Subglottic Stenosis following prolonged endotracheal intubation in the Intensive Care Unit: Two Case Studies and a review of the literature

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ABSTRACT

Subglottic stenosis secondary to prolonged endotracheal intubation is associated with severe airway obstruction and a subsequent increase in morbidity in intubated patients. It is a recognized, although preventable, complication of prolonged endotracheal intubation. Here, we describe two cases of subglottic stenosis following prolonged endotracheal intubation in the intensive care unit, followed by a review of the literature on iatrogenic subglottic stenosis.

From our two cases, we identified three factors that contributed to the development of subglottic stenosis in intubated patients. These factors include (1) prolonged endotracheal intubation of more than 12 days, (2) the use of cuffed endotracheal tubes, and (3) younger age.

We conclude that it is therefore imperative to consider these factors when performing endotracheal intubation on patients admitted to the intensive care unit.

INTRODUCTION

Subglottic stenosis secondary to endotracheal intubation is associated with severe airway obstruction and an increase in morbidity in intubated patients. It is a recognized, although preventable, complication of prolonged intubation [1]. The incidence of subglottic or tracheal stenosis following prolonged endotracheal intubation ranges from 6-21% [2-4]. More recently Schweiger and colleagues reported an incidence of post-intubation subglottic stenosis 11.38% among children [5].

Tracheal stenosis following prolonged endotracheal intubation is said to occur commonly at the area of contact of the cuff of the tube and the wall of the trachea [5].

Vogelhut [6] defined prolonged intubation as intubation in excess of seven days. Other authors have offered different definitions of what should be considered "prolonged" intubation. Santos [7] provided longer than three days of endotracheal intubation as qualifying as prolonged intubation. No matter the definition, it is quite apparent that extended periods of endotracheal intubation can cause serious complications. Astrachan [8] observed that complications were four times more likely to occur following endotracheal intubation than following tracheostomy. Among these complications of endotracheal intubation was subglottic stenosis. As the length of the period of intubation increased, the incidence of subglottic stenosis also increased.

We describe two cases of subglottic stenosis following prolonged endotracheal intubation in the intensive care unit.

CASE REPORTS

1. OV, a 16-year-old male

The patient presented with severe tetanus following a broomstick injury and was admitted into the Intensive Care unit (ICU) three days after being managed in the paediatric ward. He was subsequently intubated with a cuffed, size 7mm internal diameter polyvinyl chloride (PVC) endotracheal tube and mechanically ventilated. After 14 days of endotracheal intubation an elective tracheostomy was performed on account of prolonged intubation. He was successfully weaned off mechanical ventilation after 21 days, and later discharged to the ward with the tracheostomy in situ, having spent 49 days in the ICU. Several attempts at decannulation failed as he developed severe airway obstruction. As a result, the patient was discharged home with the tracheostomy tube in place after spending 83 days in the hospital. He was given an appointment one week later at the outpatient Ear, Nose and Throat (ENT) clinic.

An X-ray of the soft tissue of the neck revealed a soft tissue shadow at the sub-glottic region and above the tracheostomy tube (Figure 1). Flexible laryngoscopy revealed bulbous arytenoids and a fleshy mass below the vocal cords, which completely obliterated the subglottis and the superior aspect of the trachea. The vocal cords were freely mobile. A CT-scan of the neck could not be obtained due to financial constraints on the part of the patient. Surgical decannulation with dilatation with bougienage under general anaesthesia was successfully carried out and he was discharged home. He has been seen in the outpatient clinic and remains in good health.

Figure 1: Subglottic stenosis with a tracheostomy tube in place

2. EC, a 12-year-old female

This patient suffered severe traumatic brain injury following a road traffic accident (RTA). She was admitted to the intensive care unit for airway management and ventilatory support with a Glasgow coma score (GCS) of 7/15. Eye opening was 1, best verbal response was 2, and best motor response was 4. She was intubated with a size 6.5mm internal diameter cuffed PVC endotracheal tube which remained in place for 12 days after which she was offered tracheostomy.

Decannulation was attempted 13 days post-tracheostomy, but failed due to signs and symptoms of severe airway obstruction. Flexible fiberoptic laryngoscopy done approximately one week later revealed a normal glottic opening, and normal epiglottis, piriform fossae and arytenoids. She was scheduled for surgical decannulation under general anaesthesia.

Surgical findings showed a short stenotic segment just above the tracheostomy opening. The fibrotic tissue was treated with bougienage of the stenotic portion. She was decannulated and a PVS orotracheal tube, size 6mm was passed. She was then transferred to the ICU for close monitoring for 48 hours. She was subsequently successfully extubated and discharged from the ICU. Three days after being discharged from the ICU she redeveloped airway obstruction and had a reinsertion of the tracheostomy tube. She was then referred for laser excision of the subglottic stenosis at another facility.

DISCUSSION

The management of severe tetanus and severe traumatic brain injury, as well as numerous other diseases and processes, often involves endotracheal intubation for airway maintenance and ventilatory support. At a University Referral Hospital in Kigali, 82% of patients treated for various motorcycle related injuries had head injuries and fractures many of who required endotracheal intubation [9]. Although endotracheal intubation may be life saving for a majority of patients, prolonged endotracheal intubation is often complicated by subglottic or tracheal stenosis. Pressure injury to the trachea resulting from the presence of an endotracheal tube in the airway can lead to severe scarring and subsequent airway obstruction [6].

Development of tracheal stenosis following endotracheal intubation is correlated with the duration of intubation. As the duration of tracheal intubation increases, so does the risk of tracheal stenosis developing. Supance [10] developed a canine model of subglottic stenosis and found that dogs intubated for longer than 14 days had a 40% to 50% reduction of the subglottic lumen secondary to maturing fibrotic stenosis. Dogs intubated for 7 days or less showed no signs of tracheal stenosis. This occurs because prolonged intubation entails increased contact time between the endotracheal tube and the tracheal mucosa. This contact leads to the development of inflammation and tissue reaction. The two patients presented above were intubated for between 12 and 14 days before tracheostomy was performed.

Another important consideration in the development of subglottic stenosis is the age of the patient. It is likely that the nature of the airway of paediatric patients (being soft and still maturing) contribute to the development of subglottic stenosis following prolonged endotracheal intubation. Despite this, the significance of the anatomical differences between the adult and paediatric airway has been a subject of interest in recent times. Our patients were aged 16 and 12 years respectively.

The type of endotracheal tube (cuffed or uncuffed) used for intubation is another factor in the development of tracheal stenosis. Tracheal stenosis occurs most frequently at the level of the cuff of the endotracheal tube [8]. As a result of this observation, endotracheal tubes with large volume and low-pressure cuffs have been advocated for the reduction of pressure injury secondary to endotracheal tube cuffs [11]. High volume, low pressure cuffed endotracheal tubes provide a large area of contact between the cuff and the airway mucosa to prevent excessive pressure on any single location of the trachea. Even so, cuff pressure that exceeds 30mmHg pressure may lead to ischaemia and ulceration, leading to fibrotic healing and eventual stenosis. In our patients, the endotracheal tubes used were cuffed and the cuff pressures were not monitored. This may have contributed to the subglottic stenosis that we observed in our patients. In younger children less than eight years, uncuffed endotracheal tubes have traditionally been more commonly used [12]. This is because, the smallest diameter of a child's airway is the cricoid ring and an appropriately sized tube forms a complete seal. In addition, the use of cuffed tubes in children has been found to increase the risk of tracheal mucosal injury [13]. Despite the use of uncuffed tubes in children, the incidence of subglottic stenosis is still unacceptably high [5]. Other factors may thus contribute to the incidence of subglottic stenosis in this age group.

Tracheal stenosis following prolonged endotracheal intubation may manifest with signs of airway obstruction such as wheezing and stridor after extubation. It has been documented that post-intubation tracheal stenosis is often misdiagnosed as asthma in as many as 44% of cases [14]. The clinical manifestation of tracheal stenosis after intubation depends on the severity of the stenosis. Severity of tracheal stenosis has been classified as mild if less than 50% of the tracheal lumen is obstructed, moderate if obstruction is between 50-90%, and severe if more than 90% of the lumen is obstructed [15]. Patients with mild tracheal stenosis usually remain asymptomatic.

Bronchoscopy is the mainstay of diagnosis of post-intubation tracheal stenosis. Computer tomography (CT) will reveal the exact location and extent of the stenosis. Chest X-ray (CXR) may be performed but rarely detects stenosis. Direct laryngoscopy and bronchoscopy was performed for our patients under general anaesthesia, which revealed subglottic stenosis in both cases. Freitag [16] developed a classification scheme for the categorization of tracheobronchial stenosis. In this classification, post-intubation tracheal stenosis is classified as type 4 stenosis. This is important as it determines the type of treatment options available and its outcome. For type 4 stenosis for example, treatment options may include tracheal resection and reconstruction and stent implantation [17].

There are many options for the treatment of tracheal stenosis following prolonged endotracheal intubation. In a review of 32 consecutive patients with post-intubation tracheal stenosis, Brichet [17] proposed rigid bronchoscopy with laser resection or stent implantation as the management of choice. The authors reported that laser resection cured 66% of tracheal stenosis patients, while stents were inserted for the remaining patients. Another method of managing tracheal stenosis is balloon bronchoplasty. This can be done either with rigid or flexible bronchoscopy. The efficacy and safety of balloon bronchoplasty was evaluated in 26 patients in a 2007 study conducted by Freitag et al [16]. They reported a success rate of 100% when balloon dilation was used as part of a multimodal approach to the management of tracheal stenosis. As there were no adverse events reported, they concluded that balloon bronchoscopy is an effective and safe way to manage tracheal stenosis. Bougienage was carried out at our center instead because balloon bronchoplasty was not available.

CONCLUSION

We identified three factors contributing to the development of subglottic stenosis. These factors are: (1) prolonged endotracheal intubation (which we define as more than twelve days), (2) the use of cuffed endotracheal tubes, and (3) younger age. In order to prevent tracheal stenosis.

It is therefore imperative to consider these factors when performing endotracheal intubation on patients admitted to the intensive care unit. The avoidance of cuffed endotracheal tubes, monitoring of cuff pressure in intubated patients and early elective tracheostomy for patients suspected to required prolonged intubation are some ways to prevent subglottic stenosis.

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