

## 42 Airway priority

### 42.1 Causes of airway obstruction

For any trauma patient, *you must always rapidly identify if there is an airway problem* because hypoxia can quickly be lethal, or cause irreparable brain damage.

Practice techniques on simulators, mannequins, & watching videos, and then on stable patients in the controlled setting of an operating theatre. Once you are familiar with the equipment and techniques, you will find managing the airway in trauma patients much easier and less stressful.

#### ABCDE: AIRWAY, BREATHING, CIRCULATION, DISABILITY, EXPOSURE

##### PRIMARY SURVEY

***If a patient survives the initial injuries & does not have catastrophic external haemorrhage, the next immediate risk is obstruction of the airway.***

Ensure he can breathe: this must be your 1<sup>st</sup> priority.

##### Look for:

- (1) coma or decreased conscious level (GCS <8),  
*N.B.* This depresses protective airway reflexes, so incurring risk of broncho-aspiration, and causes relaxation of the tongue (which then falls backwards) and jaw musculature, *risking upper airway obstruction.*
- (2) oro- or maxillo-facial injury,
- (3) respiratory or facial burn,
- (4) penetrating neck injury (especially with an expanding haematoma)
- (5) anything that occludes the airway, such as broken or false teeth, laryngo-tracheal injury, or laryngospasm.
- (6) aspirating vomit, or oils rubbed on the face (47.4).
- (7) apnoea or hypoxia from any cause.

***A patient who can speak clearly has an open airway.***

Signs of upper airway obstruction are:

(1) Lack of air movement or any sound of breathing associated with forceful movements of the chest wall and abdomen,

*N.B.* This indicates complete airway obstruction and is an absolute emergency.

(2) Inward movements of the chest wall or epigastrium, & use of accessory muscles,

(3) General signs of hypoxia (initial tachycardia, later bradycardia)

(4) Restlessness, agitation or confusion,

(5) Cyanosis (often a difficult sign to detect),

(6) Sweating

*Never sedate such a patient!*

Monitoring will show a low O<sub>2</sub> saturation (<90%).

***Hoarse voice, noisy breathing (stridor), or sounds of snoring, indicate partial airway obstruction.***

*N.B.* Wet, bubbling sounds may indicate blood, secretions or vomitus in the upper airway or tracheo-bronchial tree.

Sometimes the airway is clear, but delayed obstruction is likely. So you should prepare for this. Suspect this in:

- (1) Respiratory & facial burns,
- (2) Neck injury,
- (3) Subcutaneous emphysema in the neck,

*N.B.* If you wait, and do nothing, the obstruction usually gets worse!

##### Feel for:

Tracheal deviation,  
Fractured ribs,  
Subcutaneous emphysema,

##### & Listen for:

Decreased & abnormal breath sounds (as well as stridor).

##### AIRWAY MANAGEMENT

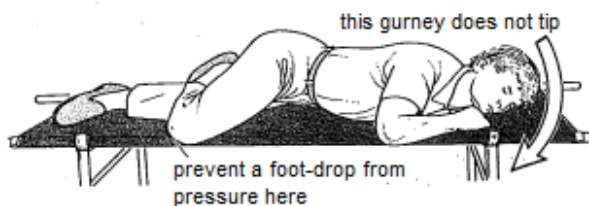
This is usually divided into basic (42.3) and advanced (42.4).

*Always administer oxygen, if available, during airway manipulation.*

***If the patient has impaired cognitive function (GCS≤8), and there are no airway tools available, make sure he is transported in the recovery position (42-1).***

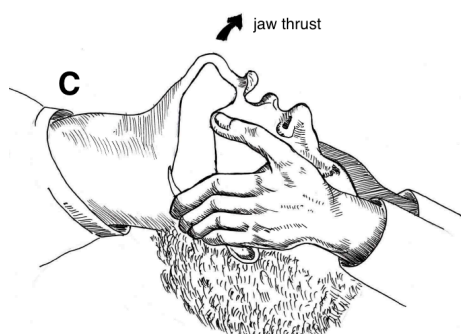
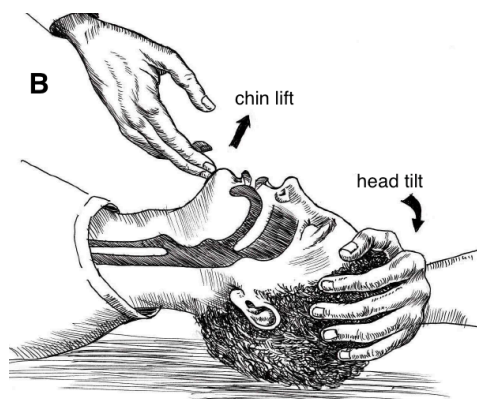
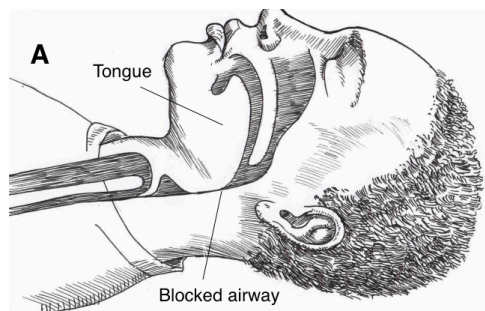
**IF IN DOUBT ABOUT THE AIRWAY, PERFORM A TRACHEOSTOMY. DON'T DELAY!**

### A PATIENT IN THE RECOVERY POSITION



**Fig. 42-1 THE  $\frac{3}{4}$  PRONE POSITION.** This is the 'recovery' position: on the side with the thorax at  $45^\circ$  to the horizontal. Support the chest with a pillow, but *don't let it interfere with breathing*. Flex the uppermost arm in front of the trunk with the hand under the jaw to give additional support. Keep the lower arm behind the back. Prevent rolling over by flexing the upper leg, while the other remains extended, but *don't let the knee press against the common peroneal nerve for a prolonged period*, as this can result in foot drop. *Always lay a pregnant woman on her left side!* *N.B. If a patient rolls over to the fully prone position, especially if obese, proper breathing may not be possible! So, return to the semi-prone position immediately!*

### HEAD TILT & JAW THRUST MANOEUVRES



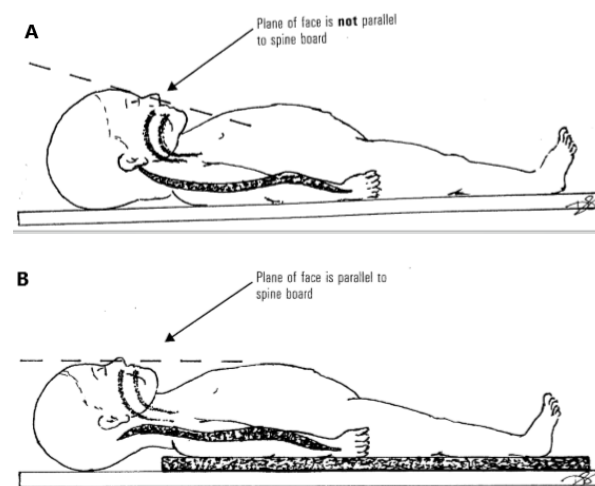
**Fig. 42-2 CLEARING THE AIRWAY.** A, the tongue from falling back & occluding the airway. B, the chin lift & head tilt or C, the jaw thrust freeing the airway.

If there is vomitus or blood in the oropharynx (and the patient is unconscious), clear the oropharynx with strong suction while the patient is in the lateral position.

*N.B. Don't use your fingers, unless a bite block is in place.*

The patient's tongue falling back is the most frequent cause of partial or complete airway obstruction in poorly responsive trauma patients. Perform the head-tilt/chin-lift or jaw-thrust manoeuvre (41-2) to improve airway patency.

### THE CHILD IN THE SUPINE POSITION



**Fig. 42-3 LYING A CHILD SUPINE.** A, the relative size of the head means that neck is flexed. B, when you put padding under the body, the face becomes parallel to the stretcher board.

In a child lying supine, the size of the head causes passive flexion of the neck. This threatens the airway, so place a layer of padding under the child's body (42-3).

*N.B. If there is a chance of cervical spine injury, pull the tongue forward with a swab, forceps or suture, or use an oral (Guedel) airway (42-3).*

## THE ORAL (GUEDEL) AIRWAY

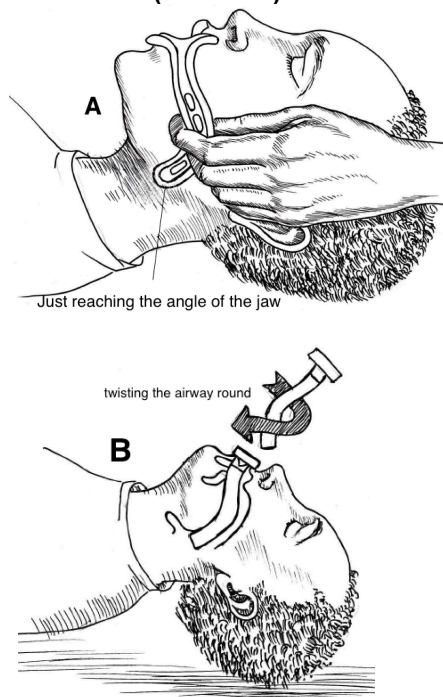


Fig. 42-4 INSERTING A GUEDEL AIRWAY. A, measure the correct size to use (*should reach the angle of the jaw*). B, insert the airway upside down into the mouth, and then turn it round so it glides over the tongue. *N.B. Sanitize metal (non-disposable) airways thoroughly after use.*

*N.B. If such an oral airway is well-tolerated, there is significant depression of the protective airway reflexes, which may mean you should intubate the patient, provided you have the necessary skills and equipment. The Guedel airway is often very useful in alcohol intoxication, in which case, however, you may not necessarily have to resort to tracheal intubation.*

A naso-pharyngeal airway will also relieve airway obstruction by lifting the soft palate and tongue (42-5). These airways are better tolerated than oral ones. They are especially valuable in cases of trismus. Use ephedrine (or xylometazoline) vasoconstrictive nasal spray, LA and lubricant jelly before passing the airway through a nostril; this helps prevent nose-bleeding and eases its passage.

You can use the jaw thrust and chin lift, to restore airway patency quickly (42-2), but this needs manpower to maintain. So, to free you for other tasks, insert an airway if the conscious level does not improve substantially quickly.

*N.B. A patient may need both an oral airway and a nasal trumpet (airway) to relieve obstruction.*

**Note if breathing responds to your initial management. If not, move rapidly to other options.**

## INSERTING A NASOPHARYNGEAL AIRWAY

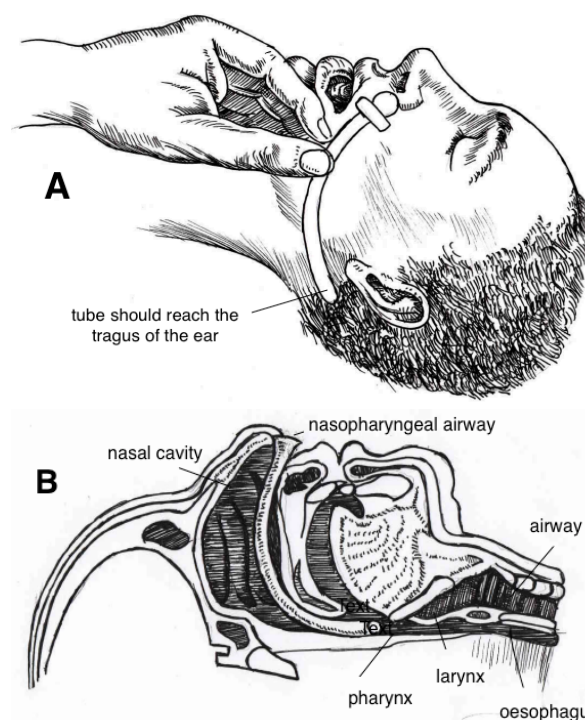


Fig. 42-5 INSERTING A NASOPHARYNGEAL AIRWAY. Choose the nostril which is least deviated. A, measure the correct size (to reach the tragus of the ear). B, pass it into the nasopharynx.

The Laryngeal Mask Airway (LMA, 42-6) is a very useful device in difficult situations. Its purpose is that the mask sits in the hypopharynx covering the glottic opening and providing an airway. The cuff forms a low-pressure seal around this opening.

## LARYNGEAL MASK



Fig. 42-6 INSERTING A LARYNGEAL MASK. A, press the LMA against the hard palate and slide it into the mouth. B, use your middle finger to push the jaw downward. C, advance the LMA till it sits in the oropharynx.

It is not a secure airway, because broncho-aspiration is still a risk, but it is an excellent rescue device if you cannot aerate a patient with a bag-mask nor intubate the trachea. After you have inserted an LMA, the patient may breathe spontaneously or need manual ventilation.

*N.B. Like the Guedel airway, you can only use this device in poorly responsive, comatose or anaesthetized patients.*

**CAUTION!** If residual reflexes are present, placement this tube may promote vomiting and subsequent broncho-aspiration.

To place an LMA, first prepare the device by deflating the cuff and lubricating the posterior surface. Open the patient's mouth and, under direct vision, press the tip of the LMA against the hard palate and slide it into the mouth (42-6A). You may use your middle finger to push the jaw downward (42-6B); this also ensures the tongue is not trapped within the LMA opening and dragged deeper into the oral cavity. Advance the LMA until it resists additional forward motion (42-6C). Inflate the cuff and attempt ventilation. If there is a leak you can reposition the LMA or try using one size larger, or smaller:

Mask size	Weight (kg)	Patient	Cuff volume
1	<6.5	infant	2-3
2	6.5-20	small child	5-10
2.5	20-30	large child	5-15
43	>30	small adult	5-20
4	<70	adult	15-30
5	>70	large adult	20-30

Once you have performed the necessary manoeuvres to maintain an open airway, assess whether the patient needs ventilatory support.

Look for these signs:

- (1) Bradypnoea,
- (2) Gasping,
- (3) Rapid shallow ventilation,
- (4) Respiratory fatigue,
- (5) Refractory hypoxia
- (6) Apnoea.

These suggest a **'Breathing'** problem needing immediate attention (41.1, 43.1,2).

You can assist a patient's breathing or breathe for him with AMBU bag ventilation. This is a skill, and it takes time to acquire the necessary expertise to ventilate difficult patients effectively. When you hold the mask, it is important that the tip of your fingers grasp the bony contour of the mandible, not the soft tissues of the floor of the mouth, which would aggravate any obstruction (42-7).

Even in experienced hands, a two-hand/two-person technique may sometimes be more effective, with one person holding the mask with both hands and another squeezing the bag.

*It is important to observe the patient's chest movements while performing BVM ventilation to ensure that you are actually ventilating the patient.*

## HOLDING A FACE MASK



**Fig. 42-7 HOLDING A FACE MASK PROPERLY.** This is a skill you must learn. Although the 'C-E' grip is recommended, you can't really properly hold on the mask with one hand.

**If the patient is breathing spontaneously, but requires ventilatory assistance,** squeeze the bag as the chest is rising and release the bag during exhalation.

*N.B. If you are not in synchrony with the patient's efforts, you might even worsen the ventilation and oxygenation!*

**If you feel or hear an air leak around the mask,** change your hand position to obtain a better seal.

**If the patient is not breathing spontaneously** (and you are assisting him), *make sure there is symmetrical chest movement with each administered tidal volume.* Get someone to check the patient's breath sounds with a stethoscope. If you have a pulse oximeter, you should maintain saturation >90%.

**If you are having trouble ventilating the chest,** consider another option to improve airflow (e.g. laryngeal mask or intubation).

**If ventilation is not adequate,** the patient is unlikely to survive. the only chance is intubation or one of the adjuncts (42.3) or a surgical airway.

## 42.2 Endotracheal intubation: indications, dangers & methods

Indications for endotracheal intubation include:

- (1) Relief of airway obstruction,
- (2) Airway protection in an unconscious patient,
- (3) Airway support where the airway may be compromised later,
- (4) Ventilatory support,
- (5) Access for bronchoscopy,
- (6) General anaesthesia.

*N.B.* A severely injured, poorly responsive or unconscious patient may not require anaesthetic drugs for intubation, but *remember the adverse effects of possible straining, gagging, and coughing.*

In preparation, work through as much of this checklist as is feasible in your specific situation:

- (1) Rapidly assess the airway.
- (2) Monitoring: (oximeter, blood pressure, ECG).
- (3) Ensure the oxygen flowing (and pre-oxygenate, if there is time).
- (4) Ensure adequate IV access.
- (5) Ensure all equipment is present and **working!**
- (6) Ambu-bag with high flow oxygen.
- (7) Masks of all sizes.
- (8) Functioning laryngoscope with blades of different sizes.

### (9) Endotracheal tubes

(7-8 for adult males; 6.5-7.5 for adult females).

*N.B.* The formulae  $(4 + \frac{1}{4} \times \text{age of child}) = \text{uncuffed child tube size}$ , &  $(3 + \frac{1}{4} \times \text{age of child}) = \text{cuffed child tube size}$ .

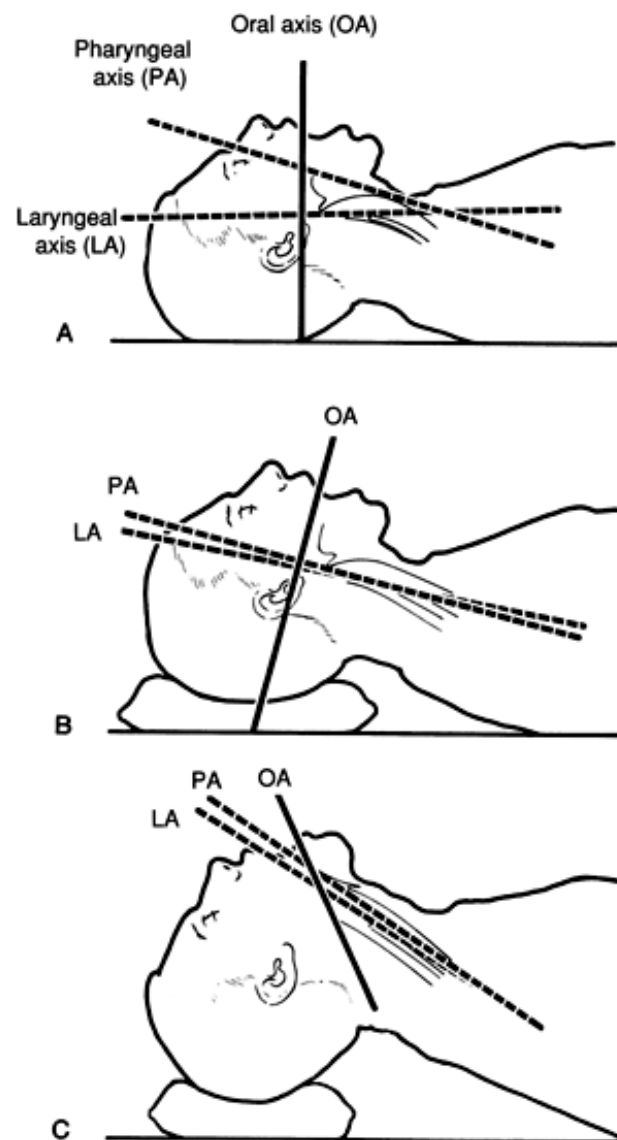
Use an uncuffed size 3 for infants >3.5kg and <1 year old.

- (10) Smaller sized endotracheal tubes (unopened).
- (11) Get a bougie or stylet ready.
- (12) Ensure suction is available and **working!**
- (13) Draw up the necessary drugs into syringes, *and label them.*
- (14) Position the patient.
- (15) Have a LMA on the back table.
- (16) Have a cricoidotomy or tracheostomy set available

### INTUBATING USING DIRECT LARYNGOSCOPY

*Positioning the patient is key to successful endotracheal intubation using direct laryngoscopy.* The goal is to align the patient's head and neck in such a way as to allow direct visualization of the vocal cords (42-8). Use the 'sniffing position' (flexion of the lower cervical spine on the thoracic spine, and extension of the head on the upper cervical spine).

### POSITION FOR ENDOTRACHEAL INTUBATION



**Fig. 42-8 POSITION FOR ENDOTRACHEAL INTUBATION.** Use the 'sniffing position' Note how the laryngeal axis changes with position

In obese patients, ramp up the patient (42-8) by placing folded blankets under the thoracic spine, and then place him in a sniffing position. In the ideal ramped-up position, the tragus of the ear is at the same level as the sternal notch when you view the patient from the side.

Hold the laryngoscope in your left hand. Open the patient's mouth with your right hand, and introduce the laryngoscope into the right side of the mouth. Sweep the tongue to the left and hold it in that position with the flange of the laryngoscope blade (42-10).

*Remove ill-fitting dentures, but keep well-fitting dentures in place.*

## POSITION FOR INTUBATION IN OBESE PATIENTS

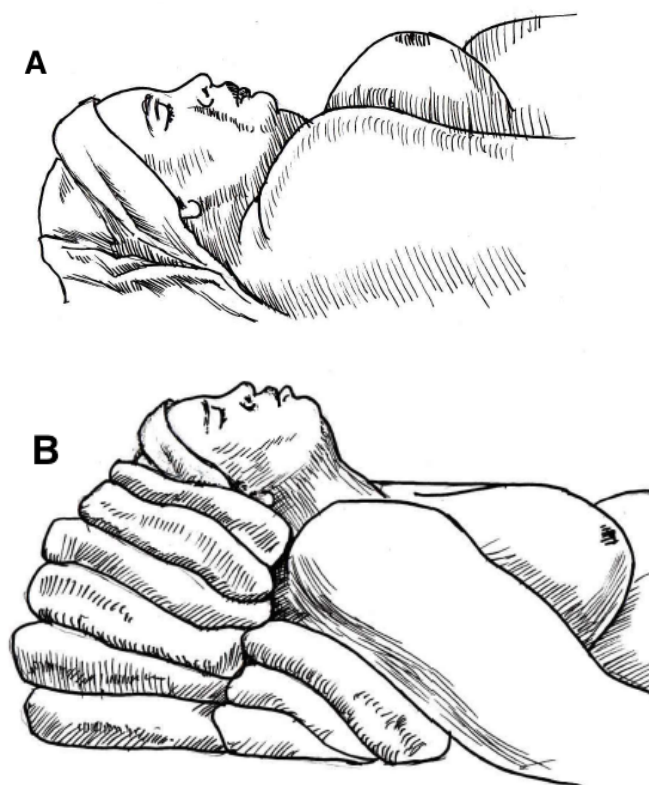


Fig. 42-9 A, the supine position (*endotracheal intubation impossible*). B, the 'sniffing' position, maintained by a careful assembly of cushions.

## INDUCTION AGENTS & PARALYTICS

Unless the patient is already unconscious, administer induction agents *before* paralyzing agents. Their duration of action is short (<3mins). For continued anaesthesia, replace them with longer acting sedatives, an inhalational agent, or a continuous infusion immediately following intubation. Ketamine is the best choice when expertise is limited. Neuromuscular blocking agents make intubation significantly easier, but are not always necessary, and carry serious additional risks.

Sweeping the tongue to the left gives a clearer view of the glottis and allows you to advance the endotracheal tube without the tube itself obstructing your view. Insert the tip of the curved blade into the vallecula, although you can also use it to lift the epiglottis. (A straight blade typically is better for this).

*Don't tilt the handle back onto the upper teeth!* Move it forward or upward, sometimes with considerable effort, in a curve aligning it with the handle of the laryngoscope. This lifts the mandible and soft tissue and exposes the vocal cords without damaging the teeth (42-11).

## VIEW OF DIRECT LARYNGOSCOPY

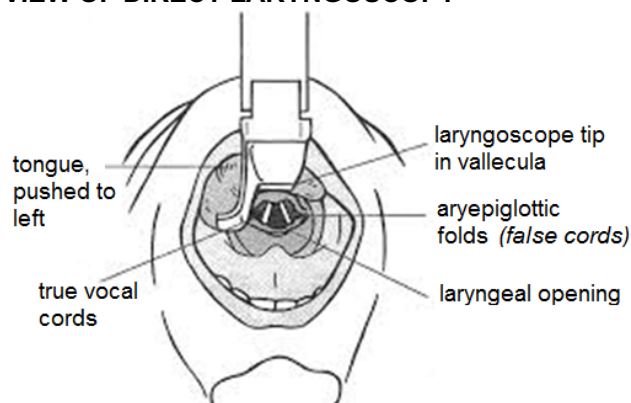


Fig. 42-10 DIRECT LARYNGOSCOPY VIEW.

## VIEW OF THE VOCAL CORDS & TRACHEA

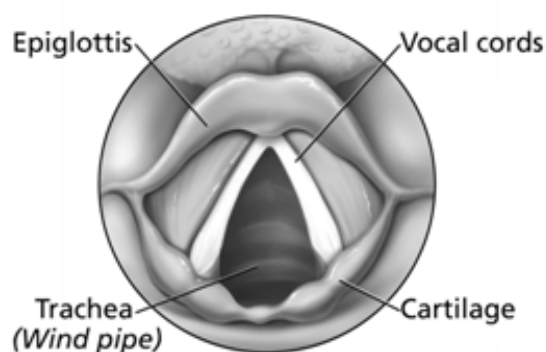


Fig. 42-11 VIEW OF THE TRACHEA

**If you are worried about a cervical spine injury,** keep the head and the neck in a neutral position and get an assistant to apply in-line-traction, either from the front (42-11) or from behind.

## IN-LINE NECK STABILIZATION



Fig. 42-12 HOLDING THE NECK RIGID WHILST INTUBATING.

Holding the neck rigid may make it more difficult for you to visualize the entire glottic opening. Try using the bougie in this situation.

**If you can visualize any portion of the epiglottis**, advance the bougie directly under it. One end of the bougie has a flexed end to make this easier, and you can mould the bougie into a useful C-shape. When you enter the trachea, you will feel the bougie bump along the superior portion of the tracheal rings as you advance it. Hold the end of the bougie and avoid tearing the endotracheal tube cuff on the teeth as you advance it over the bougie into the mouth and into the trachea.

*N.B.* It is easier to succeed in placing the endotracheal tube, if you get an assistant either to hold the laryngoscope in position, or to advance the tube.

It is not uncommon for the inferior portion of the tube opening to snag against the arytenoids. This will stop you advancing it into the trachea, but you can easily overcome this problem by rotating the tube 360° and slide it into the trachea.

If you do not have a boogie, a metal stylet inside the tube will make it handier to shape as desired (e.g. U-shape, hockey stick, etc.). In this case, the tip of the stylet must never protrude beyond the tip of the tube where it risks lacerating the trachea or larynx.

During direct laryngoscopy, as soon as the tube tip approaches the cords, get an assistant to withdraw the stylet, and advance the tube (*without the stylet inside!*) into the trachea.

*N.B.* You can easily create your own stylet by using wire of the appropriate diameter.

#### FIBRE-OPTIC INTUBATION

If you have a video-laryngoscope or a fibre-optic laryngoscope, position the patient supine (*no need for a sniffing position*), and so it is very useful in neck injuries) and advance the laryngoscope down the middle of the tongue.

For a nasal fibre-optic intubation, prepare both nostrils with vasoconstrictive drops and spray both with LA. Introduce a nasal airway coated with lubricant jelly (the size of the endotracheal tube you intend to use) into each nostril and decide which side is easier. (Patients may themselves be able to report which is the better side.)

Administer 10mg ketamine IV and repeat this dose as necessary if the patient is uncooperative. Blow oxygen through the suction port of the fibre-optic scope (this will also blow secretions away from the tip).

Thread the endotracheal tube over the fiberoptic scope and secure it as close to the eyepiece as possible with a piece of tape.

It will be threaded off the fiberoptic scope, through the nostril and into the trachea after the trachea has been entered and the carina visualized.

Advance the laryngoscope and when you visualize the glottis, spray the vocal cords and the upper trachea with 5-10ml LA through the injection port, while temporarily stopping the suction. This will make the patient cough at first, but he will subsequently be more comfortable.

Once inside the trachea, and visualizing the carina, get an assistant to hold the fibre-optic scope straight, and slide the endotracheal tube off the scope through the nostril and into the trachea.

**If there is resistance to the endotracheal tube advancing** (this may occur at the level of the choana or the arytenoids) rotate the tube slightly and push it further. When you are satisfied, withdraw the fibre-optic scope, *taking care not to dislodge the endotracheal tube*.

*N.B.* In rare instances, you can try a nasal intubation blind, *i.e.* without use of the fibre-optic scope, provided you have some experience, and understanding that the success rate is inevitably limited.

Changes in airflow from the outer opening of the tube, depending on the position of the tube and neck will help you guide the tube through the cords.

**CAUTION!** Don't do this if there might be a neck injury!

#### INTUBATION WITHOUT SEDATION

**In an unconscious patient**, sedation is not necessary. But this technique may still be stressful for the patient if he is poorly responsive (particularly as a result of excess alcohol) and carries an increased risk of regurgitation.

Prepare 10ml 2% LA; spray 4-5ml onto and over the back of the patient's tongue. Introduce a well-lubricated laryngoscope over the tongue until you see the tip of the epiglottis. Then spray a further 1-1.5ml onto it. When you see the vocal cords, spray a further 2-3 ml into the upper larynx and between the vocal cords.

Alternatively, puncture the cricothyroid membrane with a 21G needle attached to a 3ml syringe containing 2% LA. When you aspirate air, inject the LA. This will cause the patient to cough and will anaesthetize the inferior surface of the vocal cords and the trachea.

When the cords are widely abducted during inspiration, pass the endotracheal tube into the trachea and inflate the cuff. The patient may cough a little, but will tolerate the tube.

#### RAPID SEQUENCE INDUCTION & INTUBATION

Use this if you are confident in intubation, and have everything well prepared.

Position the patient 10-15° head-up (reverse Trendelenburg) if possible. This will help to prevent passive regurgitation during induction of anaesthesia. Pre-oxygenate with 100% oxygen for 3mins.

Get an assistant to administer ketamine IV 1-2mg/kg followed immediately by succinylcholine 1.5mg/kg as paralyzing (neuromuscular block) agent.

*N.B. Cricoid pressure (the Sellick manoeuvre) used to be advocated to prevent regurgitation during intubation. However this manoeuvre may make intubation difficult and there is no guarantee that you will occlude the oesophagus this way. In fact it probably causes it simply to deviate the airway laterally, though this may help the anaesthetist.*

Once fasciculation starts, introduce the laryngoscope into the patient's mouth and intubate him as described above.

#### CONFIRMING CORRECT TUBE PLACEMENT

Once the endotracheal tube is in the trachea, inflate the cuff and ventilate the patient; watch and listen to the right chest, left chest and epigastrium.

**If you hear breath sounds over the stomach but not on the chest (which is neither rising and falling as expected),** the tube is in the oesophagus. Stop the ventilation (*overdistension and even gastric rupture may occur, especially in children*), remove the tube, re-ventilate by face mask, and reposition the patient before you try a second attempt at intubation.

**If you hear breath sounds on the right, but not on the left,** you probably have introduced the tube into the right main bronchus. Withdraw the tube slowly while checking breath sounds.

*N.B. The correct position of the tube in most adult women is at 21cm from the teeth; and in most adult men at 23cm.*

After intubation and appropriate positioning of the tube, inflate the cuff with the least amount of air needed to create a seal during ventilation. Withdraw air until there is an air leak during inspiration, and then inject an additional 1-2ml of air into the cuff.

*N.B. Most endotracheal tubes today have high-volume, low-pressure cuffs that will not injure the mucosa. Nonetheless, chronic use & high inflation pressures may cause a tracheal stenosis!*

#### TRANSPORT

*A patient who has been intubated must have the tube fixed carefully in place by a figure-of-8 sticky plaster (or strap around the neck), and be accompanied by skilled personnel and equipment that will allow for mask ventilation, or re-intubation in case of accidental extubation.*

**If that is not available,** tracheostomy is safer.

#### INABILITY TO INTUBATE

*Limit the duration of your attempts at intubation! Hold your own breath when you start an intubation, and stop when you have to breathe again!*

At all costs, *avoid hypoxia* to the patient (which is what you are trying to prevent). Ventilate by mask or let the patient breathe oxygen between attempts. Check the oximeter to guide you when to stop, if you have one. *Don't make >3 attempts!*

*N.B. Excessive manipulation of the airway may lead to oedema, bleeding and its complete loss!*

#### **LOSS OF AN AIRWAY IS CRITICAL!!**

Let the most experienced person take charge, and call for help. Cricoid puncture is the easiest quick solution.

**If intubation is not possible,** because of abnormal anatomy, lack of equipment, or lack of personnel with the needed skills, rely on *mask ventilation using a LMA, or perform an emergency cricoidotomy (42.3) (or tracheostomy in children), which can be life-saving.*

**Put in place clear and agreed protocols for the difficult airway, tailored to what is locally available.**

*N.B. An emergency tracheostomy is difficult: cricoidotomy is preferable in the first instance in emergencies!*

### 42.3 Cricoidotomy & tracheostomy

#### CRICOIDOTOMY (GRADE 2.2)

Place the patient supine with the neck extended (unless this compromises the cervical spine). Place your non-dominant thumb & index finger on either side of where you are to make a hole.

*You may not have time for LA or even sterilization!* **In a dire emergency,** push in a 14G cannula to create an air entry. You will feel a "pop" as the needle enters the airway. Direct it 45° caudally. Attach a saline-filled syringe to these to check for bubbles appearing. If there are none or just blood, you have placed the needles too laterally: try again *in the midline!*



Secure the cannula with sutures and connect it to an oxygen source (if possible). Then proceed to cricoidotomy or tracheostomy.

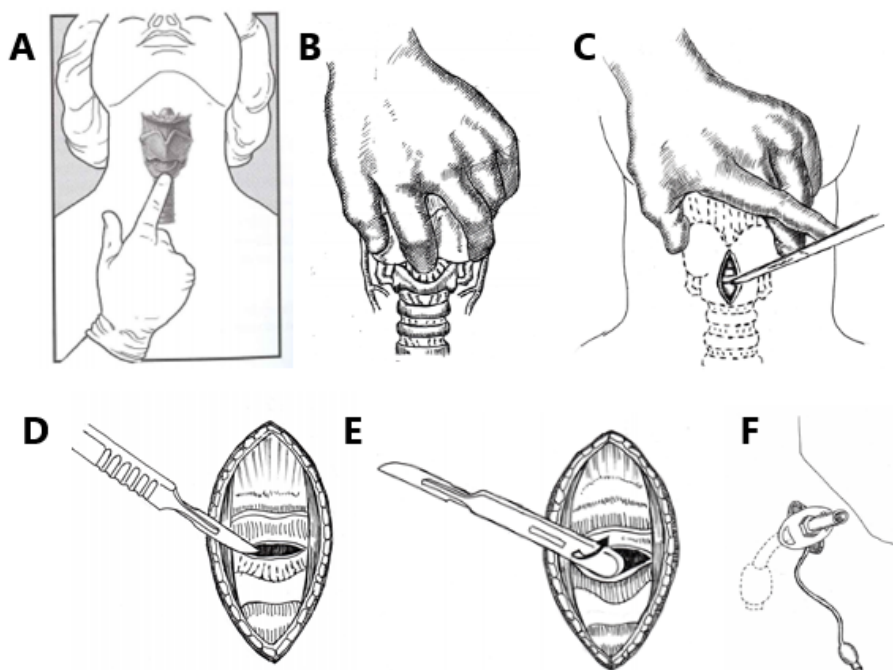
Although a cricoidotomy can only take 30secs, infiltrating some LA may well help to keep a restless patient calm!

When you are ready, keep the skin tight. *Don't let go with the hand stabilizing the cricoid!* Then make a 2cm vertical incision through the skin (42-13C) and then a small horizontal incision through the cricothyroid membrane (42-13D), *taking care not to stab the posterior tracheal wall, or push the blade upwards!* As soon as you are in the airway, there will be coughing, spluttering of frothy bloody saliva.

Widen the incision with artery forceps (or by twisting the scalpel handle in the airway wound), both horizontally & vertically.

Introduce an endo-tracheal tube (size 6 for an adult) or tracheostomy tube and check it is in the airway. Inflate the cuff. Auscultate the chest to make sure there is good air entry on ventilation. Fix the tube in place.

#### CRICOIDOTOMY



**Fig.42-13 CRICOIDOTOMY.** *N.B. Don't do this in children!* A, position the patient with the neck extended (*beware if there is a neck injury*). Identify the space for insertion of an airway. B, Verify the position of the cricoid & hold the laryngeal cartilage steady with your non-dominant hand. C, make a vertical incision in the midline, *not letting go of the cartilage*. D, make a horizontal incision deep enough to enter the airway. E, widen the opening using the back end of the Bistouri. F, insert a cuffed tracheostomy tube (or if not available, an ET tube) *After Eichelberger MR in Rob & Smith's Trauma Surgery Part 1, Butterworths, 4<sup>th</sup> ed 1983.*

Tracheostomy (29.17) is rarely needed in the emergency situation except in children. Then you can insert a Ch14 cannula at 45° to the vertical into the trachea and attach this to a 7.5 ET tube. Alternatively, if possible, introduce a longer tube with a guidewire.

However, you should always convert a cricoidotomy to a tracheostomy if it is needed for the longer term.

**If the neck is fat & you cannot feel the cricoid cartilage**, make a 6cm vertical skin incision *in the midline of the neck*. Spread the fat laterally with your fingers & insert a self-retaining retractor (or get an assistant to retract the tissues) and palpate the cricoid & trachea. When you have found your bearings, proceed as above.

**If there is much bleeding** (which is unusual), it is likely you are not in the midline. Enlarge the incision as above, and retract the tissues under a gauze swab, and palpate the cricoid & trachea. *Do not waste time trying to arrest the bleeding at this stage!*

#### 42.4 Penetrating neck wounds

For stab or gunshot wounds of the neck, the same immediate priorities (42.1) apply. However, outcomes of penetrating are different to blunt injury. The most common cause of death is either asphyxia or blood loss, so this is what you need to concentrate on initially.

Whilst you need to give to the cervical spine special attention in blunt injury (54.1), *this is not the immediate priority in penetrating trauma* (though blast injuries may give severe 'blunt' trauma (46.15) with neurological damage to the spine).

*N.B. Don't put on a cervical collar because this helps nothing, and obstructs access to wounds and may add to neck compression.*

## ANATOMICAL CONSIDERATIONS

Several vital structures meet in the neck, in the triangle in front of the cervical spine, and are surrounded by the inelastic deep cervical fascia.

The major vessels in the anterior lower neck are partially protected by the clavicle & 1<sup>st</sup> rib, but major damage can occur if these bones are fractured, especially by a high-energy projectile.

The neck is sufficiently narrow that even a high energy bullet will make a through-&-through wound (46-44A). This usually has an 'all or nothing' result: a survivor probably has no vital structure injury. However, haemorrhage from a smaller vessel may cause asphyxia because of limited space within the subfascial compartment.

The airway is relatively rigid, so when hit by a projectile, suffers a defect, which can be of variable size.

The oesophagus is a hollow organ, resistant to stretch on account of its elasticity: *small entry & exit wounds may therefore not be easily visible by endoscopy.*

Posteriorly, a projectile has a much greater chance of hitting bone: the mandible, vertebral column, or the skull base.

In about half of survived injuries, major damage is seen; notably:

- (1) ~30% of carotid artery lesions are accompanied by signs of stroke (cerebral ischaemia),
- (2) an isolated vascular injury is only likely if the cause is a small fragment projectile.
- (3) 50% of laryngo-tracheal wounds also have injury to the pharynx or oesophagus,
- (4) projectiles may also cause damage in the chest or head.

*N.B. Catastrophic haemorrhage is rare unless the victim is brought in very quickly for emergency help.*

**If digital pressure has controlled bleeding**, take the patient immediately to theatre (with the first aider's hand included in the operating field).

**If haemostasis is inadequate**, tamponade it with a large (Ch20) Foley catheter into the entry wound, inflate it with saline, clamp the drainage outlet, fix the catheter firmly to muscle or skin, and close the wound with a continuous suture. Then immediately intubate the victim's airway to prevent asphyxiation. If tamponade is successful in proximal carotid or vertebral artery injuries, leave the catheter *in situ* for 48h before removing it *in theatre*.

## **NEVER TRY BLIND CLAMPING IN THE DEPTHS OF A WOUND !**

### MANAGEMENT

#### **(a) Airway**

Symptoms and signs of airway damage are usually obvious: stridor, hoarseness, dyspnoea & haemoptysis, with tracheal deviation, instability or tenderness on palpation. More subtle signs are loss of 'clicking' of the larynx on pushing it laterally, loss of thyroid prominence, and bruising of the overlying skin. You may see blood 'bubbling' out, or crackling from subcutaneous emphysema, which may extend to the scalp (43-28) or abdomen and into the mediastinum, pericardium or pleura!

**If the wound is very small**, lie the victim in the lateral position with the head down, so that blood can trickle out of the mouth.

**If there is airway compromise**, perform a needle cricoidotomy (42-13), before converting this to a formal tracheostomy (29.15) in theatre.

**If there is a very large tracheal defect**, pass a suture through the inferior lip of the tracheal wound, and fix this to the skin. Then insert a tracheostomy tube & inflate the balloon (29-17).

**If there is copious bleeding from the tracheal wound**, pass a tracheostomy tube so that its balloon can occlude the bleeding vessel, and avoid blood trickling down the airway: use a Sengstaken-Blakemore tube to do this if you can.

*Whatever you do, make sure the airway is patent!*

#### **(b) Breathing & Circulation**

Palpate the carotid & superficial temporal pulses, and measure the BP in *both arms*.

**If you suspect a major venous injury**, put up an IV line in the contralateral arm or lower limb!

*N.B.* you may need a vein graft from one leg so *don't use both for IV lines!*

*N.B. Shock may be neurogenic (44.5), rather than haemorrhagic!*

Lung injury may result in pneumo- or haemothorax, and need an intercostal drain (43-15). Haemoptysis can occur with injury anywhere in the airway or lungs; haematemesis from anywhere from mouth to stomach.

#### **(c) Disability**

A central lesion (hemiparesis, hemiplegia, aphasia or loss of consciousness) is almost always due to carotid artery insufficiency; this may be temporary if the artery is in spasm (from the pressure wave of a passing bullet). If there is no carotid injury, a direct brain injury is likely.

A peripheral lesion is due to direct injury of:

- (1) cervical spine: tetraplegia, neurogenic shock
- (2) cervical plexus: Horner's syndrome
- (3) brachial plexus: neurological deficit in the arm
- (4) VII<sup>th</sup> nerve: drooping of corner of the mouth
- (5) VIII<sup>th</sup> nerve: auditory loss
- (5) IX<sup>th</sup> nerve: altered swallowing & gag reflex
- (6) X<sup>th</sup> nerve: hoarse voice
- (7) XI<sup>th</sup> nerve: sternomastoid weakness
- (8) XII<sup>th</sup> nerve: tongue deviation

*N.B.* Direct auditory loss in blast trauma (46.15) is common from pressure wave effects.

Injury to the pharynx & oesophagus often present late with fistula formation & infection. *Always suspect these if there is an airway injury.*

Drainage of milky fluid suggests damage to the thoracic duct.

Give a conscious patient diluted methylene blue or gentian violet to drink. Otherwise, once the airway is secured, inject some down the pharynx to find the site of the leak.

#### PROCEDURE

*Be careful not to dislodge any haematoma before you are ready. Don't pass a nasogastric tube till the patient is well sedated.*

**If in doubt about the airway, perform a tracheostomy!**

**Explore all wounds** which penetrate the *platysma*, & those in the middle of the neck, *even in the absence of clinical signs. Avoid exploring those above the level of the mandible* as a conservative approach is best here.

Remember, ligation of an artery is easier than repair. Most times ligation of the carotid artery is justifiable (49.3); likewise subclavian or axillary vessels, *but obviously not the brachiocephalic trunk!* You can ligate the internal jugular vein, *but not on both sides!*

Remember, insertion of a shunt (49-5) can get you out of a big difficulty!

Where access below the skull is very difficult, as for the proximal carotid or vertebral arteries, you can use bone wax or crushed muscle (or chewing gum) to stuff the skull foramen from which these vessels emerge.

*Don't think you need to do the definitive surgery in the emergency situation. Do only what is necessary to save life or limb!*

#### PREPARATION

Make sure blood is cross-matched. Prepare equipment for autotransfusion (5.3, 44.4)

Place the patient supine with the arms tucked in alongside the chest, and a small roll under the shoulders to extend the neck. Put the head on a ring (or doughnut pillow) to stop it rolling around, and turn it to the side away from the wound. Keep the head tilted 10° up to reduce bleeding.

*N.B. If there is massive blue (venous) bleeding, put the head down 15° to prevent air embolism!*

Put 2 towels under the head, and fold the top one over the face as in thyroidectomy (25.7). Sterilize from the chin to the groin, and include one leg for possible venous harvest.

**For a lower neck injury** (zone I), you may well need proximal control, so a simple supraclavicular incision for the subclavian artery (49-7) needs a median sternotomy extension (44-11).

**For a middle neck injury** (zone II) extend an incision along the medial border of *sternomastoid* for the carotid artery (49-6) to the median sternotomy.

You may need an anterolateral thoracotomy extension on the right for damage to the upper or mid-oesophagus, or the right hemidiaphragm and retrohepatic injury; on the left for lower thoracic oesophageal damage.

Expose the wound and try to assess the damage. You may be able to get an on-table arteriogram to help you. If necessary, get an assistant to keep on pressure digitally. Gently lift off clots and try to gain control on both sides of a vascular injury.

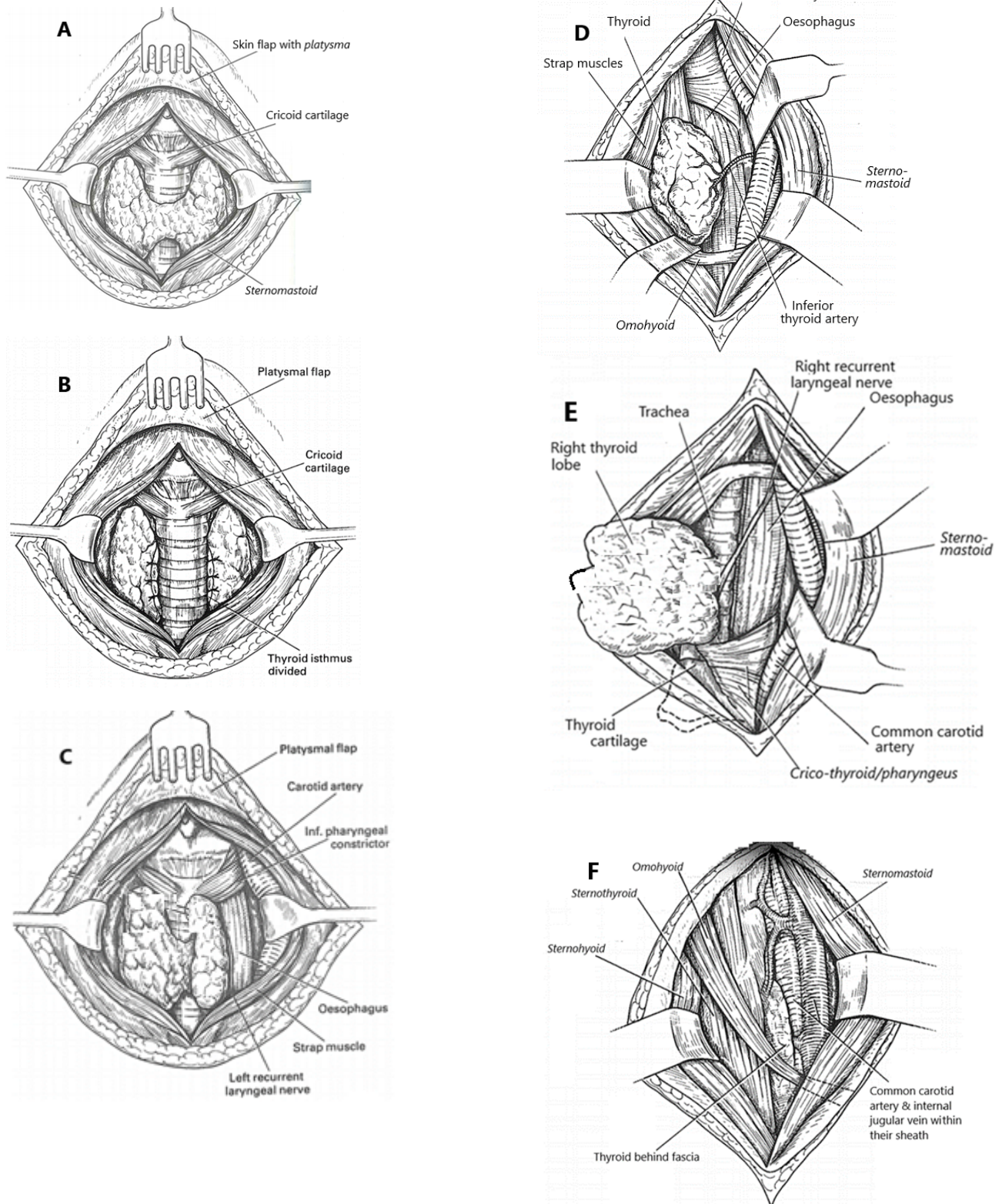
## 42.5 Laryngeal & tracheal injury

#### INTRODUCTION

Blunt injury may not be noted early, but may present with a stenosis much later. Causes are usually blows on the anterior neck (mainly in motor vehicle crashes), more rarely falling against a taut wire, through assault (attempts at strangling included), and sports, smoke burns or iatrogenic injury (especially rigid bronchoscopy, 29-16, or aspiration of oil).

Penetrating injury (42.4), however, is usually obvious. In half of cases there is also damage to the pharynx or oesophagus.

## ANTERIOR NECK EXPLORATION



**Fig.42-14 ANTERIOR NECK EXPLORATION.** A, retract the *sternomastoids* to expose the thyroid. B, divide the thyroid isthmus. C, retract the thyroid lobe to the left using your finger. D, divide the inferior thyroid artery. E, divide the omohyoid & preserve some as a flap if necessary. F, take note of the recurrent laryngeal nerves, especially the right which crosses the oesophagus. After Snyder WH III, Carder HM in Rob & Smith's *Operative Surgery Trauma Surgery Part 1*, Butterworths, 4<sup>th</sup> ed 1983.

Injuries in children are rare, because the larynx is higher up, and partially protected by the mandible.

You must keep a high index of suspicion in all cases, and if in doubt, have a look, preferably with a flexible bronchoscope. Even if the mouth & pharynx show no damage (e.g. in a burn), the larynx may still be affected.

#### MANAGEMENT

Obtain a chest radiograph as a baseline. Make sure the victim is able to breathe humidified oxygen or air. Keep the head up. Steroids may help against oedema in the 1<sup>st</sup> 12h. Start chest physiotherapy.

Minor oedema with no mucosal disruption needs only repeated observation, and usually a follow-up bronchoscopy after 24h.

Significant oedema with only minimal mucosal disruption & no exposed cartilage needs early & late follow-up bronchoscopy; be prepared to fashion a tracheostomy if there are signs of deterioration.

Severe oedema threatening to occlude the lumen, mucosal tears, exposed cartilage, and vocal cord disruption, all require an urgent tracheostomy. Try to repair lacerations carefully.

Injury to the trachea from a wire is particularly hazardous, as the upper larynx gets pulled upwards, and the distal part disappears behind the sternum. Make a low vertical incision for this injury & *don't hesitate to divide the manubrium to get good access!*

#### ANTERIOR NECK EXPLORATION (GRADE 3.4)

Make a collar incision 2cm above the manubrium, divide the *platysma* and develop superior and inferior flaps just as for a thyroidectomy (25.7). Divide the middle cervical fascia between the *sternomastoids* and develop the plane around the thyroid (42-14A). Divide the thyroid isthmus between clamps: you can best achieve haemostasis by a continuous overlapping suture (42-14B). Then retract the left thyroid lobe gently with a finger (42-14C) to expose the oesophagus.

Retract the *sternomastoid* laterally to expose the carotid artery; then ligate & divide the inferior thyroid artery & middle thyroid vein (42-14D). You will now have good views of the oesophagus and, by retracting the thyroid further to the left, of the trachea.

Divide or retract the *omohyoid* which crosses the middle cervical fascia: *N.B. you may need some of this muscle to buttress a tracheal or oesophageal laceration!* (42-14E)

*N.B. Beware of the right recurrent laryngeal nerve, which crosses over the oesophagus from inferolateral to superomedial (42-14F). The left recurrent laryngeal nerve rests in the groove between the trachea & oesophagus. Take care not to damage either of these nerves!*

**If you suspect a hole in the trachea but you can't find it**, cover the wound with sterile water and look for air bubbles coming out of a hole.

Cricoid or thyroid cartilage fractures need fixing with a special plate: try to refer such patients. You can fix the hyoid with wire.

You can preserve the lumen by introducing a home-made stent for 2wks: fill a finger of a sterile surgical glove with gel foam and pierce this making a sufficient air passage, to improvise.

*N.B. A small mucosal tear can produce alarming subcutaneous emphysema*

**If there is a tracheal defect**, introduce a cuffed tracheostomy into the defect (42.4) till you can arrange surgical closure. Repair the wound as accurately as possible, leaving knots on the outside. Buttress the repair with a small flap of muscle.

*Make sure your nurses know how to look after tracheostomy patients!* (29.15)

Speech therapy is important in the recovery period.

## 42.6 Pharyngeal & cervical oesophageal injury

### INTRODUCTION

Oesophageal injury is usually from ingestion of sharp objects, such as fragments of meat bone, a safety pin, ill-fitting dentures with metal hooks, or iatrogenic (especially from rigid oesophagoscopy (30.2). Caustic fluids (acid or alkaline) may also cause severe oesophageal mucosal damage.

In some areas particularly in Niger & Nigeria, traditional uvulectomy is still carried out, mainly on children, with primitive instruments. (It is not done to prevent snoring!) Frequent complications are haemorrhage, pharyngeal infection, including tetanus, and aspiration of the excised uvula, all of which can be fatal.

Penetrating injury which damages the oesophagus also injures the trachea in over 50% of cases. As with the airway, you must keep a high index of suspicion in all cases, and if in doubt, have a look, preferably with a flexible endoscope (13.2).

Oesophageal perforation often presents late with disastrous septic complications; depending where the perforation is, drainage may occur into the neck, mediastinum, pericardium or pleural space.

#### MANAGEMENT

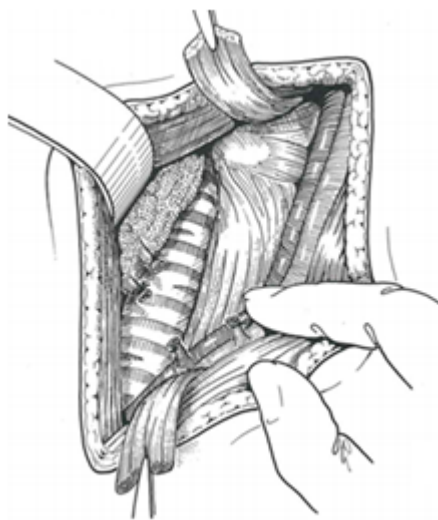
Check if the airway is patent; in any doubt, get the patient to sit up or lie with the head down, and suck out the mouth and clear the airway (42.4).

Obtain a chest radiograph as a baseline. Look especially for effusions, mediastinal air and the presence of a foreign body.

*N.B. A coin stuck in the oesophagus will appear 'flat on' on a radiograph, whereas one in the bronchus will appear 'side on'.*

Foreign bodies may rarely penetrate the oesophagus: try to remove them without damaging the oesophageal lining! (30.2). Likewise oesophageal corrosive may, in severe cases, cause necrosis and perforation; try to mitigate this by early protective measures (30.3).

#### LATERAL NECK EXPLORATION



**Fig.42-15 LATERAL NECK EXPLORATION.** Exposing the oesophagus.

#### LATERAL NECK EXPLORATION (GRADE 3.4)

Make an incision along the anterior border of the left *sternomastoid*. Follow anterior neck exploration (42-14D,E) to let you examine the oesophagus.

*N.B. Be careful not to damage recurrent laryngeal nerves by attempting to view the back of the oesophagus!*

Close any perforation with 2 layers of interrupted sutures, buttressed by a flap of *omohyoid*. Always leave a drain for a leak which usually presents as a salivary fistula and normally heals on conservative treatment.

In perforating injuries, look carefully for associated damage to the trachea, major vessels, & thyroid.

## 42.7 Drowning

Drowning can be classified as cold water (<20° C) or warm water (20° C or higher), fresh water or salt water, in natural water or man-made collections of water. The protective effect of ice-cold water in young people (the so-called mammalian diving reflex) is nullified by prolonged immersion. Hypothermia (45.2) is a problem with both cold and warm water drowning, as is rhabdomyolysis (49.7) due to intense shivering.

Long-term infectious complications are primarily related to whether the victim was submersed in a natural or a man-made body of water.

Drowning from diving-board accidents are often associated with cervical spine injuries. Be sure to protect the spine until a fracture has been ruled out.

*Terms such as 'wet drowning', 'dry drowning', 'active or passive drowning', 'near-drowning', 'secondary drowning', and 'silent drowning' are not helpful, so are not used here.*

#### TREATMENT

**If a child has fallen into water and cannot swim,** laryngeal spasm may occur (a 'gag reflex'). If this is prolonged, hypoxia results. You should initiate CPR (44.9) immediately. Results are often surprisingly good even after prolonged efforts. *So, don't give up before 20mins!*

The most critical measure is prompt correction of acidosis & hypoxaemia; the degree of the latter is often underestimated.

Administer pure oxygen and monitor the patient closely with pulse oximetry if possible. Monitor vital signs, temperature and conscious level. Intubate and use positive end-expiratory pressure (PEEP) with mechanical ventilation in any patient with poor respiratory effort, altered conscious level, severe hypoxaemia, severe acidosis, or significant respiratory distress.

Rehydrate the patient with isotonic crystalloid (20mL/kg) and await correction of the acidosis. *Don't administer sodium bicarbonate.* Hypothermia may exacerbate hypoxaemia, acidosis, and bradycardia.

Warm the patient (50.13), but if the victim remains comatose, don't *actively warm to temperatures >32°-34°C.*

Treat any seizures. Check the blood glucose level frequently, and correct hypoglycaemia.

Ventricular dysrhythmias (typically, ventricular tachycardia or ventricular fibrillation), bradycardia, and asystole may occur as a result of acidosis and hypoxaemia rather than electrolyte imbalance.

Insert a nasogastric tube to remove swallowed water and debris. Pass the tube by mouth if there is head or facial injury.

You may need bronchoscopy (29.14) to remove foreign material, such as aspirated debris or vomitus plugs, from the airway.

*N.B. Remember there may be associated head, chest or limb injuries!*