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Challenges in the management of acquired tracheal stenosis: a case report

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Nowadays intubation is thought to be a safe, routine and life-saving procedure. Prolonged endotracheal intubation can result in fibrin deposits and predispose to the development of tracheal stenosis. The most common site for the occurrence of intubation-induced tracheal damage is at the area in contact with the inflatable cuff. We demonstrate the case report that such injuries may lead to serious complications such as tracheal and laryngeal stenosis. The treatment is quite difficult and associated with significant risk and complications.

Key words: tracheal stenosis, subglottic stenosis, tracheostomy, stridor, rigid bronchoscopy, high frequency jet ventilation

INTRODUCTION

There could be many and various causes of tracheal stenosis. In pedriatric patients, congenital airway anomalies dominate. On the other hand, in adults, malignant neoplasms of the respiratory tract are the most common causes of stenosis. Importantly, a diagnosis should be made after assessing other causes, such as prolonged intubation, tracheostomy, chemical burns, or external trauma with laryngotracheal fracture, equally, idiopathic laryngotracheal stenosis (ITS), which is an uncommon condition characterized by a nonspecific inflammation of the mucus membrane (1). ITS is usually located in the upper third of the trachea (2). Rarer causes, such as Wegener's granulomatosis, collagenosis, sarcoidosis, tuberculosis, and chronic atrophic polychondritis, should be considered (3–5).

The mean processes that lead to tracheal stenosis are ulceration of mucosa and cartilage, formation of granulation tissue, development of the fibrous tissue. The process of ulcer convalescence induces regeneration of the epithelium. Then the regenerated epithelium fails to cover the granulation tissue, the growth of the granulation tissue becomes exaggerated, finally leading to contraction of the fibrous scar tissue. What is more, increased pressure in the endotracheal tube cuff or a direct contact with the endotracheal tube could raise the capillary perfusion pressure which is an important factor of mucosal injury. Cases of tracheal stenosis are infrequently reported, there are even fewer published reports of a successful management of tracheal stenosis. A description of the clinical presentation of tracheal stenosis most commonly could be concise: dyspnea (100%), stridor (35%) (6).

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Freitag and colleagues proposed the classification of tracheal stenoses. It involves structural and dynamic stenosis (7). Structural stenosis occurs due to all types of exophytic intraluminal malignant or benign tumors and granulation tissue; extrinsic compression; narrowing due to airway distortion, kinking, bending, or buckling; and shrinking or scarring (e. g. postintubation stenosis). Dynamic (functional) stenosis includes triangular-shaped or tent-shaped airway, in which cartilage is damaged, as well as inward bulging of the floppy posterior membrane (8). The location of the stenosis could be divided into 3 regions: upper one third, middle one third and lower one third of the trachea.

The gold standard for detection, valuation of tracheal stenosis is bronchoscopy. On the other hand, bronchoscopy could cause serious complications such as oxygen desaturation, cardiac arrhytmias, tachycardia, endoscopy-induced inflammation. Plain AP, lateral chest radiographs, CT scanning may be performed (9–13). In addition, stenosis quantification by bronchoscopy and CT scan are highly correlated (R^2 = 0.97, p = 0.005) (9). Generally, when the patient has an extreme tracheal stenosis, surgery and an airway management are very difficult and require extraordinary anesthetic techniques.

Case report

A 31-year-old woman was hospitalized at the Pulmonology Unit with tracheal and laryngeal stenosis. The patient had been complaining of respiratory difficulties and dyspnoea for three months. She had a past history of diabetes mellitus type 1 and six months ago she was treated for hyperglycemic coma in an intensive care unit. She underwent endotracheal intubation due to the decreased mental ability caused by diabetic ketoacidosis and respiratory failure caused by hydrothorax and pneumonia. The patient was placed on artificial ventilation with oral endotracheal intubation. The woman experienced multiple re-intubations because of persistent stridor. Tracheostomy was performed two weeks later. After that, her respiration recovered, and the woman was able to breath normally through a tracheostomal tube. After eliminating the tube, stridor strengthened and she was discharged one month later with the tube, but with no respiratory difficulty symptoms. Four months after discharge, she was admitted to our hospital because of a progressive difficulty in breathing during the last three months. The patient was diagnosed with paresis of vocal cords after the examination by an ENT surgeon, and fiberoptic bronchoscopy revealed severe tracheal stenosis below the tracheostomal tube. A computed tomographic scan showed that the diameter of stenosed trachea was ~5 mm, the length of stenosis was about 1.0–2.0 cm (Fig. 1) and the distance from the carina was ~4 cm. The second stenosis was observed below the vocal cords (Fig. 2).

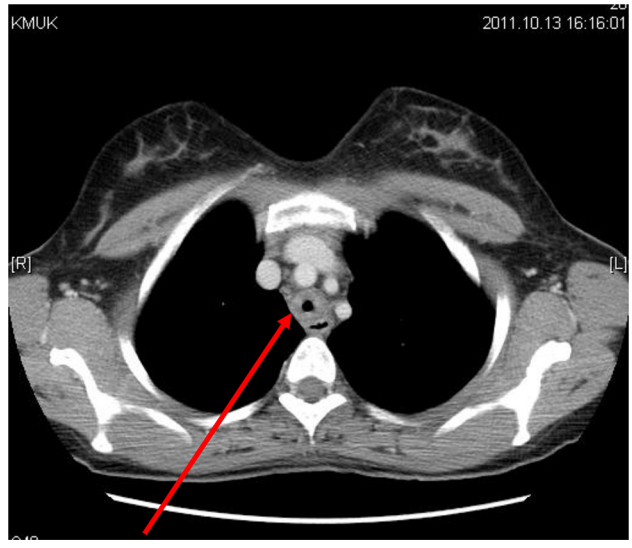

Fig. 1. The diameter of the stenosed trachea was ~5 mm, the length of stenosis was about 1.0–2.0 cm

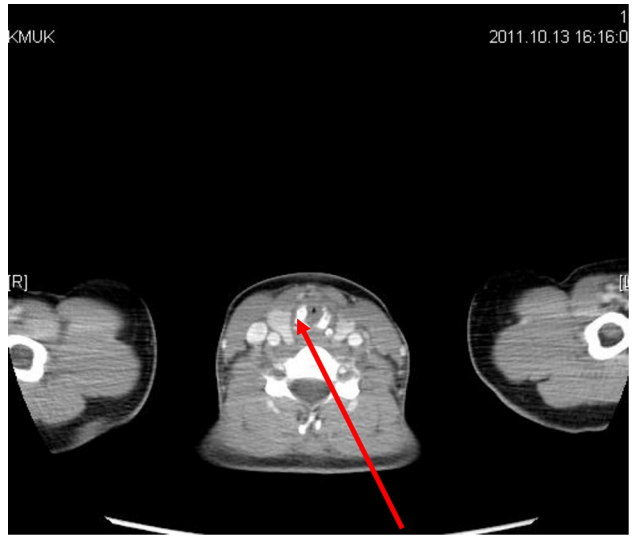

Fig. 2. Severe subglottic obstruction observed below the vocal cords

The patient underwent a pre-operative assessment, including physical examination and routine laboratory tests, which did not indicate any abnormal rates. The woman was conscious with stable heart and respiratory functions and was breathing through the tracheostomal tube. The saturation level was 96%, without oxygen supplement.

Diagnosis: Laryngeal Stenosis. Tracheal Stenosis. Tracheostoma. Diabetes Mellitus Type 1.

Double stenosis was characterized as severe (Fig. 3) and after the consultation with specalists it was decided to perform rigid bronchoscopy and implant a T-shaped stent under general anesthesia. The possible risks of the procedure were explained to the patient. The woman consented to the procedure.

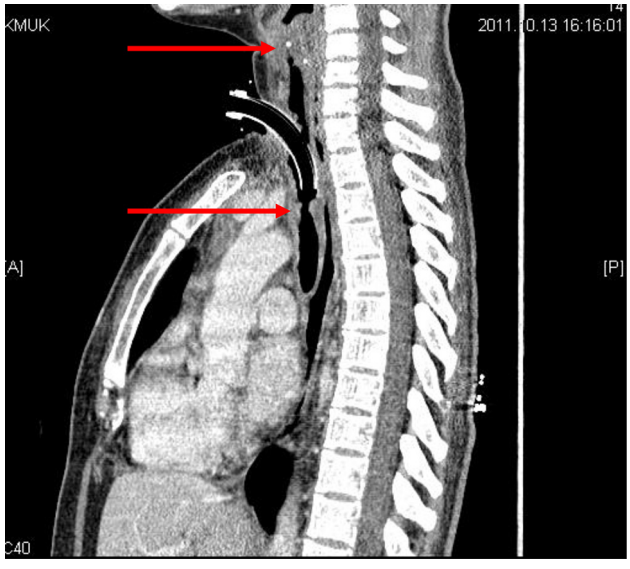

Fig. 3. Severe double stenosis

After the arrival to the operating theatre, an ENT surgeon inserted tracheostomal tube No. 7.5 with a cuff. General anesthesia was induced with fentanyl 0.05 mg, midazolam 3 mg, dexamethasone 8 mg. The patient was connected to the anesthesia machine and sevoflurane ~1 MAC and oxygen 50% were started to deliver. Breathing was adequate, tidal volume range was between 350–400 ml, expired carbon dioxide concentration was about 38 mmHg, blood oxygen saturation was 100%. When we were assured that the artificial ventilation through the stenosed trachea was undergoing smoothly, we started the administration of muscle relaxants. Succinylcholine IV 170 mg was administered. The bronchologist used electrocautery and rigid bronchoscope No. 6.5–7.5–8.5. He dilated subglottic stenosis and reached ~2 cm tracheal diameter. Anesthesia maintenance was performed with sevoflurane 1 MAC, fentanyl 0.25 mg, succinylcholine 30 mg × 2. No ventilation problems were observed. The duration of the procedure was 2.5 h. The second step was the dilating of lower stenosis. The tracheostomal tube was removed and high frequency jet ventilation was started. Electrocautery and rigid bronchoscopes No. 6.5–7.5 dilated lower stenosis and the T-shaped stent was adjusted. No ventilation problems were noticed. Blood oxygen saturation was not lower than 99%. Anesthesia was maintained with fentanyl 0.15 mg, propofol infusion, succinylcholine 30 mg × 2 and midazolam 5 mg. After the stent insertion, jet ventilation and drug administration were finished. The patient spontaneous breathing was adequate, she became conscious and was transfered to the ICU. The whole duration was 4 h without any complications. The patient was discharged 7 days later.

DISCUSSION

An effective short-term solution for stenosis includes endoscopic management. It should be provided by flexible or rigid bronchoscopy. The technique includes a mechanical dilation using balloon dilators (14), rigid bronchoscope, Jackson airway dilators. The bronchoscope associated with neodymium-doped yttrium aluminium garnet or argon laser is applied for stenosis produced by granulation tissue formation around the tracheal stoma (15). Electrocoagulation and stent placement are usable in patients with recurrent stenosis. In patients requiring temporary airway support a T tube or a distal tracheostomy tube could be used. The T tube has the advantage over an open tracheostomy of providing a closed and well humidified airway (16).

Traditionally, an airway must be under full control at all times during endoscopic intervention of the trachea. An intervention could be performed either by flexible or rigid bronchoscopy. The endoscopic management could be performed under conscious sedation with supplemental O_2 through a nasal canula or jet ventilation (JV). Jet ventilation is based on delivery of gas under high pressure through an unblocked catheter into the airway, which is open to ambient air (17). The conventional JV can be performed supraglottically, subglottically,

Table. Ventilation options (7, 29)

Ventilatory options	Benefits	Drawbacks
Intermittent positive pressure ventilation (IPPV)	• CO_2 elimination • Volatile anaesthetics	• Higher intrathoracic pressure • Pneumothorax
Jet ventilation: supraglottic, glottic, subglottic, Hunsaker Mon-Jet tube, high frequency (HFJV), percutaneous	• Visibility • Accessibility • No ETT ignition during use of laser • Low airway pressure • Decreased tracheal wall motion (HFJV)	• Barotrauma • Hypercapnea, hypoxemia • Humidification, gas heating

transtracheally (Table). JV could provide a good exposure of the larynx, trachea (18). One of the most important advantages of this method of ventilation is an effective gas transport without high airway pressure (18), elimination of the need for laryngoscopy to secure the airway (19). Aspiration of gastric contents is prevented by causing a continuous gas flow outward through the larynx (20). Shinozaki, Masahiro with coleagues performed a randomized trial in dogs and multitrial tests in tracheal stenosis models and revealed that the expiration during jet ventilation is facilitated by the reversed flow. This reversed flow may provide lower end-expiratory airway pressure at the poststenotic portion with jet ventilation than with conventional mechanical ventilation (21). JV is applied for rigid bronchoscopy through a special jet valve or a thin catheter, which can be placed at the nasotracheal position (22). JV for fiberscopes is applied without intervening tubing because the jet injector is attached to the suction channel (23). The quality of ventilation is dependent on the ability of the surgeon to align the jet with the airway, which may be affected by surgical priorities and anatomical abnormalities (24). The most common adverse effects of JV are hypercapnia, hypoxemia, haemodynamic instability (25–26). Hypercapnia in JV is a well described phenomenon and often observed in clinical studies (26–28). As a matter of routine, general anesthesia is induced only when respiratory excursions, cough, sneezing disturb the intervention, or the patient is in high poor condition.

JV allows to use a suspension laryngoscope which could be an alternative to a rigid bronchoscope. A suspension laryngoscope is ideal if the lesion is either at the vocal cords or just below the vocal cords. However, there may be a higher risk of irritation and injury to the vocal cords during insertion of surgical instruments to reach the target area which was 3 cm below the vocal cords (34). On the other hand, the using of rigid broncoscopy is safer and allows to introduce surgical instruments multiple times with a minimal damaging risk.

We found 5 reports (30–33) about the cardiopulmonary bypass which is used in non-cardiac operations. The cardiopulmonary bypass warrants gas exchange and good surgical access for the tracheal operations. What is more, it eliminates aggravating hypoxia, CO_2 accumulation. It is very important to remember that a tracheal tube inserted up the stenosis could result in high airway pressure and severe hypercarbia. One of life-saving methods could be extracorporeal circulation.

For the severe tracheal stenosis, a small aseptic tracheal tube could be placed in the main bronchus by the surgeon and single lung ventilation applied to maintain oxygenation during surgery (33).

CONCLUSIONS

In summary, we want to mention that high frequency JV, bronchoscopy and T-shaped stent implantation for patients with critical double tracheal, laryngeal stenosis is a life-saving way to ensure airway management. We want to notice that up to date there is a lack of studies which described the use of JV in patients with tracheal stenosis. Adequate ventilation is a major concern during management of tracheal stenosis. Due to the nature of stenosis it is not feasible to use standard ventilation techniques in a routine way. The proper method of a safe and efficient gas exchange establishing is the key to the successful management.

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TRACHĖJOS STENOZĖS GYDYMAS: KLINIKINIS ATVEJIS

Santrauka

Kvėpavimą užtikrinantis ir palaikantis būdas intubuojant trachėją yra saugus, gana įprastas bei gelbstintis gyvybę. Ilgalaikė endotrachėjinė intubacija gali skatinti fibrino sankaupų susidarymą, dėl to buvusio vamzdelio manžetės vietoje vystosi trachėjos stenozė. Pateikiame klinikinį rimtų komplikacijų, išsivysčiusių po ilgalaikės intubacijos, atvejį – trachėjos ir gerklų stenozę, kurios gydymas yra labai sudėtingas ir susijęs su rimtomis bei grėsmingomis gyvybei komplikacijomis.

Raktažodžiai: trachėjos stenozė, gerklų stenozė, tracheostomija, stridoras (švilpesys), standžioji (rigidinė) bronchoskopija