Advanced upper airway obstruction in ENT surgery

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The anaesthetic management of patients with critical upper airway obstruction from tumours involving the area around the larynx can be a challenging problem. A key message from the chapter on head and neck surgery in the 1998 Report of the National Confidential Enquiry into Perioperative Deaths (NCEPOD) was that ‘the management of the obstructed airway gave cause for concern’. The purpose of this review is to discuss the management of patients with advanced obstruction from tumours involving the proximal part of the airway. The sites of obstruction can be divided into supraglottic, laryngeal and subglottic. Pathologies include tumours of the supraglottis, pharynx, pyriform fossa, epiglottis, pyriform vocal cords and subglottis.

Patients considered in this article will, by definition, have significant stridor at rest. However, it is estimated that only 5% of laryngeal cancers will present with severe dyspnoea and stridor. Therefore, these patients are encountered rarely. Although many anaesthetists have strong views about how such patients should be managed, few will have had ‘hands-on’ experience, apart from those regularly working in major ENT or head and neck surgery. Since these patients may present outside regular hours, experienced anaesthetic staff may not always be on-call.

Although only proximal airway obstruction will be considered in detail, reference will be made to the important differences in management between proximal lesions and those causing obstruction at more distal levels of the trachea.

Stridor at rest

If a patient has stridor, it implies that there is a reduction in airway diameter of at least 50%. Beyond that, the precise percentage is difficult to assess clinically. The degree of distress often depends on whether or not the reduction in diameter has developed gradually or rapidly (e.g. acute epiglottitis). Tumours normally develop slowly and the patient has time to accommodate to the reduction in airway diameter and will characteristically present late in the disease. In our region, it is not uncommon for a patient to appear for the first time as an emergency in moderately severe distress from stridor. Such patients are usually heavy smokers and drinkers, are not very active and are often in denial about their symptoms.

Stridor at rest is usually obvious, although sometimes its significance may not be recognised by clinicians from other specialties. The patient should be questioned about the stridor and any positional exacerbation of symptoms. In the later stages of obstruction, nocturnal difficulties are common, usually when the patient is supine. Ask the patient (or their partner) if he/she suddenly wakes up in the night having acute difficulty in breathing. The patient who is critically obstructed will recognise this question, whereas another with a lesser degree of obstruction will not. Supraglottic, pyriform fossa and pharyngeal tumours may also produce dysphagia, sometimes with drooling, because the patient cannot swallow saliva.

Examination and investigations

Fibre-optic nasendoscopy must be performed by the ENT surgeon in the out-patient clinic or on the ward. It may require no local anaesthesia or simple preparation of the nose with lidocaine and epinephrine. The larynx is viewed from above, using a 2.7 mm, short endoscope. The view is usually documented with a photograph but, in the absence of a camera, it is important to question the surgeon as to whether their diagram was an accurate
representation of what was seen. ENT out-patient notes often contain an imprint of the larynx on which the surgeon can draw freehand and it should not be assumed that the presence of the imprint means that the larynx was actually visible. Nasendoscopy does not involve spraying the larynx with a local anaesthetic or making contact with the vocal cords since, in a patient with significant stridor, this may be a hazardous manoeuvre precipitating total obstruction. If an adequate view of the larynx cannot be obtained, it can be reasonably expected that tracheal intubation will be a problem. However, successful visualisation of the larynx with the patient awake and in the sitting position does not mean that it will be the same in a supine, anaesthetised patient.

Computerised tomography (CT) of the neck is especially helpful in assessment of the subglottis and lower extent of a tumour and any lesions further down the trachea. However, it is less helpful in assessing the supraglottis.

In the later stages of obstruction, there may be disturbances of gaseous exchange, manifested by abnormal blood gases. Serial pulse oximetry may be useful. Hypoxaemia, with or without hypercarbia, may be entirely related to the reduction in the size of the airway. However, since effective coughing becomes difficult at this stage, atelectasis or chest infection can be the precipitating factor for decompensation and admission to hospital.

**Decision making**

In advanced cases of perilaryngeal obstruction, the two main options are tracheostomy under local anaesthesia or inhalational induction of anaesthesia.

In patients with stridor at rest, the first decision to be made is whether it is safe to undertake general anaesthesia before the airway is secured. A typical patient who needs a preliminary local anaesthetic tracheostomy often comes to hospital for the first time as an emergency but may occasionally have deteriorated during radiotherapy. Nocturnal respiratory difficulties, panic attacks or hypoxaemia on admission are features suggestive of severe disease. Nasendoscopy may show a fixed hemilarynx, anatomical distortion and an airway that is small or not seen. If the ENT surgeon requests general anaesthesia because he has never done a tracheostomy under local anaesthesia, one should consider whether he/she is suitably experienced to be undertaking such surgery unsupervised. Whilst local anaesthetic tracheostomy is not particularly pleasant, it is preferable to a tracheostomy performed as an emergency when intubation under general anaesthesia has failed and the patient is hypoxaemic.

Usually, it is easy to recognise the category to which a patient belongs. The patient with less severe obstruction is usually referred to an out-patient clinic and subsequently admitted for the next operating list. This is more likely to be someone suitable for an inhalational anaesthetic.

Another factor in the decision-making process is whether or not the patient ultimately requires a tracheostomy for therapeutic reasons, as opposed to solely for examination and treatment under anaesthesia. Patients with significant laryngeal or subglottic tumours will usually need a therapeutic tracheostomy but, in those with supraglottic lesions, it may be possible, even preferable, to relieve the obstruction initially by debulking the tumour.

**Special considerations**

Epiglottic tumours can bleed alarmingly at the slightest interference. The best attempt at tracheal intubation is the first attempt and it is advisable to start off with a long blade or a McCoy blade. A bougie is often required to negotiate passage around the mass. These and other types of supraglottic tumour pose a problem because they may partially or wholly obscure the larynx, although the larynx itself is usually normal. In general, these patients will require laser debulking of the tumour followed by radiotherapy. Radiotherapists prefer to undertake radiotherapy without a tracheostomy. Therefore, the aim of debulking is to relieve the obstruction sufficiently to avoid it. At the end of the procedure, it is often advisable to leave a small diameter Cook airway exchanger taped in place so that a tracheal tube can easily be re-introduced should laryngeal oedema occur.

Except in an emergency, it is important to define the lower extent of subglottic tumours with a CT scan, since a tracheostomy incision may enter the tumour.

**Inhalational induction of anaesthesia**

An inhalational induction in a patient with stridor is difficult and it is important to involve 2 anaesthetists and an experienced anaesthetic assistant. The most difficult part of the induction is the point at which the patient initially loses consciousness, when respiration becomes obstructed. Insertion of an oral airway at this stage can induce coughing and laryngeal spasm. At best, this may result in a few minutes of difficulty whilst control is regained; at worst, there can be complete loss of the airway. Insertion of an oral airway during light anaesthesia is, therefore, contra-indicated. Recent radiographic and MRI studies have shown that, at induction of anaesthesia, the...
most important cause of obstruction is not, as previously thought, posterior displacement of the tongue, but approximation of the soft palate to the posterior pharyngeal wall. We have found that the use of a nasal airway, rather than an oral airway, helps to smooth out this difficult, initial phase of induction.

1. Prepare the nose with a vasoconstrictor local anaesthetic, so that a nasal airway can be passed in the early stages, if necessary. Four to five sprays of 5% cocaine are directed into each nostril and the patient is asked to sniff, whilst the opposite side is occluded.

2. Induce anaesthesia in theatre with full monitoring, i.v. fluids and the surgeon standing by scrubbed ready in case emergency tracheostomy is required. A rigid, ventilating bronchoscope should also be at hand.

3. Start induction of anaesthesia with sevoflurane and 100% oxygen, and continue until the blood pressure starts to decrease.

4. If the patient becomes apnoeic, as often occurs during sevoflurane induction, do not be tempted to assist ventilation. Allow the CO₂ to rise and the patient will start to breathe again. The safety of an inhalational technique lies in the maintenance of spontaneous respiration.

5. If the airway obstructs, do not insert an oral airway because the patient may start to cough and develop laryngeal spasm. Instead, gently insert a lubricated 6 or 7 mm nasopharyngeal airway. This will usually improve respirations.

6. Induction takes time and cannot be hurried. Sevoflurane is an ideal agent with which to begin induction. However, in some patients it may fail to provide anaesthesia of adequate depth and for a sufficient length of time, to perform direct laryngoscopy and pass a tube. In such patients, a change to halothane may be required. Simple clinical observations will suggest if and when this is necessary. If, during induction, the blood pressure fails to decrease on sevoflurane and the pupils do not become small and central, it is likely that anaesthesia is not deep enough for instrumentation. In this event, a change to halothane is worthwhile.

7. When anaesthesia is finally considered to be deep enough, gentle laryngoscopy should be attempted, using a long or McCoy blade. A rapid decision must now be made as to whether or not to pass a suitably sized tube. If, under direct vision, the anatomy is difficult to visualise, or the aperture is judged to be too small, it may be prudent to withdraw and allow the surgeon to undertake an unhurried tracheostomy while the patient still maintains adequate spontaneous respiration. If a decision is made to try to pass a tube, only one or two attempts must be made. Ill-judged or persistent attempts at tracheal intubation may result in total obstruction, or bleeding from the tumour. It is unwise to give a muscle relaxant until the tube is down, particularly when the tumour is subglottic. Sudden complete obstruction requires immediate tracheostomy, or, if the surgeon is experienced in the technique, a single attempt at passing a rigid bronchoscope may be contemplated.

Severe stridor requiring tracheostomy under local anaesthesia

Those patients with severe stridor, a large tumour, fixed hemilarynx, gross anatomical distortion or a larynx not visible on nasendoscopy should undergo tracheostomy under local anaesthesia. No sedation should be given. The use of a helium/oxygen mixture undoubtedly improves symptoms. Heliox cylinders contain only 21% oxygen. Therefore, to achieve higher concentrations, a medical helium cylinder can be adapted to fit into the air rotameter on the anaesthetic machine and the flow meters adjusted to deliver the required percentage of oxygen. However, once oxygen is given, tracheostomy should not be delayed because, in a chronically obstructed patient, relief of hypoxaemia may precipitate CO₂ retention and loss of consciousness. Patients who are close to becoming completely obstructed may find it difficult to tolerate the supine position, so initial preparations for surgery may have to be made with the patient sitting. Once the tracheostomy tube is in place and its position confirmed with the capnograph, anaesthesia is induced so that a full examination can be made and biopsies taken.

Anaesthesia after securing the airway

Once the airway has been secured, the surgeon will examine the tumour under anaesthesia, take biopsies or perform a debulking procedure. Choice of anaesthetic technique is not critical for this stage but we prefer to use a total intravenous infusion technique using remifentanil and propofol as this provides better control of extubation.

Tracheostomy management

If a surgical tracheostomy has been formed, the patient will need analgesia before reversal of anaesthesia. We prefer intramuscular morphine and cyclizine given 30 min before the end of surgery. Morphine also acts as a cough suppressant and helps the patient tolerate the presence of the tracheostomy tube in the initial stages. Humidification will be required until the tracheal mucosa has adapted to the outside air.

Tracheal tube management

If tracheostomy has been avoided, the tube must not be removed until the patient is awake. One advantage of remifen-
tanil is that the return of consciousness and the cough reflex occur almost simultaneously. This avoids the period of intense coughing and associated cardiovascular stimulation which occur with most other techniques when the tube is still in place. Since laryngeal oedema can develop initially when the tube is no longer splinting the larynx, in some patients, the tube can be removed over a small Cook airway exchanger. This is often well tolerated and can be left in place until it is certain that the patient can breathe adequately. The Cook airway exchanger has the advantage of allowing either insufflation of oxygen via a normal connector or Venturi ventilation with a Manujet (VBM Medizintechnik GmbH, Neckar, Germany) using the Luer lock connector.

If debulking has been undertaken, humidification and dexamethasone may be required for 24 h. In patients in whom a severe degree of obstruction has been present for some time, pulmonary oedema may follow tracheostomy. This may be exacerbated by the fact that the patient can no longer generate an expired positive pressure. In cases of mild hypoxaemia, a CPAP device connected to the tracheostomy may be sufficient to improve oxygenation; in more severe cases, IPPV may be required for 24 h.

**Why is fibre-optic intubation not a safe technique for a patient with advanced obstruction from a periglottic tumour?**

Why do many anaesthetists believe that awake fibre-optic intubation is the method of choice in obstructing laryngeal tumours? The answer most often given is that ‘the awake patient maintains his/her own airway’. Whilst this is true for the patient in whom conventional tracheal intubation is impossible for anatomical reasons, it does not necessarily apply to the patient who has severe pathological obstruction from a lesion in the periglottic area. In fact, the patient whose breathing is increasingly being compromised by tumour finally presents to hospital for the very reason that he cannot maintain his own airway. If we examine the conditions required to produce a smooth awake fibre-optic intubation and apply them to a patient with severe obstruction, then it becomes apparent why it is a less than ideal technique in these circumstances.

1. Judicious, light sedation - it is dangerous to sedate a patient with stridor.
2. A calm patient - a patient with critical airway obstruction is terrified.
3. Perfect local anaesthesia - in the presence of a tumour, good local anaesthesia is difficult to achieve by any method. In addition, laryngeal spasm may precipitate total airway obstruction in the patient who is awake.
4. Ability to distinguish the anatomy - if the anatomy is difficult to distinguish with a standard laryngoscope, what hope is there with the view provided by a 4 mm fibrescope? The ability to see through a fibrescope depends on the presence of an air space. In addition, the view is much worse than that seen using a Macintosh laryngoscope.
5. Minimal blood and secretions - there is a risk of dislodging tumour or of causing haemorrhage, particularly with supraglottic tumours.
6. The ‘cork-in-bottle’ situation - if you try to pass a 4 mm bronchoscope into a 5 mm hole, it completely obstructs the patient's airway. If you do succeed in passing the fibrescope into the larynx, you will have ‘corked off’ the patient's remaining airway and he will fight vigorously to prevent you threading a tube into the trachea. These patients are often mildly hypoxaemic to start with. If adequate pre-oxygenation has not taken place, oxygen saturations rapidly decrease, so unconsciousness and apnoea will supervene rapidly. If you fail to pass a tube at this stage, the only fall-back strategy will be emergency tracheostomy, in the anaesthetic room, in a patient unconscious from hypoxaemia.

**Cautions concerning other techniques**

Some rely upon cricothyrotomy and Venturi ventilation as a fall-back strategy. Whilst this can be life-saving under many circumstances, in the case of advanced tumours barotrauma is a risk because the obstruction does not allow sufficient room for expiration. If cricothyrotomy has to be performed, it is important to begin with very low pressures. A commercial Venturi device that allows control of the inspired pressure, such as the Manujet, must be available in theatre.

Percutaneous tracheostomy is unsuitable for first-line management of obstructive lesions, because of the inability to monitor the insertion procedure with a fibrescope. In addition, with subglottic lesions, there is a danger of inserting the guidewire directly into tumour. However, it may be a useful alternative to surgical tracheostomy, as a temporary measure once the airway has been secured and anaesthesia induced.

**Importance of locating obstruction in the lower trachea**

Obstruction of the mid and lower trachea poses an entirely different management problem from that of laryngeal obstruction.
When mid-tracheal obstruction results from a thyroid mass compressing the trachea, tracheostomy cannot be performed because the thyroid is in the way. Thus, an inhalational induction would be unsuitable as a first choice of induction because, if obstruction suddenly occurs, emergency tracheostomy is not an option. Fortunately nowadays, with the advent of CT scans, the site and exact dimensions of the narrowest portion of the trachea can be measured. Provided there is sufficient clearance above the carina for the tracheal cuff, in most cases a standard intravenous induction can be performed. With benign thyroid lesions, the compression is soft, so it is possible to pass a larger tube than the CT measurements show. In contrast, thyroid carcinomas are unyielding and tumour can invade the tracheal wall. Thus, there is always the possibility of tracheal collapse following muscle relaxant administration. In all cases, a rigid bronchoscope should be at hand.

In the case of a lymphoma or carcinoma compressing the lower trachea (and possibly a bronchus), again a tracheostomy will not solve the problem, since the tracheostomy tube will not be long enough to relieve the obstruction. General anaesthesia in which a muscle relaxant is given is contra-indicated because it may precipitate complete airway obstruction. Again, a CT scan is essential. If the obstruction is close to the carina, or invading a bronchus, the patient should be transferred to a unit with cardiothoracic facilities, in case cardiopulmonary bypass is needed. In the event of an emergency in which a scan cannot be performed, insertion of a rigid bronchoscope may be life-saving.

Key references
Mason RA, Fielder CP. The obstructed airway in head and neck surgery. Anaesthesia 1999; 54: 625-8

See multiple choice questions 89–93.