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Case Report / Olgu Sunumu

Tracheal stenosis and reconstructive surgery: Our experience on anesthesia and airway management

Trakeal darlık ve rekonstrüktif cerrahi: Anestezi ve havayolu yönetimindeki deneyimimiz

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ABSTRACT

Tracheal stenosis is an important clinical problem. Several treatment modalities are being used such as tracheal dilatation, laser surgery, surgical resection, and reconstruction. Surgery of the trachea is a special endeavor where the airway is shared by the surgeon and the anesthesiologist. In this article, we discussed the various methods of anesthesia and airway management in three cases who developed tracheal stenosis secondary to prolonged intubation in intensive care and were performed tracheal dilation, laser surgery, resection, and end-to-end anastomosis.

Keywords: Airway management, prolonged intubation, tracheal resection and reconstruction, tracheal stenosis.

ÖZ

Trakeal darlık önemli bir klinik sorundur. Trakeal dilatasyon, lazer cerrahisi, cerrahi rezeksiyon ve rekonstrüksiyon gibi çeşitli tedavi yöntemleri kullanılmaktadır. Trakea cerrahisi, hava yolunun cerrah ve anestezist tarafından paylaşıldığı, özel bir çabadır. Bu yazıda, yoğun bakımda uzamış entübasyona ikincil olarak trakeal darlık gelişen ve trakeal dilatasyon, lazer cerrahisi, rezeksiyon ve uç-uca anastomoz uygulanan üç olgudaki çeşitli anestezi yöntemleri ve havayolu yönetimi tartışıldı.

Anahtar Sözcükler: Havayolu yönetimi; uzamış entübasyon; trakeal rezeksiyon ve rekonstrüksiyon; trakeal darlık.

Laryngotracheal stenosis develops when scar tissue grows in the trachea and rarely, in the larynx itself. Despite progress in intensive care unit airway maintenance, the incidence of tracheal stenosis from prolonged intubation or tracheostomy can still reach up to 21%. Symptoms depend on the degree of airway obstruction and can range from an asymptomatic state to severe respiratory problems.[1,2] Several treatment modalities have been used but resection of the stenotic segment and reconstruction with end-to-end anastomosis has become the standard surgical care.[3,4]

Surgery of the trachea is a special situation where the airway is shared by the surgeon and anesthesiologist. Securing the airway and maintaining oxygenation and ventilation throughout the procedure can be challenging during tracheal

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surgery. With written informed consents, we discuss our experience with various methods of anesthesia and airway management in three patients who developed tracheal stenosis secondary to prolonged intubation in the intensive care unit (ICU) and underwent segmental resection and end-to-end anastomosis.

CASE REPORT

Case 1- A 45-year-old man with maxillofacial and cranial trauma was admitted to the ICU and percutaneous tracheostomy was performed in the course of treatment after a prolonged intubation period. Although the patient was successfully weaned from mechanical ventilation, severe inspiratory difficulty occurred following multiple decannulation trials. Computed tomography revealed granulation tissue formation around the tracheal stoma obstructing 70% of the lumen. The stenotic area was confirmed by rigid bronchoscopy. Circumferential tracheal resection with end-to-end anastomosis was planned. After standard monitoring including radial artery cannula and anesthetic induction consisting of propofol, fentanyl and rocuronium, the airway was secured using a flexible 7.0-mm internal diameter (ID) reinforced, cuffed endotracheal tube through the tracheotomy. A second oro-tracheal upper tube charged with a high frequency jet ventilation (HFJV) catheter was placed with the tip just below the vocal folds. Maintenance of anesthesia at this stage was provided by sevoflurane inhalation, remifentanil infusion and additional rocuronium doses.

The larynx was reached with blunt dissection and an hourglass-shaped circular stricture was seen along the four tracheal cartilages. A tracheal resection that included five tracheal rings was performed. During anastomosis, once all the sutures were in place at the upper posterior membrane, the distal endotracheal tube was removed and a 4-mm diameter 40-cm long HFJV catheter was advanced through the upper endotracheal tube beyond the anastomosis, passed into the distal trachea and fixed in the infraglottic position. The proper position of the subglottic catheter was checked by bilateral presence of typical jet ventilation sounds. The HFJV parameters were adjusted as driving pressure (DP): 1.3 bars, inspiration duration (IT): 50%, fraction of inspired oxygen (FiO_2): 0.8 and frequency: 130/min. Upon detection of a drop of oxygen saturation to 94% at the 15th minute of the procedure, DP was augmented to 1.4 bars, and IT was increased to 60%. During HFJV, $ETCO_2$ (End-Tidal CO_2) monitored by the sampling line of the jet ventilator (Monsoon, Acutronic Medical Systems AG Hirzel, Switzerland) adapted via a Y connector to the ventilation catheter. The targeted $ETCO_2$ range was between 35-45 mmHg during this period and adjusted by manipulating jet ventilation settings (RR and DP). Oxygen saturation remained at levels of 97-98% and the end-to-end anastomosis was terminated in 35-minutes. Anesthesia was maintained intravenously with propofol and remifentanyl infusion during the jet ventilation period. The HFJV catheter was withdrawn upon completion of the anastomosis and the upper endotracheal tube was advanced into proper position (Figure 1). At the end of surgery a suture was applied between the chin and anterior chest, to fix the patient's head in a flexed position. The patient was then transferred to the ICU while orotracheally intubated. After four hours of mechanical ventilation he was successfully extubated and discharged to the inpatient clinic the day after. The mechanical ventilation was performed by pressure controlled mode then transformed to pressure support ventilation upon commencement of patient's ventilatory efforts. The airway pressures were limited to 20 and 5 cm H_2O respectively for peak inspiratory and end expiratory pressures during mechanical ventilation.

Case 2- A 36-year-old man with previous ICU history due to a septic state underwent percutaneous tracheostomy following long-term intubation. Respiratory distress occurred after decannulation due to a 1-cm stenotic segment at the suprasternal level that was diagnosed by bronchoscopy. Resection of the stenotic segment followed by end-to-end anastomosis was planned. Standard anesthesia induction (propofol, fentanyl, rocuronium) was performed after monitoring (radial artery cannulation added to standard monitoring) as described in the first case. The airway was secured using a flexible 7.0 mm ID, reinforced, cuffed endotracheal tube through the tracheotomy. Maintenance of anesthesia was provided by sevoflurane inhalation, remifentanil infusion and additional rocuronium doses. The second orotracheal tube charged with a HFJV catheter was inserted and positioned as described in the first case.

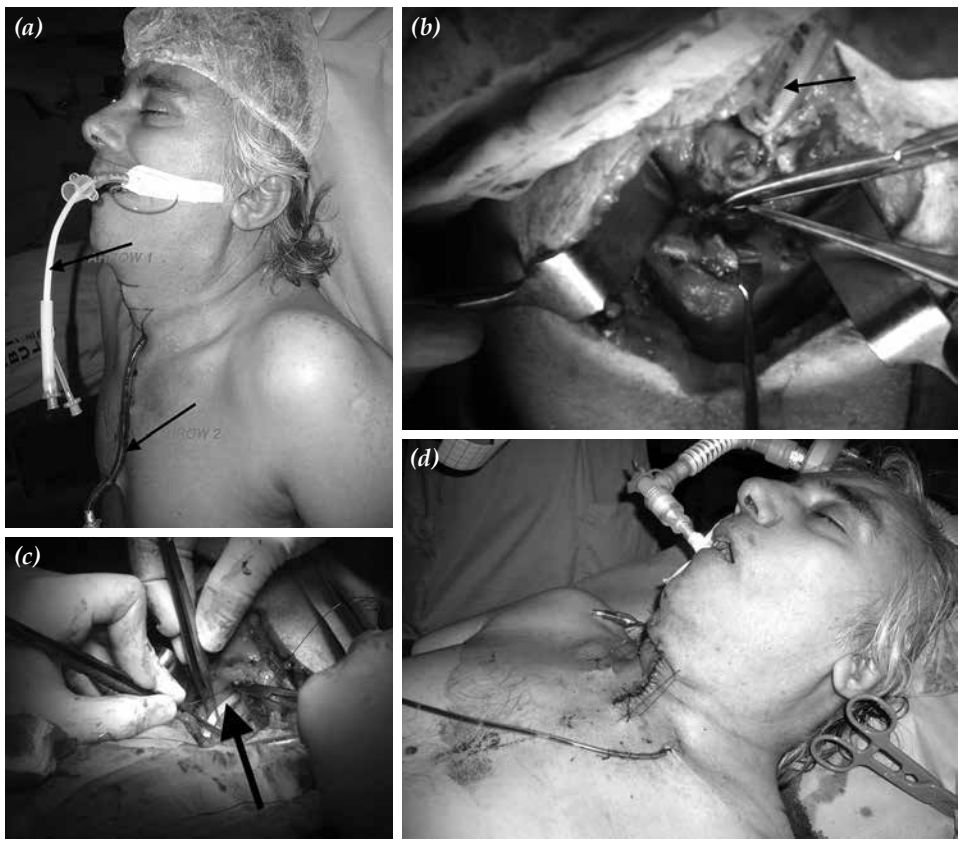

Figure 1. ***(a)*** *High frequency jet ventilation catheter inserted through the upper endotracheal tube (arrow 1) and a flexible spiral-wire-reinforced endotracheal tube through tracheostomy (arrow 2).* ***(b)*** *Conventional ventilation via distal endotracheal tube (arrow) during surgical dissection.* ***(c)*** *High frequency jet ventilation via infraglottic catheter (arrow) during tracheal anastomosis.* ***(d)*** *The high frequency jet ventilation catheter was withdrawn with the completion of the anastomosis and upper endotracheal tube was advanced into the proper position.*

During the course of surgery, a 2 cm tracheal resection that began at the first tracheal ring was performed and rest of the trachea was anastomosed to the cricoid cartilage. Throughout the resection and anastomosis, gas exchange was provided by the HFJV through a catheter in the orotracheal tube, extended to the infraglottic area. Jet ventilation was started after standard initial settings (driving pressure (DP): 1.3 bars, inspiration duration (IT): 50%, FiO_2: 0.8 and frequency: 130/min) were revised (FiO_2: 1; DP augmentation up to 2 bars, IT prolongation up to 60%) after a decline of oxygen saturation till 92% at the 10^{th} minute. Despite these adjustments, oxygenation persisted outside of acceptable limits (SpO_2 85-90%) and HFJV was terminated. Cross-field ventilation was started with a sterile 7.0 mm ID, reinforced, cuffed endotracheal tube through the distal trachea and connected to a sterile ventilation circuit. The patient's saturation was ameliorated and remained around 98% during the procedure. The patient was extubated in the operating room at the end of the procedure after suturing the chin to the manubrium sterni to secure the neck in flexion. On the second postoperative day, the patient was discharged from the ICU to the ward.

Case 3- A 70-year-old man who presented with hoarseness was scheduled for surgery upon detection of a thyroid tumor with tracheal invasion. Tracheal resection from the lower margin of the cricoid cartilage to the fifth tracheal ring and anastomosis of the resected ends combined with a total thyroidectomy and paratracheal lymph node dissection was planned. After standard monitoring including electrocardiogram, pulse oximetry, and arterial blood

pressure, anesthetic induction was performed with propofol 2.5 mg/kg and fentanyl 1 mg/kg. The patient was intubated after mivacurium injection (0.5 mg/kg) using a 7.5 ID, flexible, reinforced tube equipped with a neural integrity monitor system (Medtronic Inc., Minneapolis, Minnesota, USA). Anesthesia was maintained by sevoflurane inhalation, remifentanil infusion and additional mivacurium doses if required in a manner to allow recurrent laryngeal nerve monitoring. Following planned tracheal resection, HFJV was commenced with an infra-glottic catheter placed through the upper oro-tracheal intubation tube for the purpose of maintaining gas exchange during anastomosis. The HFJV parameters were adjusted as driving pressure (DP): 1.3 bars, inspiration duration (IT): 50%, FiO_2: 0.8 and frequency: 130/min. Due to persisting arterial desaturation despite modification of the HFJV parameters (DP): 1.6 bars, inspiration duration (IT): 60%, FiO_2: 1), cross-field ventilation with a 6.0 ID sterile standard endotracheal tube through a distal airway replaced the HFJV. During anastomosis of the posterior tracheal wall, the distal tube was periodically removed to allow better visualization and apneic episodes were applied. These sessions comprised an apneic period after 3-4 minutes of a hyperoxic hyperventilation maneuver that lasted till the patient's saturation dropped to 90%. The cross-field ventilation was terminated after completion of posterior wall suturing and the upper oro-tracheal tube was re-advanced to resume conventional ventilation. Sutures were placed between the chin and the anterior chest to secure head flexion. The patient was transferred to the ICU and was extubated at the fourth postoperative hour and discharged to the surgical ward the day after.

DISCUSSION

The principal anesthetic priority during tracheal surgery is the maintenance of adequate ventilation and oxygenation without obstructing surgical visualization. Ventilation during tracheal procedures can be managed through different ways, including high frequency jet ventilation, high frequency oscillation, cross-field ventilation via distal tracheal tube and intermittent apneic oxygenation. Two other extreme methods that could be considered beyond these techniques are extracorporeal gas exchange or tracheal resection under local anesthesia while the patient breathes spontaneously.[5-7]

The standard approach to ventilation in our institution during all endolaryngeal minor surgery is to perform HFJV via a subglottic catheter. Based on this experience, we preferred HFJV in tracheal surgery especially during the posterior wall anastomosis of the resected tracheal ends to provide a spacious area for surgeons.[8,9] Using this technique, anatomical structures are better visualized due to the thin catheter within the airway and the surgical area becomes more comfortable. The first two cases presented here were previously tracheostomized and at the beginning of surgery conventional ventilation was performed by tracheostomy. Additionally, an upper tracheal tube charged with an HFJV catheter was placed orally. During the procedure these three different routes (upper endotracheal tube, HFJV catheter, tracheostomy) and three techniques (conventional ventilation, HFJV, cross-field ventilation) were applied in an alternating manner to optimize surgical conditions.[10]

Gas exchange failure (hypercapnia and hypoxia) during HFJV is common as reported previously and can limit its use despite the transient character of these complications.[11] Although hypercapnia was stated as the most frequent complication of the method, we did not observe any problem regarding CO_2 retention during HFJV. We were obligated to discontinue HFJV and switch to other ventilation modalities in our two patients because of hypoxia. Hypoxia during HFJV can be caused by endobronchial placement of the catheter tip, air entrainment, or by previous parenchymal lung disease. We believe that in our two patients in whom HFJV failed the cause was multifactorial including all aforementioned conditions.

Cross-field ventilation is a well-known method of tracheal surgery that is frequently used owing to its simplicity. However, the presence of the tube within the distal tracheal lumen complicates surgery and stitching becomes difficult, especially when passing sutures from the posterior tracheal wall. Intermittent apneic periods can be used to overcome this issue. We used this approach in our third case and the posterior wall anastomosis was performed during those apneic periods. In order to avoid hypoxia and hypercarbia, patients were "prepared" before every

apneic period with three minutes of hyperoxic hyperventilation.

Long-term ventilatory support after tracheal surgery is not usually required; on the contrary early extubation is desirable to avoid the risks carried by mechanical ventilation. The presence of a cuffed endotracheal tube and cyclic positive airway pressure during mechanical ventilation are both considerable threats for a newly anastomosed trachea. Given these considerations, we aimed to extubate our patients as soon as possible after surgery. We were able to extubate patient number 2 in the operating room at the end of surgery; the two remaining patients received mechanical ventilation for a short period until full recovery.

In conclusion, tracheal resection and reconstruction is a real challenge in the operating room. The anesthesiologist should be competent with different methods of securing the airway and maintaining gas exchange during surgery. Communication between the surgeon and anesthesiologist is also very important. The HFJV technique may be preferred because it provides safe airway management and appropriate working conditions for the surgeon. However, anesthesiologists need to be able to modify the strategy and switch to alternative methods.

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