Management of central airway obstruction

Opening Vignette

A 65-year-old male chronic smoker presented at the emergency department with shortness of breath, cough and sputum production over the past 3 days. His vital signs were as follows: temperature 36.5°C, pulse rate 90 beats/min, blood pressure 120/80 mmHg, respiratory rate 40/min and peripheral oxygen saturation 92% in room air. He was unable to lie supine and had to sit upright. Use of accessory muscles of respiration and bilateral monophonic wheeze were present on physical examination. His chest X-ray showed a widened mediastinum [Figure 1]. An urgent computed tomography scan of the thorax revealed a large mediastinal mass compressing the distal trachea and bilateral main bronchi, resulting in severe narrowing and slit-like appearance of the involved airways [Figure 2].

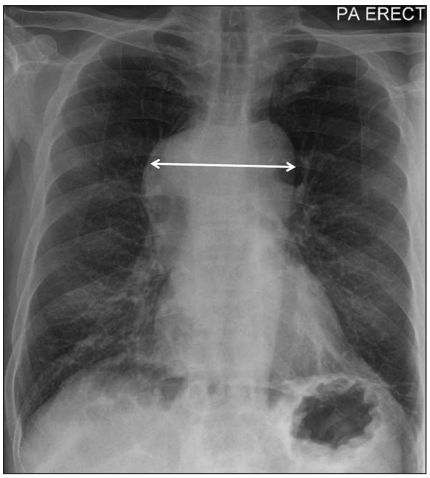

Figure 1: Chest radiograph shows a widened mediastinum (arrow).

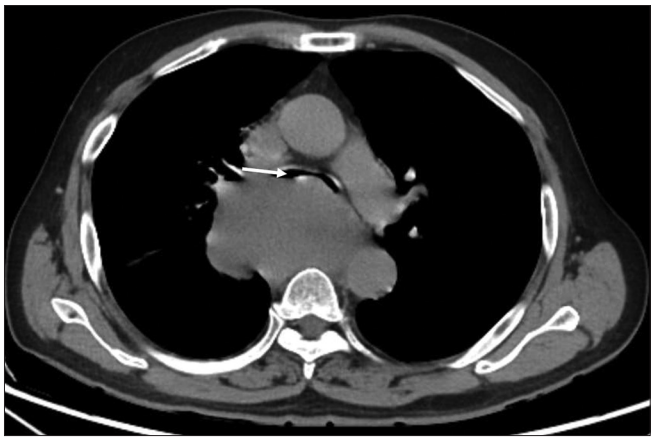

Figure 2: CT image of the thorax shows a slit-like appearance of the distal trachea and bilateral main stem bronchi (arrow) due to extrinsic compression by the mediastinal mass.

INTRODUCTION

Central airway obstruction (CAO) is generally defined as airflow limitation due to >50% occlusion, as quantified on imaging by decreased cross-sectional area or diameter of the trachea, main stem bronchus, bronchus intermedius or lobar bronchus.[1,2] Malignant causes of CAO are more common than benign ones. Primary lung cancer, mediastinal tumours, oesophageal carcinoma, thyroid cancer and secondary metastases that arise in the airway lumen or adjacent to the airways can cause CAO [Box 1].

Airflow is exponentially related to airway diameter. At moderate degrees of compression, airflow is maintained and symptoms are minimal. However, acute exponential drop in airflow occurs in severely narrowed airways, and acute breathlessness over days can occur, even if the narrowing process has been gradual. Near-complete airway occlusion can easily occur in severely narrowed airways when mucous plugging occurs, which then leads to sudden respiratory failure and possible cardiorespiratory collapse.

GENERAL APPROACH AND IDENTIFICATION

The evaluation and management of patients with CAO requires a thorough knowledge of the aetiology, physiology, diagnostic options and treatment options. Optimal management is facilitated by a multidisciplinary team that includes radiologists, anaesthesiologists, medical oncologists, thoracic surgeons and interventional pulmonologists.[3] This article focuses mainly on frontline management of CAO and how CAO can be managed emergently or urgently to optimise outcomes for further downstream diagnostic and therapeutic

Box 1. Causes of central airway obstruction.

Primary cancer	**Metastatic cancer**
Lung cancer	Breast carcinoma
Carcinoid tumour	Renal malignancy
Lymphoma	Colorectal carcinoma
Thymic tumours	Oesophageal carcinoma
Germ cell tumours	Thyroid carcinoma
Infection	**Systemic illness**
Tuberculosis	Relapsing polychondritis
Diphtheria	Sarcoidosis
Fungal	Amyloidosis
Latrogenic	Granulomatosis with polyangiitis
Post-intubation	Tracheobronchomalacia
Post-tracheostomy	
Radiation	
Foreign body	

interventions [Figure 3]. On a related note, potential pitfalls when managing CAO should be avoided [Table 1].

Various classifications of CAO have been proposed.[2] Stenotic lesions can be intraluminal, extraluminal or mixed. Severity of obstruction can be graded as 0%–50% (mild), 51%–70% (moderate), 71%–99% (severe) and 100% (complete) occlusion. For practical purposes, key features of CAO are location and length of the lesion, severity of stenosis, anatomical relation of the lesion with the surrounding structures and the underlying cause of the lesion.

Central airway obstruction may be missed in patients not previously diagnosed with lung cancer.[4] Patients often present with dyspnoea, orthopnoea, cough and wheezing. Due to the presence of wheeze, they are often treated for exacerbations of asthma or chronic obstructive pulmonary disease. Clinicians who have a higher index of suspicion for CAO may ask about change in quality of voice and listen for voice hoarseness, stridor and unilateral wheeze. Detection of abnormalities, such as mediastinal widening on chest X-ray, is often the the main reason a clinician may request for a computed tomography (CT) scan, which definitively diagnoses CAO and provides valuable information regarding the location, length, severity of stenosis and the anatomical relation to adjacent structures.

STABILISATION

CAO patients may present *in extremis* before, during or after CT. Therefore, stabilisation of the airway and haemodynamic parameters[5] is required before detailed evaluation by CT should be undertaken. In an unstable patient with CAO, acute deterioration can be precipitated by use of sedation and paralysis administered for the purpose of intubation and airway management. Sedation, with or without paralysis, may depress ventilation and relax the respiratory muscles sufficiently to cause a relatively stable airway to become unstable, leading to acute respiratory failure. Sedation and paralysis can also compromise the haemodynamic status of a relatively stable patient, especially one with locoregional disease involving the heart or main mediastinal vessels.[6]

For emergency management, securing of the airway is usually achieved by endotracheal tube intubation. When there is concern that acute respiratory failure can be precipitated by sedation, one may choose awake fibre-optic intubation (using

Table 1. Potential pitfalls in the management of CAO.

Potential pitfall	Measures to avoid the pitfall
Failure to identify CAO	• Check for hoarseness of voice, orthopnoea, persistent wheeze, stridor, abnormal CXR • Proceed to do CT thorax if clinically suspicious
Inability to secure airway	• Multidisciplinary team assessment and discussion on the option of airway management in the operating theatre with fibre-optic, rigid bronchoscopy and ECMO support • Avoid upper limb intravenous cannulation for SVCO patients to avoid aggravating upper airway oedema with fluid administration
Airway collapse from loss of muscle tone and spontaneous ventilation	• Consider awake intubation • Keep patient on spontaneous ventilation and avoid deep sedation and paralytics until the airway is secured
Haemodynamic instability due to locoregional malignant involvement	• Avoid deep sedation and paralytics • Correct hypovolaemia with adequate intravenous fluid administration • Inotropic support • In high-risk cases, consider ECMO
Degradation of tissue for definitive diagnosis	• Avoid nonemergency medical or surgical treatment that may degrade specimen quality

CAO: central airway obstruction, CT: computed tomography, CRX: chest X-ray, ECMO: extracorporeal membrane oxygenation, SCVO: superior vena cava obstruction

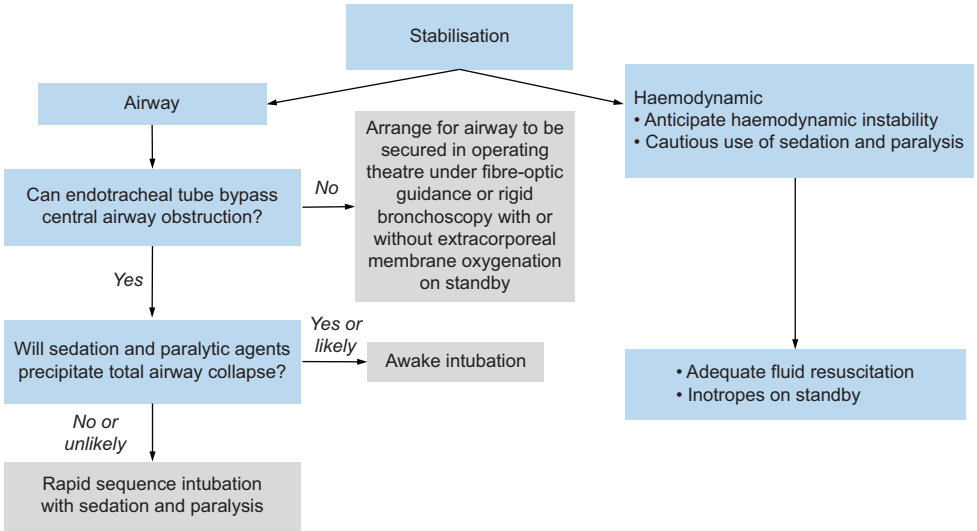

Figure 3: Algorithm for stabilisation of unstable central airway obstruction.

flexible bronchoscopy) or rigid bronchoscopy under general anaesthesia. Nonetheless, endotracheal intubation (or even tracheostomy) may not address lesions that involve the distal trachea or main bronchi. Such perils are usually visualised only on CT. In such cases, arrangements should be made for the airway to be secured in the operating theatre.

In patients who are assessed to be at high risk, every effort should be made to plan and prepare for the deterioration of the patients. The following airway therapeutic options may be prepared: fibre-optic intubation, rigid bronchoscopy, emergent airway debulking, balloon dilatation, airway stenting and extracorporeal membrane oxygenation (ECMO). Rigid bronchoscopy offers a means to secure the airway, provides a conduit for ventilation and oxygenation, and enables interventions such as debulking, dilatation and stenting to relieve CAO. In certain cases where the risks of critical airway occlusion and haemodynamic compromise are sufficiently high, paralytic agents can be used to precipitate respiratory failure and cardiovascular collapse. Such patients should be kept on spontaneous ventilation as much as possible during therapeutic procedures, and if deterioration occurs, they are initiated on ECMO.[6] In cases assessed to be of extremely high risk, expert centres may initiate ECMO before therapeutic procedures.[7]

FURTHER INVESTIGATIONS

As far as possible, a definitive diagnosis should be obtained before treatment. During airway stabilisation, degradation of biopsy samples may happen when ablative procedures, such as argon plasma coagulation or laser, are used to relieve CAO. Therefore, mechanical debulking with forceps or cryotherapy may be preferred, with ablative procedures reserved for control of bleeding. For mild–moderate malignant CAO accompanied by superior vena cava obstruction, a previous case series showed that the large majority of such cases were not emergencies.[8] Given that treatment with steroids and radiotherapy can degrade biopsy tissue quality, empirical application of such treatments should be avoided.

If patients with suspected CAO present to primary care, direct referral to an expert centre should be done expediently.[9] At the hospital, stabilisation of unstable CAO patients would allow multidisciplinary teams to assess the patient and perform appropriate diagnostic and therapeutic procedures more safely. As a principle of good practice, the most appropriate diagnostic procedure should target the most accessible, least invasive and safest site. In certain cases, this procedure could be fine needle aspirate of palpable supraclavicular lymph nodes, transthoracic biopsy guided by ultrasound or CT, or biopsy via a mini-thoracotomy under local anaesthesia.

TREATMENT

The goals of CAO treatment are to relieve airway obstruction, alleviate symptoms and buy time for definitive treatment. Ideally, patients with malignant CAO should go on to receive cancer-specific therapy such as chemotherapy, radiation or surgery. Prospective studies demonstrate that patients who receive therapeutic procedures for malignant CAO can be discharged from intensive care units (ICUs) earlier. In addition, patients who successfully received specific cancer therapy had better survival than those who could not receive further oncological treatment.[10,11]

Table 2. Therapeutic bronchoscopy for central airway obstruction.

Type of stenotic lesion	Therapeutic modalities
Endoluminal	• Mechanical debulking • Thermal ablation (e.g., argon plasma coagulation, laser, electrocautery) • Cryotherapy • Brachytherapy • Photodynamic therapy
Extraluminal	• Mechanical dilatation • Balloon dilatation • Airway stent
Mixed	• A combination of the above options

Central airway obstruction can be relieved by surgery or therapeutic bronchoscopy. Techniques based on bronchoscopy to relieve CAO are summarised in Table 2. Techniques can be broadly categorised as those for endoluminal lesions or extrinsic compression. In mixed lesions involving both endoluminal obstruction and extrinsic compression, combined modalities can be used. In our practice, therapeutic bronchoscopy involving thermal ablative debulking, dilatation via balloon or mechanical coring, and silicone or self-expandable metallic stents are available. Therapeutic bronchoscopy can be performed using rigid or flexible bronchoscopy. The operating theatre, ICU and endoscopy suite are the facility sites where procedures can be performed under general anaesthesia or conscious sedation. Decisions regarding use of specific techniques, equipment and facility sites are made based on multiple considerations, including patient and lesion characteristics, after multidisciplinary discussion.

TAKE HOME MESSAGES

1. Central airway obstruction occurs when airflow is limited owing to blockage of the airway. Symptoms of CAO do not correlate with the degree of stenosis, while airflow is related exponentially to airway diameter.
2. Only a small airway radius is necessary to maintain airflow in the airway. However, acute exponential drop in flow can occur in severely narrowed central airways, resulting in clinical presentation of collapse caused by acute respiratory failure..
3. Assess and consider the risk of sudden respiratory collapse from sedative and paralytic agents due to loss of spontaneous ventilation and airway muscle tone.
4. In patients who are assessed to be at high risk of central

airway collapse, every effort must be made to secure the airway and preserve oxygenation and ventilation.
5. Avoid nonemergent treatment that might damage the tissue resulting in diagnostic difficulty.
6. Successful relief of malignant CAO should facilitate cancer-specific therapy that aims to improve symptoms and/or survival.

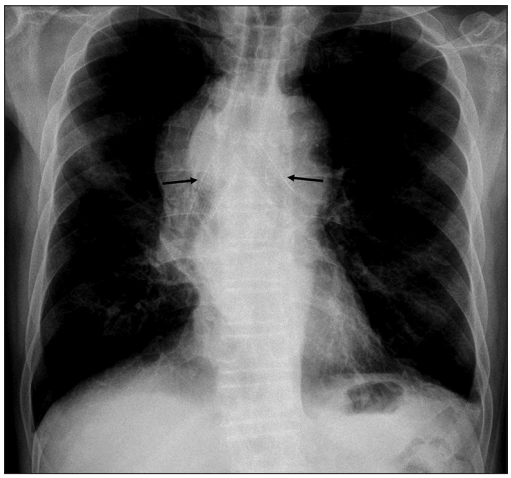

Figure 4: Chest radiograph shows metallic airway stents in the bilateral main stem bronchi (arrows).

Closing Vignette

Given the severity of CAO on CT thorax, the patient was given oxygen therapy via nasal prongs and transferred to the ICU. CT-guided percutaneous biopsy was done at the radiology suite. As the patient was too breathless to lay supine, an ultrasound-guided core needle biopsy was performed under local anaesthesia. Due to presence of compression of bilateral proximal bronchi, both the left and right main bronchi required stenting. The next day, after discussion with the multidisciplinary team, left main bronchus stenting by flexible bronchoscopy was performed under conscious sedation and high-flow oxygenation in the operating theatre with anaesthesia, rigid bronchoscopy, and thoracic and vascular surgeons and ECMO on standby. During the procedure, the patient had an episode of severe desaturation, which reversed promptly with stent deployment. A few days later, his right main stem bronchus was stented in the ICU via flexible bronchoscopy under conscious sedation, fluoroscopy and high-flow oxygenation [Figure 4]. Diagnosis on histology was malignant thymic carcinoma. The patient received palliative radiotherapy and was discharged. He passed away weeks later from pneumonia.

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Conflicts of interest

See KC is a member of the SMJ Editorial Board, and was thus not involved in the peer review and publication decision of this article.

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SMC CATEGORY 3B CME PROGRAMME

Online Quiz: https://www.sma.org.sg/cme-programme

Deadline for submission: 6 pm, 06 Sep 2023

Question	True	False
1. Central airway obstruction (CAO) is defined as 'airflow limitation due to occlusion of trachea, main stem bronchus, bronchus intermedius or lobar bronchus'.		
2. Benign CAO is more common than malignant CAO.		
3. There is more than one classification of CAO.		
4. Location, length, severity of stenosis and anatomical relation to adjacent structures are the key features to note for frontline management of CAO.		
5. Patients with CAO may be wrongly treated for asthma and chronic obstructive pulmonary disease.		
6. Presence of orthopnoea indicates severe airway stenosis.		
7. Bilateral wheezing excludes CAO.		
8. Chest X-ray abnormalities can prompt clinicians to consider CAO.		
9. Patients with CAO should always be intubated and paralysed before computed tomography (CT) scan.		
10. In managing patients with CAO, there is minimal cause for concern regarding haemodynamic stability if the airway is stabilised.		
11. Patients with CAO should always be sent to the operating theatre for airway management.		
12. A multidisciplinary team assessment and discussion on treatment should be initiated for patients with CAO, whose clinicians have anticipated difficulty with airway management.		
13. Rigid bronchoscopy is the definitive method for securing the airway for patients with CAO.		
14. High-risk CAO patients may require extracorporeal membrane oxygenation before diagnostic and therapeutic procedures.		
15. Degradation of tissue specimen can occur during acute management of CAO patients.		
16. Patients with superior vena cava obstruction (SVCO) seen at primary care settings have to be referred to the emergency department.		
17. Patients with SVCO without thrombosis require immediate relief of SVCO by vascular stenting or radiotherapy.		
18. For CAO management, the goals are to relieve airway obstruction, alleviate symptoms and allow patients to receive further treatment.		
19. Therapeutic bronchoscopy for malignant CAO can effect change in the level of care, for example, facilitate discharge of patients from the intensive care unit to the general ward.		
20. For patients who receive cancer-specific therapy after relief of CAO, there is no evidence of increased survival.		