



Case Reports:

Anesthetic management of emergent critical tracheal stenosis

ZHOU Yang-feng, ZHU Shao-jun, ZHU Sheng-mei, AN Xiao-xia^{†‡}

(Department of Anesthesiology, the First Affiliated Hospital, School of Medicine, Zhejiang University, Hangzhou 310003, China)

[†]E-mail: anxx6830@yahoo.com.cn

Received Nov. 28, 2006; revision accepted Mar. 5, 2007

Abstract: Two case reports of emergent anesthesia of critical tracheal stenosis are presented. The use of extracorporeal circulation may be a lifesaving method for these patients. Two patients both with severe lower tracheal stenosis were admitted with severe inspiratory dyspnea. The first patient had a tracheal tube inserted above the stenosis in the operating room, but ventilation was unsatisfactory, high airway pressure and severe hypercarbia developed, therefore extracorporeal circulation was immediately initiated. For the second patient, we established femoral-femoral cardiopulmonary bypass prior to induction of anaesthesia, and intubated above the tracheal tumor orally under general anesthesia, then adjusted the endotracheal tube to appropriate depth after the tumor had been resected. The patient was gradually weaned from cardiopulmonary bypass. The two patients all recovered very well after surgery.

Surgery is lifesaving for patients with critical tracheal stenosis, but how to ensure effective gas exchange is crucial to the anesthetic management. Extracorporeal circulation by the femoral artery and femoral vein cannulation can gain good gas exchange even if the trachea is totally obstructed. Therefore, before the induction of anesthesia, we should assess the site and degree of obstruction carefully and set up cardiopulmonary bypass to avoid exposing the patient to unexpected risks and the anesthesiologist to unexpected challenges.

Key words: Tracheal stenosis, Extracorporeal circulation, Anesthesia

doi:10.1631/jzus.2007.B0522

Document code: A

CLC number: R64

INTRODUCTION

Critical lower tracheal stenosis is a rare life-threatening emergency that needs to be treated urgently. Surgery is the most effective treatment, although the procedure is challenging to the anesthesiologists. Conventional anesthetic technique would not be suitable, or even catastrophic, if attempts are made to insert a tracheal tube above the stenosis. This might cause a complete obstruction of the airway (Chiu *et al.*, 2003). On the other hand, tracheotomy might be accessible only beyond the stenosis, and might hinder the surgical field. How to establish an adequate gas exchange to maintain the life of patients in the shortest time and allow good surgical access is what we should consider during the anesthesia procedure. We report two successful cases of emergent anesthesia for critical tracheal stenosis utilizing cardiopulmonary bypass.

CASE REPORTS

Case 1

A 36-year-old man who was injured in a boat accident 4 months ago had multiple rib and left shoulder fractures resulting in bilateral hemopneumothoraces. He was treated by endotracheal intubation and immediately underwent emergency surgery. He was placed on artificial ventilation with oral endotracheal intubation, and a tracheotomy was performed 3 d after the operation. After that, his respiration recovered and he was discharged 18 d after surgery with no respiratory symptoms. Four months after discharge, he was admitted to our hospital because of progressive difficulty in breathing over one month. Severe tracheal stenosis was revealed after fiberoptic bronchoscopy, the diameter of stenosed trachea was 2~3 mm. A computed tomographic scan and 3-dimensional reconstruction showed that the length of stenosed trachea was about 1.5 cm just above the

[‡] Corresponding author

carina, the narrowest region was located 0.5 cm over the carina. On retrospective inspection, we diagnosed that the patient's tracheal stenosis was due to tracheotomy damage. At first we tried nonoperative treatment, considering his health state. However, 3 d after admission, the patient suddenly suffered excessive inspiratory dyspnea, with severe stridor, and he could not lie down. A blood gas analysis showed severe respiratory acidosis, the highest PaCO₂ was 73 mmHg. Emergency operation was indicated. The patient developed hypoxia and coma because of apnea on the way to the operating room. After emergency endotracheal intubation in the operating room, we found the airway resistance was very high and ventilation was unsatisfactory, the PaCO₂ reached 130 mmHg. Extracorporeal circulation was immediately initiated with cannulation of the femoral artery and femoral vein. Utilizing the support of normothermic extracorporeal circulation, the surgeon exposed the trachea via a right lateral thoracotomy, while the left main bronchus was isolated and incised, a sterile size 6 mm tracheal tube was inserted into the left main bronchus by the surgeon through the open thoracotomy site. One lung ventilation was started. Then we gradually reduced the flow of assisted circulation. The PaO₂ and PaCO₂ was maintained around 180~390 mmHg and 26~34 mmHg respectively during extracorporeal circulation. The narrowed tracheal loop was resected and end-to-end anastomosis was carried out smoothly. We found that the trachea had ruptured and was dystopic 0.5 cm above the carina and its interface was connected with cicatricial tissue which resulted in the tracheal stenosis. The assisted circulation time was 163 min. The tracheal extubation was carried out successfully 24 h after the operation in the intensive care unit. However, the patient complained of panting and dyspnea 48 h after operation, hemothorax was diagnosed after medical examination. He received the second surgery to be stanchied, and during the procedure, we found incision bleeding and seepage in the chest wall. After that, the patient recovered very well and was discharged from the hospital after fiberoptic confirmation of a fluent trachea.

Case 2

A 25-year-old man was hospitalized because of severe respiratory insufficiency. He had a history of progressive tachypnea for two months that worsened

one week ago. Anti-asthmatic therapy in a district hospital was ineffective. The patient had severe inspiratory dyspnea, dyslogia and could not lie down. Fiberoptic bronchoscopy, computed tomographic scan and 3-dimensional reconstruction of trachea showed that there was a 2 cm×3 cm×2 cm of smooth, round tumor that occupied almost all the tracheal lumen 6 cm below the vocal cords and was causing severe tracheal obstruction. The remaining tracheal space was only 1 mm. Immediate operation was indicated under extracorporeal circulation after careful consultation. The patient was taken to the operating room where oxygen administration by facemask was given and cardiorespiratory monitoring was instituted. Intravenous and arterial catheters were established. The patient was placed in the semi-supine position. A catheter was placed in one of the patient's nares to monitor EtCO₂ by capnography. Arterial blood gas analysis showed hypercapnia, with a PaCO₂ 73 mmHg. The cannulation of femoral artery and vein was done under local anesthesia. During cannulation, the patient developed progressive dyspnea and hypoxia, displayed agitation, high blood pressure, tachycardia and low oxygen saturation (89%). After the set up of extracorporeal circulation, general anesthesia was induced immediately with midazolam 3 mg, etomidate 10 mg, fentanyl 0.3 mg, rocuronium 6 mg, scopolamine 0.3 mg, and the trachea was intubated with a size 8 mm tracheal tube placed above the tumor. With the aid of extracorporeal circulation, the surgeon exposed the trachea and opened the fourth to sixth tracheal ring by cervical median incision and found that there was a pedunculate-tumor on the back of the fifth annular cartilage that almost blocked the trachea. We adjusted the endotracheal tube to appropriate depth after the tumor had been resected, then gradually stopped assisted circulation. The assisted circulation time was 64 min. Surgery was uneventful, the patient recovered very well and left hospital on the fifth day after operation. Histopathological diagnosis confirmed the tumor as a benign hypervascular leiomyoma.

DISCUSSION

The causes of adult tracheal stenosis are trauma, chronic inflammatory diseases, benign neoplasm, malignant neoplasm and collagen vascular diseases.

The most common cause of tracheal stenosis continues to be trauma, which can be internal (prolonged endotracheal intubation, tracheotomy, flame burn injury) or external (blunt or penetrating neck trauma) (Chao *et al.*, 2005). Therapeutic strategies for these patients include surgical resection combined with appropriate reconstruction and interventional bronchoscopic procedures (dilation, laser tracheoplasty, and tracheobronchia stent) (Gaissert *et al.*, 2006; Bolliger *et al.*, 2006), but each has its own merits and limitations. For a short (<1 cm), membranous stenosis without damage to the cartilages, laser incisions followed by gentle dilatation or tracheal stent is the safe and complete treatment. But for complex tracheal stenosis, longer with circumferential hourglass-like contraction, scarring or malacia, surgical sleeve resection and end-to-end anastomosis are considered the standard curative treatment (Vergnon *et al.*, 2000). Laser tracheoplasty under bronchoscopic guidance has been proposed as a reliable method for treating benign tracheal tumors. However, if a tumor almost occludes the airway and causes severe respiratory insufficiency, any manipulation of the airway would precipitate increased oxygen consumption leading to further hypoxia and probable cardiac arrest. After careful consultation, we believed that laser tracheoplasty or tracheal stent would be unsuccessful for our two patients with critical tracheal stenosis, therefore we decided to carry out emergent surgery just under cardiopulmonary bypass.

The symptoms of central airway stenosis are distressing. Generally, when the patient presents stridor and tachypnea, the tracheal stenosis has reached about 50% of the tracheal diameter. When the patient has extreme respiratory insufficiency the tracheal stenosis has reached a critical level of 75% or more. For the latter, surgery and the anesthetic airway management are very difficult. Besides the degree of tracheal stenosis, the stenosed position is also important for anesthesia. For upper tracheal stenosis, a tracheal tube can be inserted below the stenosis under local anesthesia or cervical nerve block; for mild mid-level tracheal stenosis, a small tracheal tube can be inserted past the stenosis by the help of fiberoptic scope; for severe mid-level tracheal stenosis, a tracheal tube can be intubated rapidly above the stenosis first, then a smaller aseptic tracheal tube is placed in the main bronchus by the surgeon and single lung

ventilation applied to maintain oxygenation during surgery. After tracheoplasty, the main bronchus tube is removed and a tracheal tube is placed at a suitable level. For the most severely obstructed patients with critical tracheal stenosis and at risk for complete respiratory failure at any time, conventional anesthetic technique would be catastrophic if attempts are made to insert a small tube which may cause complete obstruction of the airway. In many of these patients, the anatomy of the stenosis is such that they can only ventilate when breathing spontaneously.

Blind anesthesia induction and intubation can depress the patient's auto-compensation, which could result in severe consequence of cardiac and respiration arrest, especially in patients who have had hypoxia because of the increase in oxygen consumption (Mentzelopoulos *et al.*, 1999). How to establish safe and efficient gas exchange is the key to the successful management of the patients with critical tracheal stenosis and to survival. It is reported that cardiopulmonary bypass is widely used in non-cardiac operations (Belmont *et al.*, 1998; Chuqhtai *et al.*, 2002; Goh *et al.*, 1999). It could allow gas exchange and good surgical access for the tracheal operations and avoid aggravating hypoxia and carbon dioxide accumulation which may result in cardiac arrest during normal anesthesia and tracheal intubation.

Our two patients were both with critical lower tracheal stenosis which required extraordinary anesthetic techniques. We inserted a tracheal tube up the stenosis for the first patient, but high airway pressure and severe hypercarbia developed (the PaCO₂ reached 130 mmHg). Extracorporeal circulation was initiated with cannulation in the femoral artery and femoral vein immediately. To that patient, extracorporeal circulation was a lifesaving method. For the second patient, we drew lessons from the first case, established femoral-femoral cardiopulmonary bypass prior to induction of anaesthesia under local anesthesia, then intubated above the tracheal tumor orally under general anesthesia induction. After the surgeons had resected the tracheal stenosis and reconstructed the trachea with the support of normothermic extracorporeal circulation, we adjusted the tracheal tube depth to allow two lungs ventilation and then weaned the patient from cardiopulmonary bypass.

Although bypass may be the only safe and practical method of induction and maintenance of anes-

thetia for operation on the trachea if the lumen diameter is compromised severely (Mentzelopoulos *et al.*, 1999; Belmont *et al.*, 1998), systemic anticoagulation increases the risk of bleeding postoperatively especially for those patients who need extensive dissection and a prolonged time of extracorporeal circulation. In our first case, the patient required a second operation to be performed because of incision bleeding 48 h after the first operation.

In summary, surgical resection is lifesaving for the patients with critical lower tracheal stenosis and how to ensure effective gas exchange is crucial to the anesthetic management. Extracorporeal circulation by the femoral artery and femoral vein cannulation is an effective method of gas exchange even if the trachea is totally obstructed. Before the induction of anesthesia, the site and degree of obstruction should be carefully assessed and the set up for cardiopulmonary bypass should be considered to avoid exposing the patient to increased risks of conventional anesthesia.

References

- Belmont, M.J., Wax, M.K., Desouza, F.N., 1998. The difficult airway: cardiopulmonary bypass—the ultimate solution. *Head Neck*, **20**(3):266-269. [doi:10.1002/(SICI)1097-0347(199805)20:3<266::AID-HED12>3.0.CO;2-I]
- Bolliger, C.T., Sutedja, T.G., Strausz, J., Freitag, L., 2006. Therapeutic bronchoscopy with immediate effect: laser, electrocautery, argon plasma coagulation and stents. *Eur. Respir. J.*, **27**(6):1258-1271. [doi:10.1183/09031936.06.00013906]
- Chao, Y.K., Liu, Y.H., Hsieh, M.J., Wu, Y.C., Liu, H.P., Wang, C.J., Ko, P.J., 2005. Controlling difficult airway by rigid bronchoscope—an old but effective method. *Interact. Cardiovasc. Thorac. Surg.*, **4**(3):175-179. [doi:10.1510/icvts.2004.098038]
- Chiu, C.L., The, B.T., Wang, C.Y., 2003. Temporary cardiopulmonary bypass and isolated lung ventilation for tracheal stenosis and reconstruction. *Br. J. Anaesth.*, **91**(5):742-744. [doi:10.1093/bja/aeg244]
- Chuqhtai, T.S., Gilardino, M.S., Fleiszer, D.M., Evans, D.C., Brown, R.A., Mulder, D.S., 2002. An expanding role for cardiopulmonary bypass in trauma. *Can. J. Surg.*, **45**(2):95-103.
- Gaissert, H.A., Grillo, H.C., Shadmehr, M.B., Wright, C.D., Gokhale, M., Wain, J.C., Mathisen, D.J., 2006. Uncommon primary tracheal tumors. *Ann. Thorac. Surg.*, **82**(1):268-272. [doi:10.1016/j.athoracsur.2006.01.065]
- Goh, M.H., Liu, X.Y., Goh, Y.S., 1999. Anterior mediastinal masses: an anaesthetic challenge. *Anaesthesia*, **54**(7):670-674. [doi:10.1046/j.1365-2044.1999.00961.x]
- Mentzelopoulos, S.D., Romana, C.N., Hatzimichalis, A.G., Tzoufi, M.J., Karamichali, E.A., 1999. Anesthesia for tracheal resection: a new technique of airway management in a patient with severe stenosis of the midtrachea. *Anesth. Analg.*, **89**(5):1156-1160. [doi:10.1097/00000539-199911000-00013]
- Vergnon, J.M., Costes, F., Polio, J.C., 2000. Efficacy and tolerance of a new silicone stent for the treatment of benign tracheal. *Chest*, **118**(2):422-426. [doi:10.1378/chest.118.2.422]