Bronchoscopy as a salvage therapy in a mechanically ventilated status asthmaticus patient: A case report

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A 23-year-old male patient presented with acute exacerbation of asthma with type 2 respiratory failure. He was mechanically ventilated and started on intensive medical therapy including nebulization with β2 agonists and antimuscarinic drugs, steroids, antibiotics and magnesium sulphate as per standard protocol. As there was no response to the above-mentioned line of treatment, other nonstandard therapies such as intramuscular adrenaline and ketamine were also tried but to no avail. After a meticulous literature search, bronchoscopy was planned to look for any alternative diagnoses as well as to perform bronchial toileting. The patient showed dramatic improvement after the procedure, was subsequently extubated and discharged in stable condition. This case essays the significant role of bronchoscopy in refractory status asthmaticus patients, discusses the pathophysiological mechanisms addressed by bronchoscopic toileting and, furthermore, reviews the contemporary literature for evidence in its favour.

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Case report

A 23-year-old male patient, who was a known case of poorly controlled bronchial asthma, presented to the emergency department of Fortis Hospital, Vasant Kunj, New Delhi, with complaints of severe breathlessness and cough for 1 day. On examination, he was drowsy, with a respiratory rate of 40/min, heart rate of 130/min, blood pressure of 180/90 and saturation of 86% (room air). Arterial blood gas showed respiratory acidosis.

The patient was promptly intubated in the emergency room with rapid sequence intubation (midazolam and vecuronium) and started on volume-controlled ventilation with tidal volume of 4 ml/kg (plateau pressure kept below 30 cm of H_2O), FiO_2 of 50%, rate of 10/min and inspiratory : expiratory ratio of 1 : 5 with sedation and paralysis. He was promptly shifted to the respiratory ICU where nebulization with β2 agonists and anticholinergics was started along with intravenous steroids as per standard protocol [1]. His peak and plateau pressures were 85 cm of H_2O and 30 cm of H_2O, respectively. His chest radiography showed hyperinflation (Fig. 1). Magnesium sulphate injection and aminophylline infusion were added. Strategy of permissive hypercapnia was adopted with bicarbonate infusion to keep the blood pH above 7.15. Endotracheal suctioning was performed at regular intervals, but only scanty secretions were aspirated.

Because of poor response to conventional therapy, nonstandard therapies were initiated. Injection ketamine[2] was started at the dose of 1 mg/kg over 2 min followed by infusion (0.5 mg/kg/h gradually increased to 2 mg/kg/h). Epinephrine 0.5 mg was administered intramuscularly. However, there was no improvement in the airway pressures and blood gas parameters. Subsequently, the patient developed bilateral pneumothoraces, which were promptly drained with intercostal tube drainage. A computed tomography of the thorax was performed subsequently, which showed bilateral pneumothoraces with pneumomediastinum and subcutaneous emphysema (Figs 2 and 3).

Next, a thorough literature review was carried out, and the possible salvage therapies were considered. It was decided to perform a videobronchoscope to look for any other cause of airway obstruction as well to perform bronchial toileting. Expecting the peak and plateau pressures to rise further during bronchoscopy, it was decided that the toileting would be performed in short intervals of 20–25 s. The tidal volume was decreased further to 3 ml/kg, FiO_2 to 1, Positive End Expiratory Pressure (PEEP) to 0 in volume-controlled ventilation and inspiratory : expiratory to 1 : 5; the rate of bicarbonate infusion was increased. After ensuring adequate sedation, analgesia and neuromuscular paralysis (bolus fentanyl doses were added to the running vecuronium and midazolam), an Olympus BF TYPE 1T160 bronchoscope (Olympus, Ishikawa-machi, Hachioji-shi, Tokyo, Japan) was

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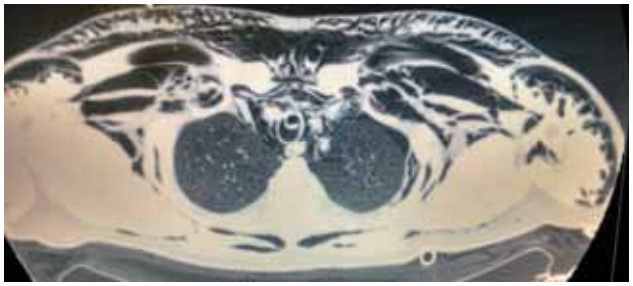
Figure 1

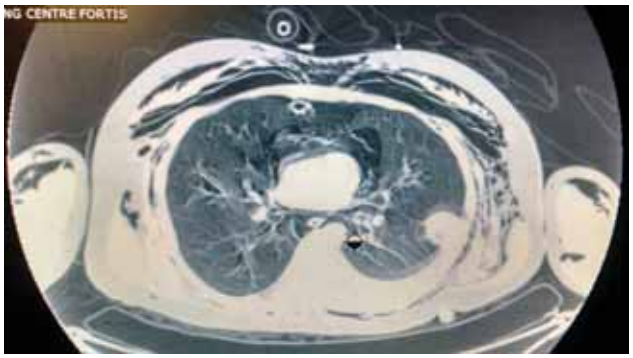
Chest radiography showing hyperinflation of lung fields.

Figure 2



Computed tomography thorax showing pneumomediastinum and subcutaneous emphysema.

Figure 3



Computed tomography thorax showing pneumothorax together with pneumomediastinum and subcutaneous emphysema.

introduced into the endotracheal tube (8.5-mm inner diameter). Sticky, whitish mucoid secretions were present in the tracheobronchial tree bilaterally distal to the carina (Fig. 4). The secretions were thoroughly aspirated from the segmental and subsegmental bronchi with liberal instillation of normal saline.

Figure 4

Sticky, whitish secretions in the bronchial tree.

Each period of bronchoscopic suctioning (of around 20–25 s) was continued, ensuring that the SpO_2 was above 88%, followed by removal of the bronchoscope as the SpO_2 fell. Altogether, this routine was repeated four times till the aspirate was clear. Following bronchoscopic toileting, marked reduction in peak pressures and plateau pressures were seen (Figs 5 and 6). The patient's arterial blood gases improved with significant reduction in partial pressure of CO_2.

Conservative management of the patient was continued; the patient improved and he was extubated after 2 days. He was kept on noninvasive ventilator support for 12 h and then gradually weaned off it. The patient's course was complicated by critical illness neuropathy from which he improved gradually. He was subsequently discharged after 14 days.

Discussion

The clinical spectrum of acute asthma ranges from the mild phenotype, which can be promptly controlled with the use of inhaled β2 agonists, to the severest form of status asthmaticus, requiring mechanical ventilatory support. It is estimated that 2–20% of ICU admissions may be due to severe asthma, out of which a third may require mechanical ventilation [1]. The mortality in such population of patients can range between 10 and 20% [2].

Pathophysiologically, asthma is characterized by bronchial smooth muscle contractions, inflammation of the

airway walls and secretions. As a result, significant airway flow limitation [3] leading to ventilation–perfusion mismatch occurs with hypoxaemia, and in more severe cases hypercarbia may develop. In life-threatening cases of status asthmaticus, mucus plugging may play a prominent role leading to luminal obstruction. The mucus plugging represents a mixture of cellular contents (inflammatory cells and denuded epithelial cells), mucus and protein exudates [4]. With increasing airway wall inflammation, there is more shedding of epithelial cells, resulting in increased sputum viscosity [5]. The thick mucus secretions increase the resistance of the airway leading to enhanced work of breathing and worsening ventilation–perfusion mismatch [5]. Furthermore, the layer of tenacious secretions adhering to the luminal wall can lead to ineffective delivery of inhaled medications and consequent poor response to treatment. As the secretions are sticky and adhere to the tracheobronchial tree, they may not be effectively removed by routine endotracheal tube suctioning. Fibreoptic bronchoscopy (FOB) provides an effective option to perform toileting under direct visualization and also to target the smaller airways that are out of the reach during Endotracheal (ET) suctioning, as well as to rule out alternative/coexistent conditions such as airway tumours. Although there have been some reports of use of these modalities in asthmatic patients on mechanical ventilation [6,7], it has not yet been incorporated in any guidelines dealing with asthmatic patients on mechanical ventilation [8,9].

Figure 5

High peak pressure in the ventilatory graph.

Figure 6

Postbronchoscopic toileting decreased peak pressure in the ventilatory graph.

Early reports have indicated about a possible role of FOB in bronchial asthma [6,7], but subsequently there has been a long hiatus where it has been largely ignored. Although Maggi *et al*. [11] had reported that FOB in children with acute asthma resulted in reduced length of ICU stay and reduced duration of mechanical ventilation, similar studies are lacking in the adult population.

We conducted a systematic review of the English literature over the last 20 years (1995–2015) pertaining to the use of FOB in adult patients with status asthmaticus on mechanical ventilation. The search terms were 'acute asthma', 'status asthmaticus', 'mechanical ventilation', 'intubation', 'bronchoscopy' and 'toileting' in various combination. The extensive search revealed only two similar instances where status asthmaticus adult patients benefitted from FOB-guided tracheobronchial toileting, the details of which has been outlined in Table 1. In all these patients, bronchoscopy was performed after all the conservative measures had been exhausted. It can be appreciated that in all the three patients there was significant improvement in the lung parameters and blood gases after bronchoscopy. This highlights the significant role of FOB as a salvage therapy in status

Table 1 Characteristics of the patients in whom bronchoscopic toileting was successful among cases of mechanically ventilated status asthmaticus patients

References	Age	Sex	Diagnosis	Associated conditions	Day of FOB	Effect of FOB on P_{peak}		Effect of FOB on P_{plat}		Effect of FOB on pCO_2	
						Pre	Post	Pre	Post	Pre	Post
Khan *et al*. [10]	36	Male	Acute asthma	Pneumonia	Third day	56	NA	NA	NA	75	45
Khan *et al*. [10]	43	Female	Acute asthma	Sepsis of unknown origin	NA	75	25	35	18	71	32
This study	23	Male	Acute asthma	–	Third day	82	35	28	20	90	52

In all the cases of postbronchoscopic toileting, there was a significant reduction in the airway pressures. FOB, fibreoptic bronchoscopy; NA, not applicable; pCO_2, partial pressure of carbon dioxide; P_{peak}, peak pressure; P_{plat}, plateau pressure.

asthmaticus patients not responding to standard therapy.

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Conflicts of interest
There are no conflicts of interest.

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