with the necessary inclusion criteria, leading to the selection of a cohort of patients who logically may have higher chance of particulate contaminants in the airway. Such particles are likely to get further pushed in or impacted with positive-pressure ventilation.

Another concern expressed in multiple studies and guidelines is related to the possibility of scope-induced infection. However, these studies were not related to trauma but to long-term ventilation or procedures including bronchoalveolar lavage. This issue needs to be addressed with serious attention to the process of cleaning. The author in the present study maintained single-person handling of equipment so that the process of cleaning was stringent. No procedures other than bronchial lavage with 15 to 20 mL of normal saline containing either gentamycin (80 mg in 100 mL) or Chloromycetin (500 mg in 100 mL) were done, thereby reducing the source of infection.

Hence the benefits of check bronchoscopy and lavage should be discussed. If appropriate care is taken to prevent complications such as hypoxia and iatrogenic infection, the removal of particulate matter from the airway of a comatose patient on positive-pressure ventilator support should help. These particulate materials, if left behind in the airway, will result in increased bacterial burden. Removal of clots and decomposable material will improve the immediate progress of patient. This study identifies the practical feasibility of such intervention without increasing the existing risk. The clinical progress observed in this study is encouraging and certainly makes a point for considering a randomized comparative study between those patients who were given the benefit of bronchoscopy and others without it. Such a study should not only consider the mortality but other comorbidity of prolonged antibiotic therapy, antimicrobial resistance, and cost of therapy.

Conclusion

1. The observations made in this study emphasize the possible scope of further improvement in the survival of brain-injured patients, especially in rural sectors of the world working with limited resource.
2. Neurologic outcome may improve indirectly if prolonged ventilation and antibiotic therapy can be eliminated.
3. This center has been continuing the study by developing a comparison group where check bronchoscopy is withheld. Similar such studies from developing countries on the lines of the mentioned protocol could allow us to better assess the benefits of the intervention.
4. Shortcomings of the present study: PMAT scoring is not validated and the study lacks a comparison group.

Acknowledgments

This study was self-funded. I thank Dr. Nirmal Kusum Chaudhuri for the editorial assistance during preparation of this article.

References

1 Tom K, Peter BL, Geoffrey L. Guidelines for the Field Management of Combat-Related Head Trauma. New York, NY: Brain Trauma Foundation; 2005

2 Du Rand IA, Barber PV, Goldring J, et al; British Thoracic Society Interventional Bronchoscopy Guideline Group. British Thoracic Society guideline for advanced diagnostic and therapeutic flexible bronchoscopy in adults. Thorax 2011;66(Suppl 3):iii1–iii21
3 Alister C, Dianne J, Elizabeth W. Guidelines Infection Control in Endoscopy. Gastroentrology Society of Australia. 2nd ed. 2003
4 Neeraj B, Nancy C, Todd JC, et al. Guidelines for prehospital management of traumatic brain injury. Prehosp Emerg Care 2007;12:Suppl 1
5 Raghavendran K, Nemzek J, Napolitano LM, Knight PR. Aspiration-induced lung injury. Crit Care Med 2011;39(4):818–826
6 Knight PR, Rutter T, Tait AR, Coleman E, Johnson K. Pathogenesis of gastric particulate lung injury: a comparison and interaction with acidic pneumonitis. Anesth Analg 1993; 77(4):754–760
7 Raghavendran K, Davidson BA, Mullan BA, et al. Acid and particulate-induced aspiration lung injury in mice: importance of MCP-1. Am J Physiol Lung Cell Mol Physiol 2005;289(1): L134–L143
8 Shanley TP, Davidson BA, Nader ND, et al. Role of macrophage inflammatory protein-2 in aspiration-induced lung injury. Crit Care Med 2000;28(7):2437–2444
9 Rotta AT, Shiley KT, Davidson BA, Helinski JD, Russo TA, Knight PR. Gastric acid and particulate aspiration injury inhibits pulmonary bacterial clearance. Crit Care Med 2004;32(3): 747–754