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Anaesthetic Management for Tracheal Reconstruction Surgery: A Case Report

Dr. S. Premalatha[1*], Dr.B.Kala[2]
[1]DA, DNB (Anaes), Specialist, ESIC Medical College and PGIMSR, K.K.Nagar, Chennai -78, India.
[2]MD, Director, Institute of Anaesthesiology and critical care, Madras Medical College, Chennai-3, India.

***Corresponding Author:**
Name: Dr. S. Premalatha
Email: latha20022001@gmail.com

Abstract: Anaesthetic management becomes difficult and challenging in a variety of conditions and syndromes associated with difficult airway. But in some cases like diseases involving trachea, trauma, tumour involving trachea, there will be a difficulty even during induction and intubation. These cases are very much challenging for the anaesthetist to maintain airway and ventilation. A 38 year old female, a case of tracheal stenosis was posted for tracheal reconstruction. She had a history of twenty days of mechanical ventilation for neurotoxic snake bite. She was admitted with stridor and was in tubated with a smaller size Endotracheal tube (size 5 uncuffed) in the emergency room. Now the patient was posted for tracheal reconstruction. The anaesthetic management during tracheal reconstruction for this patient is discussed here.
Keywords: Anaesthetic management, Endo Tracheal Tube (ETT), tracheal stenosis, tracheal reconstruction.

INTRODUCTION

Tracheal surgery was first performed in the 1950s [1].At that time, 2 cm was believed to be the maximum length that could be resected. Technical Advances in the field of reconstructive surgery and anaesthesiology permit more than half of the trachea to be safely excised in selected cases.

A brief description of the various causes of tracheal stenosis, symptoms and clinical presentations and the various diagnostic methods to detect the level of stenosis are discussed.

Post intubation stenosis and tumours are the most frequent indications for tracheal resection and reconstruction. However the incidence of post intubation stenosis has decreased since the introduction of high volume, low pressure cuffed Endotracheal tubes [2] and also due to early intervention by tracheostomy for patients on long term ventilator therapy. The site of stenosis was variable depending on whether the trachea was intubated orally or nasally as opposed to a patient who had a tracheostomy. Malignant primary tumours are relatively rare, the incidence is around 2.7 new cases per million per year [3]. Squamous cell carcinoma and adenocystic carcinoma are the most common malignancies.

Symptoms may be gradual or abrupt depending on the pathology. The presence of non-specific symptoms delay the diagnosis for many years [3-5]. Progressive exercise intolerance is the most common symptom. Others include persistent cough, haemoptysis, progressive wheezing while exercise, Inspiratory stridor and even stridor at rest when the diameter of the trachea reaches 5mm or less, dysphagia and hoarseness due to recurrent laryngeal nerve involvement. If the lesion is obstructing one or both of the main stem bronchi, the patients may have recurring bouts of unilateral or bilateral pneumonitis. Cyanosis is a very late and ominous sign, signalling almost complete occlusion of the airway. Most of these patients are diagnosed as adult onset asthma and get treated with bronchodilators andsteroids. Further evaluation is done at a later date when these patients are not responding to the treatment and hence the diagnosis is delayed. Grillo states: " Any patient who has received ventilator support in the recent past or even not so recent past, who develops signs and symptoms of upper airway obstruction, has an organic lesion until proved otherwise [6]."

Diagnostic evaluation should be carried out under careful monitoring of the patients with pulse oximeter saturation and providing humidified oxygen to the patients as and when required. The following diagnostic studies are used for identifying and/or characterising a tracheal lesion:

- Chest X ray – not much useful except for abnormality in the tracheal lumen for some patients [4].
- Linear Tomography of the Trachea – most accurate tool to characterise the lesion – it's degree, level and length [6,7].
- Computed Tomography (CT) – little use for benign stenosis [5]. Useful adjunct to evaluate extratracheal or extrabronchial involvement by

tumour as well as oesophageal and mediastinal invasion [4].

- Fluoroscopy – used to know the function of the glottis and larynx and also helps in identifying malacic segments [6].
- Barium study of the oesophagus – this helps to identify the oesophageal involvement by tumour invasion or extrinsic compression [4].
- Pulmonary Function Tests (PFT) – the flow volume loops identifies an obstruction and defines if it is intra or extrathoracic, variable or fixed. The ratio of peak expiratory flow to FEV1 is more useful. If this ratio is ≥ 10:1, then airway obstruction should be suspected [8]. Complete assessment of pulmonary function is essential with the perspective of an eventual pneumonectomy for carinal lesions.
- Bronchoscopy – Bronchoscopic examination will be required in all patients with tracheal pathology [5]. With a patient breathing spontaneously, segments of tracheal malacia can be identified. However it is not considered safe in patients with moderate to severe obstruction and deferred until the time of definitive surgery.

CASE REPORT

A 38 year old female weighing 40kg, height 160cms with tracheal stenosis was posted for tracheal reconstruction. She had a history of neurotoxic snake bite followed by 20 days duration of mechanical ventilation. After one month duration she recovered from neurotoxicity of snake bite and was discharged from our hospital. After a period of one month from the day of discharge she came to the hospital with stridor.

Immediately she was shifted to emergency OT for emergency tracheostomy. At that time she was gasping and was in a state of shock. She was resuscitated and in tubated with smaller size oral endotracheal tube size 5.0 (as the bigger size tubes could not be used) and CPR continued and the patient was revived. With the inability to intubate with bigger size endotracheal tubes and from the history of mechanical ventilation in the past, we diagnosed that she had stenosis of the airway. She was taken care by ENT surgeons. After 20 days duration the tube was changed and this time only 4.5 size tube could be used. Otherwise her cardiopulmonary system was unremarkable. Since the patient had a progressive narrowing of the trachea she was planned for tracheal reconstruction surgery.

Investiations	Examination	Airway Assessment
Haemoglobin: 9.6 gms%	She was moderately built and nourished, not aneamic Acyanotic	Patient on ET Tube
Blood Suar: 74 mg/dl	CVS: PR: 106/min	Neck movement: Normal
Urea: 34 74 mg/dl	BP: 130/90 mm of Hg	Thyromental distance: Four finger breadth
Creatinine: 1.2 74 mg/dl	Rs: Normal Vesicular breath heard, bilateral air entry present	
Electrolytes: Normal	CNS: Normal	
ECG: Within normal limits	Abdomen: Soft	
X-ray Chest: Normal		

Preparation

The patient was assessed for surgery under ASA III. High risk informed consent was obtained from the patient and her relatives. Antibiotic prophylaxis and acid aspiration prophylaxis was given a day before and on the day of operation through a Ryle's tube. Ryle's tube feeding was stopped the night before surgery. Anaesthetic drugs and equipment were checked.

Intra Operative Event

Intra venous cannulation started in both dorsal vein of hand with 18G cannulae. Right radial artery was cannulated and connected to Intra Arterial Blood Pressure Monitoring. A sample was sent for baseline blood gas analysis. ECG and pulse oximeter were connected. Pulse oximeter showed saturation of 100% on room air. She was premedicated with Inj Glycopyrrolate 0.2mg and Inj. fentanyl 100 µg IV. Then patient was preoxygenated through ET tube with 100% O2 6 liters for 3 minutes. Endotracheal tube patency and bilateral air entry were checked. Before induction Arterial blood gas analysis showed a PaCO2 60mm Hg and PaO2 226mm Hg on FIO_2 100% (after connecting to the anaesthetic circuit with oxygen 6 lit/min). Patient was induced with Inj Propofol 100mg IV and maintained with 100% O2 initially. Patient was paralysed with a loading dose of Inj Vecuronium 4mg. Anaesthesia was maintained with the small size ETT itself since it was only for a short period until the trachea was exposed. A new Ryles tube was inserted. Intraoperatively after the trachea was exposed by surgeon, a sterile 7.5size cuffed armoured tube was advanced into the distal trachea below the level of stenosis by the surgeon and it was connected to a sterile breathing circuit for further ventilation during the procedure. The oral small ETT was removed. Arterial Blood Gas analysis after controlled ventilation showed a PaCO2 of 40mm Hg and PO2 of 650mm Hg with FiO2 of 100%. Then anaesthesia was maintained with 50; 50 N2O and O2 and Isoflurane 0.5 – 1%.

Following the resection of tracheal stenosis and completion of posterior tracheal wall anastamosis, a sterile Ryle's tube was introduced into the proximal trachea by the surgeons and retrogradely introduced upto the mouth. Under the guidance of the Ryle's tube a new sterile 7.5 size ET tube was inserted through the mouth and fixed above the surgical site by a silk thread which was passed through the Murphy's eye. After completion of lateral tracheal wall anastamosis, distal armoured tube was removed and the new 7.5 size cuffed ET tube was advanced distally cross the anastamotic site and ventilation was continued through the oral ETT. Sternotomy was done for lower tracheal exploration. Tracheal anastomosis was completed. Sternotomy closure was done. Wound was closed in layers after complete hemostasis. Post operatively patient was positioned with neck flexion with chin sutured to the anterior chest wall, to minimize tension on suture line.

Total duration of surgery was 2 1/2 hrs. The residual effect of muscle relaxation was reversed with titrated dose of neostigmine and glycopyrrolate (2.5mg neostigmine and 0.4mg glycopyrrolate). Butsince the patient was drowsy and the neck was in flexion, she was not extubated and was kept for observation in the post operative anaesthetic care unit for complete awakening with T – piece ventilation. She was then extubated on the same day evening after complete recovery.Inj.Dexamethasone8mg was given intraoperatively to reduce airway edema.

Post extubation: Patient was conscious, obeying commands, comfortable with neck in flexion. Her vitals were: PR: 100/min, BP: 100/80mmhg, CVS / RS: normal, O2 saturation 100% on room air. Neck flexion was released after one week duration.

DISCUSSION

Patient selection is mandatory for tracheal reconstruction surgeries. The diagnostic procedures described above aids to know whether the lesion is respectable, the exact location of the lesion and the length of the lesion [9]. The glottis must be functional; otherwise surgery will be invain [10]. We diagnosed the location and severity of stenosis in this patient with the help of indirect laryngoscopy, video endoscopy and CT neck.

Early extubation is highly desirable in these patients to prevent wound dehiscence. To this effect, patients should be weaned from ventilator before proceeding to surgery [3, 7, 10]. Steroids should be discontinued two to four weeks before surgery [11] because they induce poor wound healing and are a cause of attenuated restenosis [6]. Any active infection or inflammation at the site of surgery should be treated before surgery [6].

Anaesthesia for tracheal resection is one of the most challenging aspects of anaesthetic practice because of the unique conditions associated with narrowed airway diameter and the problem of maintaining ventilation during induction, bronchoscopy and the period of surgical repair [12]. The anaesthesiologist must provide adequate ventilation and oxygenation to a patient with a pre-operative critical airway, followed by an intra-operative transacted airway and finally a precarious post-operative airway that may be edematous due to multiple manipulations and also because of cervical flexion positioning.

Pre-operative sedation requires good judgement and will be dictated by the tightness of the obstruction. Patients with moderate obstruction may be benefitted by sedation which alleviates anxiety in turn leading to quieter breathing and decrease in airway resistance [13]. Respiratory depression must be strictly avoided in all patients with severely narrowed airway.

In our case, the patient was already on an Endotracheal tube with spontaneous breathing. After confirming the patency of the ETT and SpO2 100%, the patient was sedated with fentanyl. Cautious use of anti-sialagogues was advised as drying of secretions can cause a mucous plug that can obstruct an already tight lumen. However in our case injection glycopyrrolate was given since the patient was already on ETT and in the operating room. It is best to defer all medications until the patient was in the supervised surrounding of the operating room.

Preoperatively all the diagnostic studies should be closely examined to know the anatomic characteristics and the severity of obstruction. A detailed history should be obtained. The physical examination should be done with thorough evaluation of the airway. Routine blood tests are sufficient unless the patient presents with a medical condition requiring special investigation. Our patient was a young female with no co morbid conditions. Her routine blood investigations were more than sufficient.

Monitoring should include ECG, saturation, capnography, invasive blood pressure monitoring, arterial blood gas analysis, high inspiratory pressure alarm and a nerve stimulator. Equipments required for tracheal reconstruction are (a) Anaesthesia machine capable of delivering upto 20 lit/min O2 (b) Assortment of endotracheal tubes like size 4 to size 8 Portex tubes, extra long ETT, sterile armoured tubes of various sizes (c) Sterile corrugated tubing attached to a sterile Y piece (d) Nasogastric tubes (e) A second anaesthesia machine [14].

Induction of anaesthesia in patients with severely compromised airways requires time and patience. The surgeon should be ready in the operating room. Following five minutes of pre oxygenation with

100% O2, slow and gentle inhalational induction with the patient breathing spontaneously is the safest and the most recommended method [13, 15]. Ventilation can be assisted now and then with high flow of O2, but spontaneous ventilation must be maintained. When an adequate depth of anaesthesia is attained, topicalization of the airway with local anaesthetics is done and mask ventilation resumed. Muscle relaxants are generally avoided before securing the airway, ventilation verified and shown to be possible. Another option is awake intubation after topicalizing the airway with local anaesthetics and the patient breathing spontaneously if bronchoscopy is not to be done first [16]. However in our case since the patient was already intubated with a small size tube and was maintaining saturation, intravenous induction was done and patient was paralysed. Controlled ventilation was opted to correct the hypercapnia and hypoxaemia which was present during spontaneous breathing (though the patient's saturation was 100%, ABG showed hypercapnia and hypoxaemia).

Several agents have been used for maintenance of anaesthesia. Incremental doses of opioids with or without Diazepam [17-19] and more recently Propofol [16, 20] have all been used during the tracheal resection and anastamosis phase. Maintenance with inhalational agents has also been reported [21-24]. N2O can be administered up to the point of transaction and then replaced with 100% O2 during the stage of resection and reconstruction. In our case, we used 100%O2 till the armoured tube was introduced into the distal trachea after which N2O was added. We switched over to 100%O2 again during the tube changing phase.

Regarding anaesthetic management we should assess the stenosis of the trachea and its anatomic position (supraglottic or subglottic) and severity before induction and intubation. Literature shows that there are various induction and intubation techniques.

- Intubation with small size ET tube.
- Maintaining spontaneous respiration during induction with mask ventilation by using Propofol, Sevoflurane or Isoflurane, Fentanylor Remifentanyl and Glycopyrrolate.
- High frequency jet ventilation for severe tracheal stenosis.
- LMA ventilation.
- Rarely extracorporeal circulation /CPB for lower tracheal or carinal reconstruction.

We induced with the first method.

During intra operative period there are various methods for ET tube change after completion of posterior tracheal wall anastamosis. We performed nearly 20 cases of tracheal stenosis in a month. In this case we intubated with a new ET tube with the help of Ryle's tube introduced retrogradely into the trachea proximal to the anastamotic site by the surgeon. In most other cases we intubated with the help of the laryngoscope and an appropriate size ETT before positioningitself (if the patient was already on tracheostomy) and fixed proximal to the stenosis using a silk thread. Anaesthesia maintained through an armoured ET tube changed for the tracheostomy tube distal to the stenosis. After completion of lateral tracheal wall anastomosis, Proximal ET tube was advanced distally cross the anastamosis with the help of silk thread after the surgeon removed the distal armoured tube. In this patient since the patient already had a small size ETT insitu, the tube was changed through the retrograde method.

Ventilation was carried by five different ways. (a) Manual O2 ventilation (i.e) low frequency jet ventilation: delivers 100%O2 at high pressures via a narrow catheter. Advantages are good and free access to the surgical field. Disadvantages include hypercarbia due to hypoventilation, excessive movement of the catheter tip, blood and other debris entrainment into the distal trachea, spraying of blood across the surgical field caused by the high-flow O2 [20] movement of the lungs and mediastinum, high tidal volume with possible hemodynamic repercussions, catheter plugging by blood or other debris, and contamination of the surgical field by the catheter which passes through thenon-sterile proximal ETT. A patent passageway for gas outflow must be ascertained before using jet ventilationto avoid gas trapping with resulting barotrauma.(b)High frequency ventilation (HFV) : Used to induce patient with severe tracheal stenosis. There are three methods of HFV namely High Frequency Positive –Pressure ventilation (HFPPV), High Frequency Jet Ventilation (HFJV) and High Frequency Oscillation Ventilation (HFOV). *Advantages* of HFV include improved gas mixing and accelerated diffusion which results in good gas exchange, the presence of auto-PEEP (Positive End Expiratory Pressure) due to continuous positive airway pressure which increases functional residual capacity and decreases ventilation-perfusion mismatch and also decreases the risk of atelectasis, [20] minimal hemodynamic repercussion, unobstructed surgical field, minimal lung expansion and mediastinum movement providing the surgeon with a quiet field, decreased danger of aspiration of blood and other debris into the distal airway due to continuous outflow of gases[25], and less catheter displacement. Here also, free egress of gas from the lungs must be ascertained to avoid barotrauma. (c) Spontaneous ventilation: Rarely used with anaesthesia maintained by continuous intra venous anaesthetics. In addition to hypercarbia and respiratory acidosis, other disadvantages to this technique are aspiration of blood and debris despite careful suctioning by the surgeon, and cough.

Standby cardio pulmonary bypass (CPB) for induction of anaesthesia in patients with severely

obstructing lesion is a reasonable approach. The use of CPB in paediatric patient is also reasonable considering the smaller airway, leaving us with fewer manoeuvres before total obstruction [26].

Post operative airway management include inserting a small ETT or tracheostomy tube (preferablyuncuffed) or a T tube with upper limb 0.5 -1 cm above the vocal cords where glottis edema is a concern or for patients requiring ventilatory support. Humidified O2 should be provided. The ETT is removed as early as possible. Reintubation if necessary is best done using a flexible fibreoptic bronchoscope (FOB). Clearing of secretions is essential with the help of chest physiotherapy and sometimes with FOB.

Prevention of Tracheal Stenosis

The incidence of tracheal damage and tracheal stenosis after intubation can be reduced by the use of tracheal tubes with cuffs that have a high volume and large area of contact with the tracheal mucosa, thus minimising the pressure exerted.

Researches on Topical Heparin: A Promising Agent for the Prevention of Tracheal Stenosis in Airway Surgery. Endotracheal tubes with a smaller ID/OD should be used. Patients should be positioned carefully during the anaesthetic procedure to reduce contact between the endotracheal tube and the tracheal wall.

The endotracheal tube should be disconnected from the anaesthetic circuit when repositioning the patient. And finally, caution should be exercised when using endotrachealtubes in patients with pre-existing tracheal disease, or an air sac cannula should be placed for anesthesic delivery. Tracheostomy should be considered in patients who require ventilation for more than 7 days. Early tracheostomy in patients requiring prolonged ventilation will minimize the chances of post intubation tracheal stenosis which can be even lethal when the patients present with stridor in emergency department.

SUMMARY

Team work consisting of communication, coordination, and cooperation between surgeon and anaesthesiologist is mandatory. Meticulous planning and anticipation of problems is essential. Numerous anaesthesia techniques for airway management have been reported. The knowledge of these must be well known to the anaesthesiologist involved in the care of a patient undergoing tracheal or cranial surgery.

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