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Intraoperative herniation of a tracheostomy tube cuff

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Abstract
A case of intraoperative tracheostomy tube obstruction is reported. The clinical features and the chain of events leading to the diagnosis of cuff herniation are presented. The different mechanisms of herniation are discussed. In the present case we speculate that a manufacturing defect together with nitrous oxide diffusion into the cuff caused dilatation and herniation of the latter which led to obstruction of the distal tube lumen. We draw attention to this rare but life-threatening complication.

Key words: Tracheostomy; Airway obstruction

Introduction

The intraoperative enlargement of the endotracheal tube cuff is a rare event. The consequences of this condition may at times be life-threatening. This report deals with our recent experience with such a condition, where the intraoperative enlargement and eventual herniation of a tracheostomy tube cuff interfered with the patient's ventilation process. Awareness of this condition prevents catastrophic consequences.

Case report

A 32-year-old male was severely injured in a road accident. He was treated on the scene by a mobile intensive care team. An orotracheal intubation was performed. The patient was then transferred to the emergency room of our medical centre where he was found to be unconscious but haemodynamically stable.

Chest X-ray films and computed tomography (CT) of the brain were normal. CT of the facial bones revealed mandibular and bilateral maxillary fractures. The patient was then taken for surgical stabilization of his fractures.

Surgery under general anaesthesia started with a tracheostomy. A size 8, low pressure cuff, disposable tracheal cannula was inserted. Prior to insertion the cuff was checked for perforation by inflation. Ventilation and anaesthesia were continued through the cannula. About an hour later, airway pressure started to rise to 50–60 cm H_2O. This was followed by elevation of end-tidal CO_2 to 60–70 mmHg. Upon the assumption that the airway was plugged by bloody secretions, deep suction was performed through the tracheostomy cannula. After a transient normalization of signs, airway pressure rose again to 60 cm H_2O, end-tidal CO_2 rose to 70 mmHg and the pulse to 120 bpm. Oxygen was turned on to 100 per cent, halothane to 3.5 per cent and only manual ventilation could overcome the resistance. By that time surgery was stopped. The patient's chest seemed almost motionless while forcefully ventilated manually with a bag-valve. Auscultation of both lungs revealed only very weak inspiratory wheezing. Severe bronchospasm was diagnosed and treated with subcutaneous injection of 0.5 mg adrenaline and an intravenous dose of 500 mg hydrocortisone. A bolus dose of 250 mg theophylline was added. These measures failed to bring about the expected improvement.

Another trial of suction failed to yield material and it was speculated that a large blood clot was occluding the lower airways. Accordingly, bronchoscopy was indicated. The bronchoscopy was performed through the tracheostomy tube with a flexible fibreoptic endoscope. The airways distal to the carina were found to be normal and clear of secretions. By that time O_2 saturation had started to drop to 60 per cent. When the surgeon mentioned his difficulty during introduction of the endoscope through the cannula, it was decided that the cannula had to be removed and replaced. Immediately upon removal of the air from the cuff the chest relaxed. All the trapped air therein was exhaled. Airway pressure dropped to normal (20 mmHg), O_2 saturation rose to 100 per cent and the patient's vital signs normalized. The tracheostomy tube was then replaced by an endotracheal tube. Upon reinflation of the removed cannula cuff a large bulge was noticed on its side (Figure 1) confirming cuff herniation. The rest of the operation was uneventful. The patient awoke within a few hours following surgery with no neurological deficit.

Discussion

Intraoperative dilatation of the endotracheal tube cuff may occur as a result of a manufacturing defect, by diffusion of nitrous oxide into the cuff (Stanley *et al.*, 1974; Partridge, 1988), or by inadvertent overinflation. It is our experience that intracuff pressures of 30–35 mmHg may be reached under these circumstances. This may lead to inward herniation into the tube lumen in some tubes (Roland and Stovner, 1975; Dorsch and Dorsch, 1984) or asymmetrical distention of the cuff balloon causing the end of the endotracheal tube to abut against the tracheal wall (Davidson and Zimmer, 1989). The cuff balloon may also protrude and herniate over the distal opening of the tube (Figure 2) (Dorsch and Dorsch, 1984; Patterson and Keane, 1990; Viallard *et al.*, 1990).

In the present case, when all routine procedures failed to ameliorate ventilation the tracheostomy cannula was removed and replaced by an endotracheal tube. Immediately, ventilation of the lungs became normal. Upon reinflation of the removed cannula cuff, herniation was detected. The cause of the ventilatory problem was obviously mechanical in nature. A herniated cuff had partly occluded the distal end of the tracheal cannula. This obstruction most probably created a one-way

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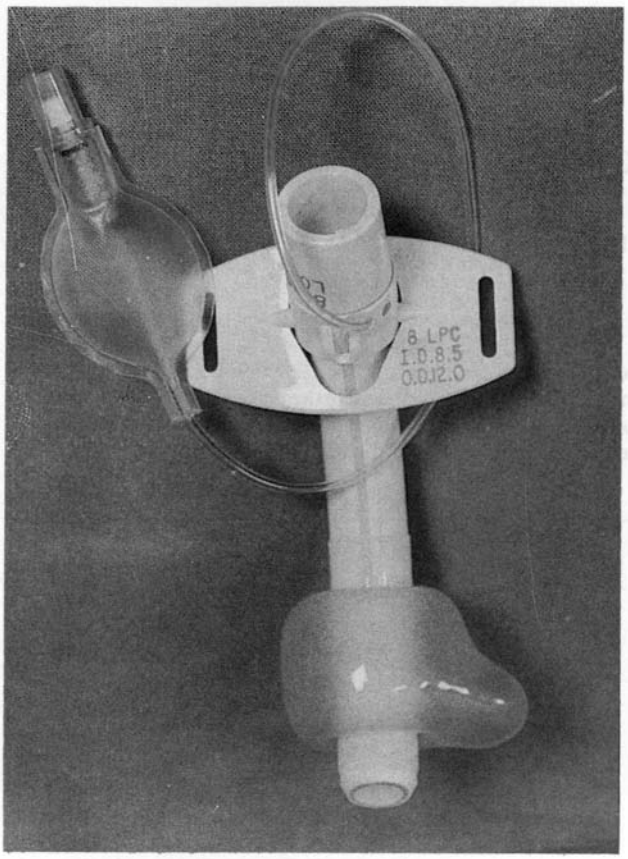

FIG. 1
Asymmetrical dilatation of the tracheostomy tube cuff.

check valve mechanism which at the beginning enabled inspiratory ventilation but prevented exhalation of air. As the lungs distended to their full capacity no more air could be forced into them, and ventilation could no longer be performed. Further forceful ventilation of the lungs would have led to a tension pneumothorax with dire consequences.

Although such an obstructive process has been previously described in low pressure cuffed endotracheal tubes, it possibly has never been reported until now with the use of cuffed tracheostomy cannulae. We report this case to alert physicians to the possibility that cuff herniation may occur with tracheostomy tubes and that awareness of this may prevent catastrophic consequences.

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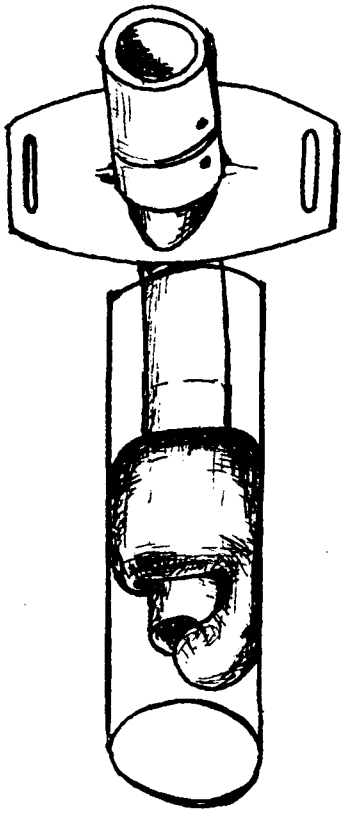

FIG. 2
Proposed mechanism of herniation and obstruction of the distal end of the tracheostomy cannula.

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