Significant Tracheal Obstruction Causing Failure to Wean in Patients Requiring Prolonged Mechanical Ventilation*

A Forgotten Complication of Long-term Mechanical Ventilation

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Introduction: Modern low-pressure, high-volume cuffed tracheostomy tubes have been shown to decrease tracheal injury. However, injury still occurs in patients requiring prolonged mechanical ventilation and prevents weaning, delays decannulation, prolongs hospitalization, and may totally obstruct the airway. We describe 37 patients, including the first reported case of failure to wean due to tracheal obstruction.

Methods: Over a 3-year period, from September 1994 to August 1997, the hospital records of 37 patients requiring prolonged mechanical ventilation (> 4 weeks) and found to have tracheal obstruction were reviewed retrospectively. They were a subgroup of 756 patients admitted to hospitals during the same period. The average endotracheal/tracheostomy cannulation time was 3 weeks/12 weeks (range 2 to 4 weeks/8 to 14 weeks). Average age was 76 years (range, 34 to 81). Underlying diseases included COPD, postcoronary artery bypass graft surgery, postpneumonectomy, severe pneumonia, acute lung injury, and ischemic heart disease.

Results: All 37 patients who initially failed to wean had difficulty in breathing and developed intermittent high peak airway pressures either early or during the weaning process or just on being ventilated. The insertion of a longer tracheal tube bypassed the obstruction, reestablished the airway, decreased peak airway pressures, and allowed the patient to breathe more easily. The obstruction was confirmed on bronchoscopy. Treatment consisted of either placement of a longer tracheal tube (34 of 37 patients) or placement of a tracheal stent. All but two of the patients (5.4%) were able to be weaned within a week. The two patients who still failed to be weaned were subsequently diagnosed as having amyotrophic lateral sclerosis.

Conclusion: Tracheal obstruction in patients requiring prolonged mechanical ventilation prevented weaning. Reestablishment of the airway with a longer tracheal tube or tracheal stent allowed most of the patients to be weaned.

Key words: bronchoscopy; failure to wean; granulation tissue; prolonged mechanical ventilation; respiratory insufficiency; tracheal disease; tracheal obstruction

Modern tracheostomy tubes have low-pressure, high-volume cuffs designed to decrease the tracheal injury occurring with prolonged use.1 Tracheal obstruction still occurs and may go unrecognized in patients requiring prolonged mechanical ventilation.2,3 This may be severe enough to prevent active weaning and to totally obstruct the airway. Since reporting the first such case in which the relief of the obstruction resulted in weaning from the ventilator,4 we have recognized 36 other patients. Failure to wean after following our weaning protocol,5 and one or more of the following—(1) rising peak airway pressures; (2) difficulty in passing the tracheal suction catheter; (3) difficulty in breathing; (4) sudden change in the weaning status (respiratory rate > 30 breaths/min, pulse rate or BP increase or decrease by 20% necessitating return to mechanical ventilation)—led us to investigate these patients. Recognition and relief of the obstruction allowed all but two of the patients to be weaned.
Materials and Methods

Patients

Over a 36 month period, from September 1994 to August 1997, the case records of 37 patients requiring prolonged mechanical ventilation (> 4 weeks) were reviewed retrospectively. This was a subgroup of 756 patients admitted to the James A. Haley Veterans Hospital, Tampa (FL) General Hospital, and Vencor Hospital Tampa for failure to wean. There were 23 women and 14 men. The average endotracheal/tracheotomy time was 3 weeks/12 weeks (range, 2 to 4 weeks/8 to 14 weeks). Average age was 76 years (range, 34 to 81). Major underlying diseases include COPD, postcoronary artery bypass graft, postpneumonectomy, severe pneumonia, various degrees of acute lung injury, and ischemic heart disease.

Weaning

On admission to the above hospitals, all the reversible causes of failure to wean were corrected.3,5,6 In those patients whose echocardiograms were abnormal or who exhibited signs and symptoms of congestive heart failure, therapy for cardiac failure was intensified. Weaning trials consisted of pressure support ventilation, intermittent mandatory ventilation, or cool air mask trials with and without the guidance of the Bicore (Cybermedics; Irving, CA).5 (This is a device that is capable of measuring and calculating the work of breathing, frequency time index, and rapid swallow breathing index by an esophageal balloon built into a nasogastric tube.) As previously reported, the patients were rested completely between weaning trials.3,5,6

Weaning was described as the ability of the patient to progress to the point at which he or she was not supported by the ventilator for 24 hours, the heart rate was between 60 to 100 beats/min, respiratory rate was between 10 and 25 breaths/min, and the BP was 100 to 150 mm Hg systolic and 45 to 95 mm Hg diastolic. The patients were not in any distress, in particular, there was no sweating or paradoxical breathing.3

Signs of failure to tolerate the weaning trials were tachycardia or bradycardia, high or low BP, high or low pulse rate, sweating, anxiety, and paradoxical breathing. This resulted in termination of the weaning trial. Full ventilator support was initiated and the weaning trials resumed the next day.3,5,6

Bronchoscopy Protocol

Following several failed weaning attempts, each patient underwent fiberoptic bronchoscopy as previously described.3 Briefly, a fiberoptic bronchoscope was introduced through the tracheotomy tube and the trachea was assessed. The tracheotomy tube was withdrawn as far out of the trachea as possible without losing the airway. The trachea was then inspected again. The bronchoscope was then withdrawn from the tracheotomy tube and inserted through the upper airway into the trachea from above. The entire trachea was inspected to detect significant obstruction.3

This study was retrospective and did not require institutional review board permission.

Results

All 37 patients presented with signs of failure to wean, intermittently high peak airway pressures, and difficulty in passing the suction catheter. Twenty-nine patients developed shortness of breath, uneasiness, and intermittent high peak airway pressures even in the absence of weaning trials. Twenty patients had a rise in peak airway pressures, 13 had difficulty in breathing, 14 had difficulty in passing the suction catheter, and 12 had a sudden change in their weaning status. These numbers add up to more than 37 as some patients had more than one symptom. One patient developed full cardiopulmonary arrest as the first presenting sign of tracheal obstruction.3 Insertion of a longer tracheotomy tube in the tracheal axis relieved the obstruction and allowed 35 patients to be weaned from the ventilator within 1 week. Three tracheal stents were placed. Two patients could not be weaned because they had subclinical neurologic disease subsequently diagnosed on electromyogram.

Discussion

Thirty-seven patients failed to wean from mechanical ventilation despite following our standard weaning protocol.3,5,6 They presented with signs and symptoms of tracheal obstruction. Despite the use of high-volume, low-pressure tracheal cuffs, damage still occurs to the tracheal mucosa.7–10 This injury includes tracheal stenosis, tracheomalacia, and granulation tissue formation (Fig 1). Rarer complications include tracheoesophageal and innominate artery fistula formation.7–10 Mucosal ulcers begin to form...
Figure 2. Top left, a: the normal tracheotomy tube in relation to the normal trachea. Bottom right, d: the “extra-long” tracheotomy tube for the obese patient. This is longer in the horizontal length. Bottom left, c: this reveals what happens to an extra-long tracheotomy tube if it is inserted into a normal trachea in an attempt to overcome an obstruction in the vertical length. Top right, b: this reveals the vertical extra-length placement of the correct tracheotomy tube that is usually custom made. A double-cuffed Portex (Keene, NH) can be used until the custom tube is available. Be aware that this cuff is a high-pressure low-volume cuff.
within a few days, coalesce, and become infected with bacteria.7–10 The mucosa and cartilage rings necrose, soften, fragment, and form a nonsupported scar.7–10

Major risk factors for the development of damage to the trachea include high-pressure low-volume cuffs. If a small tracheostomy or endotracheal tube is used, the cuff balloon has to be overinflated to prevent leakage. This changes the usual low-pressure high-volume cuff to a high-pressure cuff, increasing the incidence of tracheal damage.3 Failure to adequately secure the tracheotomy tube may also cause significant damage to the trachea.

In patients requiring prolonged mechanical ventilation, the prevalence of significant obstruction (> 50%) is 10%.3,7 This is despite tracheotomy tube placement and is usually diagnosed after successful weaning from mechanical ventilation but before tracheal tube decannulation.3 The obstruction will increase the work of breathing if it obstructs a significant proportion of the tracheal lumen. In this series, the prevalence of obstruction posttracheostomy tube was 4.9%. Early bronchoscopy confirmed the obstruction. Reestablishment of the airway with a longer tracheal tube or tracheal stent allowed most patients (94.6%) to be weaned. Because the patients weaned within a week (in a group who had taken at least 4 weeks to wean thus far), we believe that it was the relief of the obstruction that caused the weaning rather than the resolution of the underlying cause. All the known causes of failure to wean had been corrected.

The tracheal tubes that were inserted were longer in the tracheal length. The “extra long” tracheostomy tubes usually refer to the distance from the anterior tracheal wall to the skin surface, not in the superior/inferior length of the trachea. If this fact is not recognized, as the “extra long” tracheotomy tube is fully inserted, the angle of the tube changes. This may cause localized pain, tracheal damage, and further tracheostomy tube occlusion compounding the problem. The correct type of tracheal tube is essential (Fig 2).

In keeping with our study and other previous studies,3,4 there were many more female patients who had damage to their tracheas than male patients. The reason for this is unknown. We speculate that the female tracheal lumen is smaller than the male tracheal lumen and more susceptible to damage by the same-size tracheostomy tube.

In summary, we have found significant tracheal obstruction in patients requiring prolonged mechanical ventilation. This may prevent weaning and be severe enough to be life threatening. Most of these patients had localized lesions, but three (5.4%) had diffuse tracheomalacia requiring insertion of tracheal stents. These patients are mainly female and present classically with difficulty breathing and high peak airways pressures. The suction catheter may not be able to be inserted into the trachea. Occasionally failure to wean is the only symptom of this disease. Patients requiring prolonged mechanical ventilation who fail to wean should all undergo fiberoptic bronchoscopy.

REFERENCES