Elaine Bromiley

[died in the UK in March 2005 at the age of 37]

Brought about a re-look at the role of human factors (HF) in critical incidents in medical practice in the UK.

Libby Zion

[died in the US in October 1984 at the age of 18]

Admitted to A+E with agitation, confusion and muscle twitching. Given Demerol despite a history of depression for which she took Nardil (phenelzine). Became restless, tied down. Died from high fever within 8 hours from admission. Later there were claims that she also took Cocaine.

Throughout his crusade, Sidney Zion's anger was paramount. Indeed, it is quite possible that without this rage, he might not have accomplished what he did. Zion was "aggressive, narcissistic, self-indulgent, pushy, persistent and paranoid," psychiatrist Willard Gaylin memorably wrote in ***Nation***, "but that is precisely the stuff successful reformers are made of."

Brought about a limit to the amount of resident physicians' working hours in the USA.

(New York State Department of Health Code, Section 405, also known as the Libby Zion Law)

Chapter 3
Airway management is essential

Essentials of airway management

University of Pretoria

MBChB V

Block 18

May 2013

Any of the three components of modern day anaesthesia results in loss of airway control

Components of a general anaesthetic

- Anaesthesia
  - Absence of consciousness / awareness
- Analgesia
  - Absence of pain / sympathetic stimulation
- Muscle relaxation
  - Absence of movement / motor reflexes

Any of these three groups in-and-of-itself causes loss of airway control

Indications for airway management

- *Physiological factors*
  - Central nervous system suppression (Glasgow coma scale ≤ 8/15)
  - Loss of muscle tone
  - Loss of reflexes (loss of airway sensation)
  - Ventilation – if intubation is not indicated
  - Prolonged procedures cause atelectasis and accumulation of secretions. These conditions often need lung recruitment and toilet and are actually indications for intubation.
  - Patients of the *extremes of age* have anatomical and physiological factors that make them more prone to loss of the airway, decreased muscle tone, and decreased airway reflexes.
- *Pharmacological factors*
  - Loss of airway sensation (topical anaesthesia)
  - Neuromuscular block
  - All central nervous system suppressants cause a dose-dependent loss of airway tone.

You may have noticed that unconsciousness is one of the main indications for airway management. All patients with a Glasgow Coma Scale of ≤ 8/15 must be intubated and ventilated. This forms part of neurological resuscitation and the prevention of secondary brain injury in the patients who have sustained brain injuries. Remember: the most common cause of coma is general anaesthesia. Therefore, general anaesthesia is the most common indication for airway management and ventilation.

While reading the rest of this chapter, you must constantly keep the following aspects of the airway in mind and integrate them:

- The *anatomy* of the airway
- The *physiology* of the airway
- The *pharmacology* of the airway
- *Monitoring* of the airway: are the indications and methods of airway management appropriate and safe? In this regard, pulse oximetry and capnography (see Chapter 4) is indispensible. Briefly, the *pulse oximeter* measures the oxygen saturation of arterial blood. There is a very good agreement between the saturation displayed by the pulse oximeter (SpO_2) and arterial oxygen saturation (SaO_2).

  The capnograph samples gas from the filter between the airway and the anaesthetic circuit (the tubing system connecting the patient airway to the anaesthetic machine). When the patient exhales, the gas contains CO_2, and when the patient inhales, the gas contains a little (rebreathing system or circuit) or no CO_2 (non-rebreathing or circle system). The CO_2 in the gas is analysed by the capnograph and displayed on a graph (*the capnogram*) with CO_2 on the y axis and time on the x axis. If the CO_2 does not increase during expiration, the patient is not breathing, there is an obstruction in the airway, the artificial airway is not functional (e.g. oesophageal intubation), disconnection between the airway and anaesthetic circuit, or a disconnection of the capnograph sampling cannula. For a discussion on capnography and oximetry, see Chapter 4.

ANATOMY

In this section, the anatomy that is pertinent to management of the airway is discussed. ***Please look at the relevant structures in your anatomy atlas***. The airway refers to the continuous tube and is divided into two parts:

- The upper airway stretches from the lips and nostrils to the vocal cords.
- The lower airway consists of the trachea and bronchi.
- The level of the sixth cervical vertebra is an important landmark as this is the junction between the larynx and trachea.

All the parts of the airway are composed of a *lumen, a wall, and structures outside the wall* (Figures 1 and 2). The wall consists of mucosa, muscle, skeleton (bony or cartilaginous). The airway is in

- **GCS < 8 = intubation**
- **Most common cause of coma is general anaesthesia**
- **General anaesthesia is the most common indication for airway management**

Methods of airway management

- Face ma
- Larynge
- Endotrac

METHODS OF AIRWAY MANAGEMENT

Regarding acute airway management, the priorities are patency and protection of the airway.

Pre-induction equipment check
Before you embark on airway management, the equipment necessary to create, maintain, and secure the airway must be immediately available:

- An assistant. ***Do not do airway management on your own***.
- The anaesthetic machine must have been checked.
- Suction.
- The theatre table must be in working order.
- An intubation pillow (about 10 cm thick for adults and 5 cm for children)
- Laryngoscope with a choice of blade sizes
- Stylet and Magill forceps
- An oral airway and laryngeal mask airway (LMA) (see Table 1)
- An endotracheal tube of which the cuff has been tested for a leak must be on the anaesthetic machine. A tube of one size smaller must also be available.

The indication for airway management determines *the method or route (Tables 1 to 3)*. These methods are supraglottic, translaryngeal, and transtracheal.

- *Supraglottic* (Table 1): These open the airway up to *the hypopharynx*. Supraglottic airways are inserted with the knowledge what path they follow, but usually not under direct vision; they are *inserted blindly* and may be used when inspection of the airway (pharynx and vocal cords) is not possible. Therefore, supraglottic airways are often used *when laryngoscopy has failed* and/or as emergency airways. They do not ensure patency of the rima glottides, such as anatomical lesions and laryngospasm. All the transoral supraglottic airways keep the upper and lower jaws apart and therefore prevent swallowing. They can also, irritate the pharynx, cause coughing, vomiting, and laryngospasm and therefore promotes aspiration – especially in the lightly anaesthetized patient. Therefore, *they create and maintain the upper airway but do not protect the airway*. They do not protect the airway from aspiration. They are often used to create and maintain an airway *in an emergency, e.g. cannot intubate cannot ventilate (CICV)*. The supraglottic airways are contraindicated in *elective (planned) surgery if the patient*:
  - If the patient runs the risk to *regurgitate and aspirate*;
  - If the patient is operated in any *other position than the position*;
  - If the patient runs must be *ventilated* during the procedure.
  - When the airway is shared with the surgeon or when you will be *unable to reach the airway* during surgery (head and neck surgery)

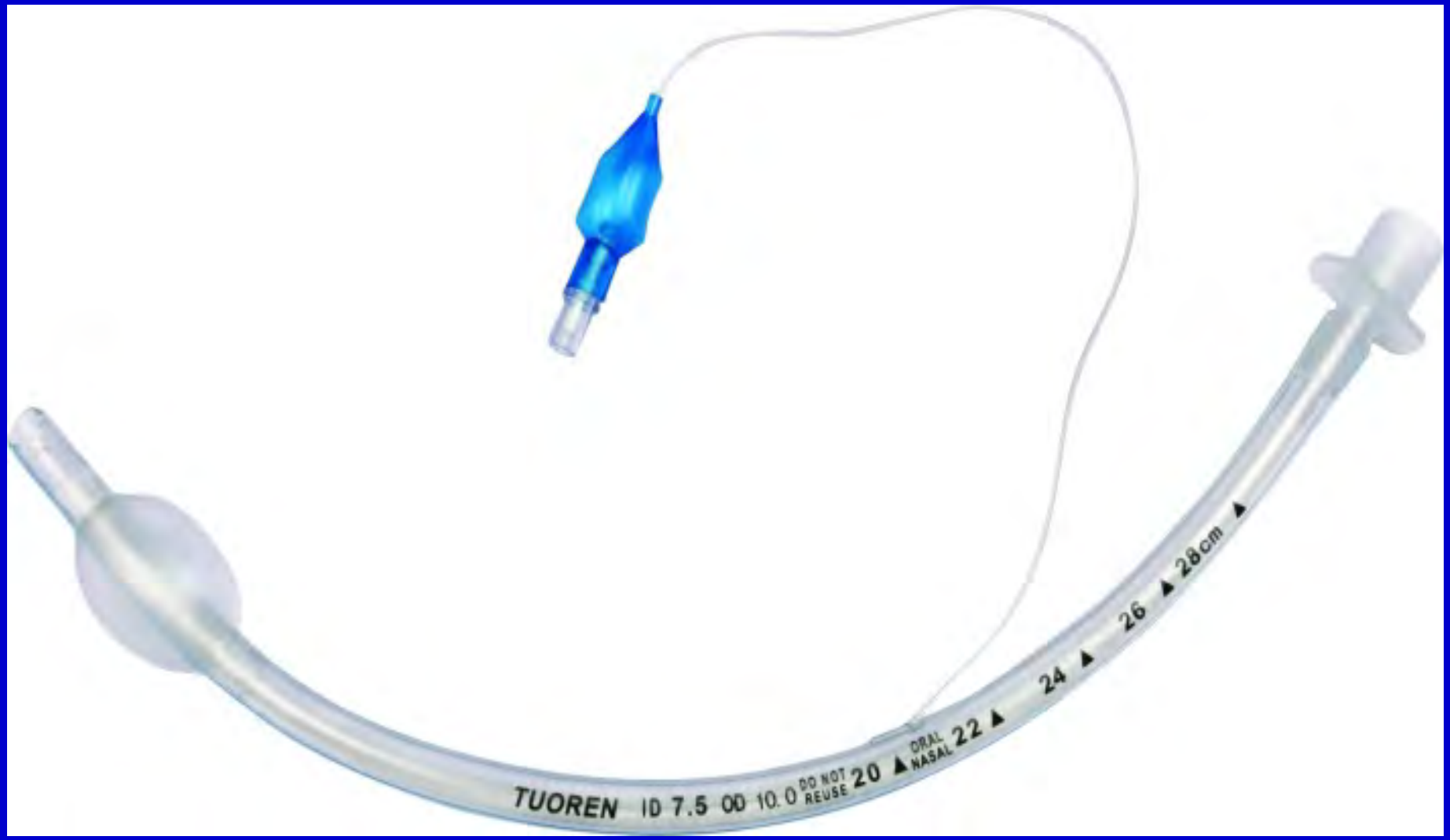
- *Translaryngeal* (Table 2): "Endotracheal tubes" (ETT) is the collective term for tubes that are inserted via the mouth or nose into the trachea. These tubes remain the safest and most predictable airways. Insertion of translaryngeal airways *requires direct or indirect (fibreoptic) laryngoscopy*. If one knows how, or is lucky, an ETT can be inserted *blindly*. Translaryngeal airways create, maintain, and protect the airway, and allow ventilation. Bronchoscopy and bronchial toilet can be done through the straight tubes but not through RAE tubes. The number of the tube refers to the inner diameter in mm. The size inserted is determined by the size and age of the patient. Men are usually intubated with Nr 8 to Nr 9, and women with Nr 7 to Nr 8. For paediatric sizes, see Chapter 22.

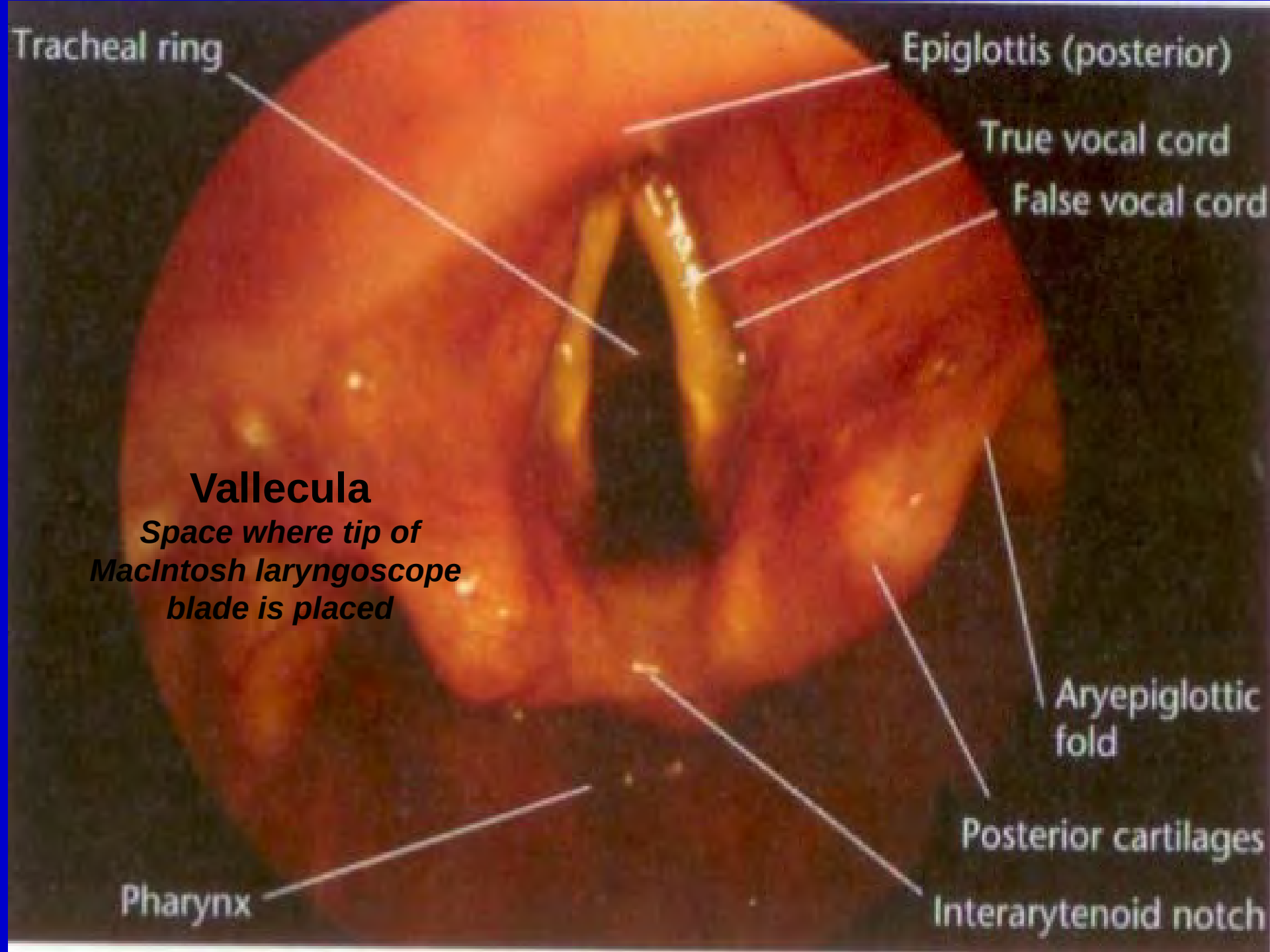
- *Infraglottic* (Table 3): These airways are obtained electively or in the CICV scenario. These are surgical airways where an airway is passed into the trachea under vision.

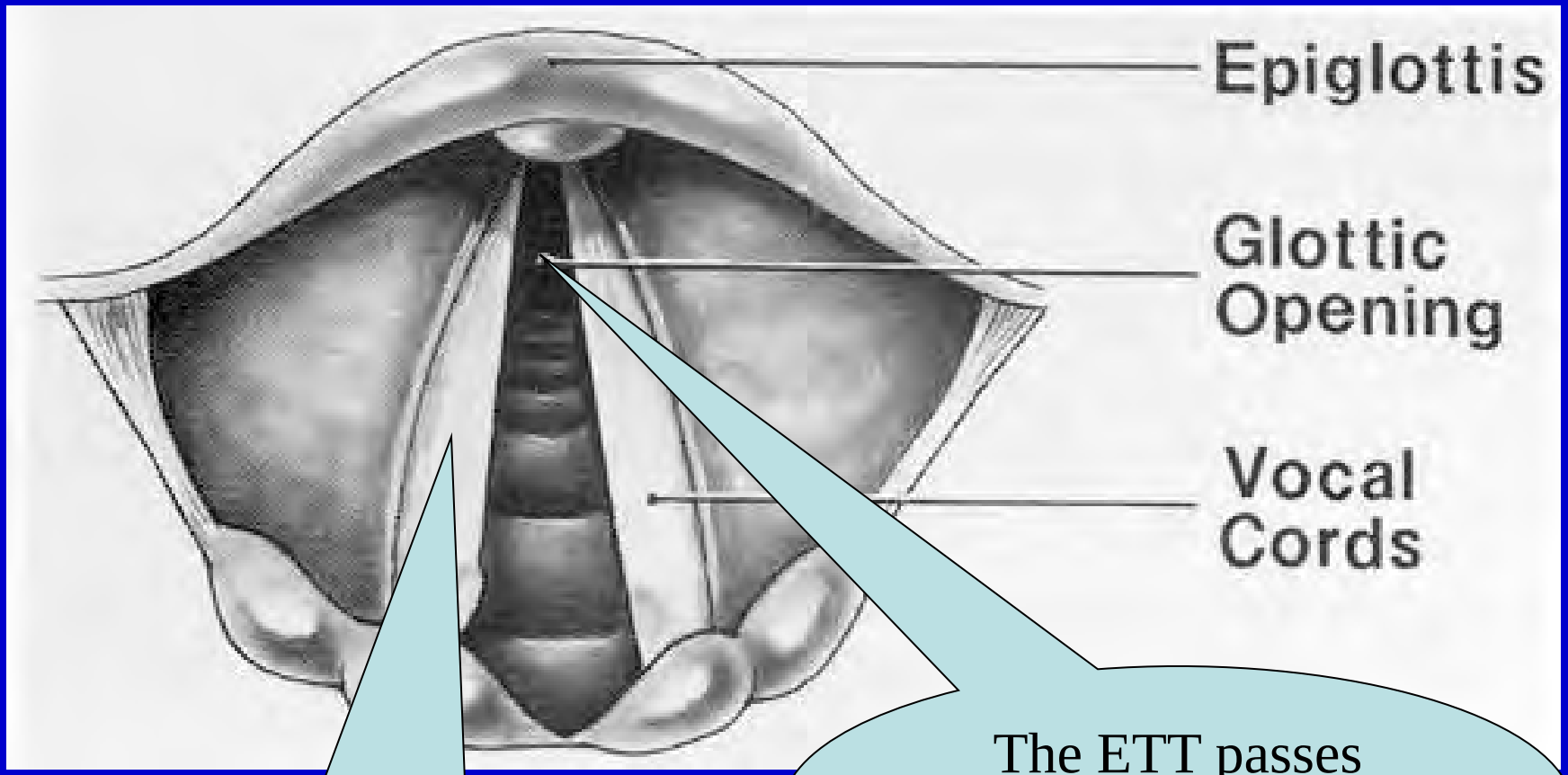
A face mask is a

An laryngeal mask is a

An endotracheal tube is a

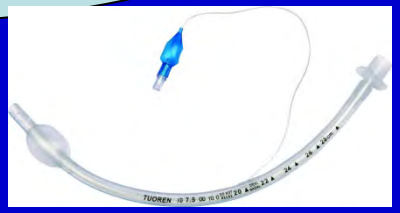



Tracheal ring
Epiglottis (posterior)
True vocal cord
False vocal cord
Vallecula
Space where tip of MacIntosh laryngoscope blade is placed
Aryepiglottic fold
Posterior cartilages
Pharynx
Interarytenoid notch



The ETT passes **<u>through</u>** the glottic opening!

The LMA remains **<u>outside</u>** the glottic opening!



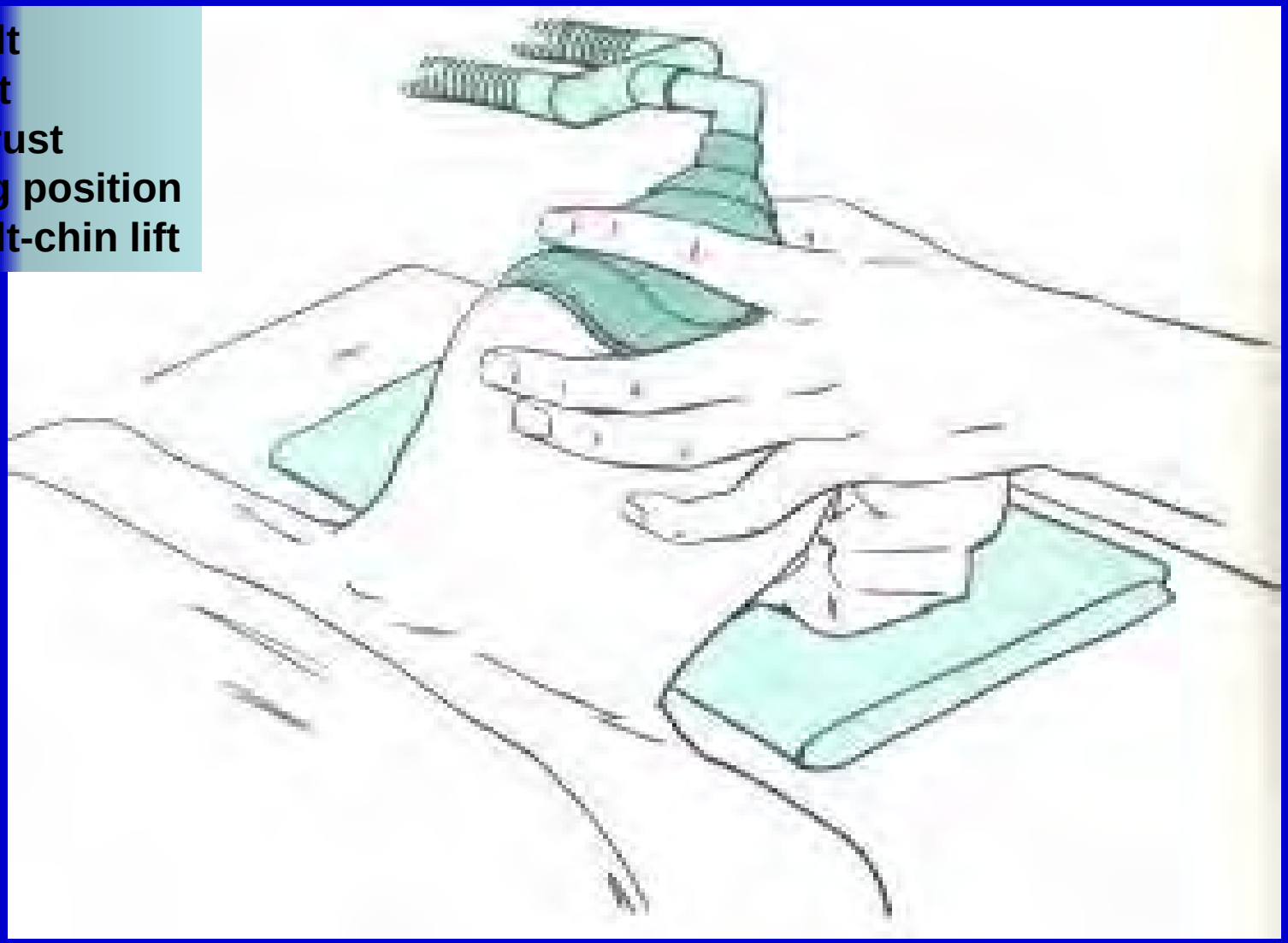
When evaluating the airway think of 3 separate components

1. **Ventilation**
2. Laryngoscopy and **intubation**
3. **Rescue** airway

Face mask ventilation

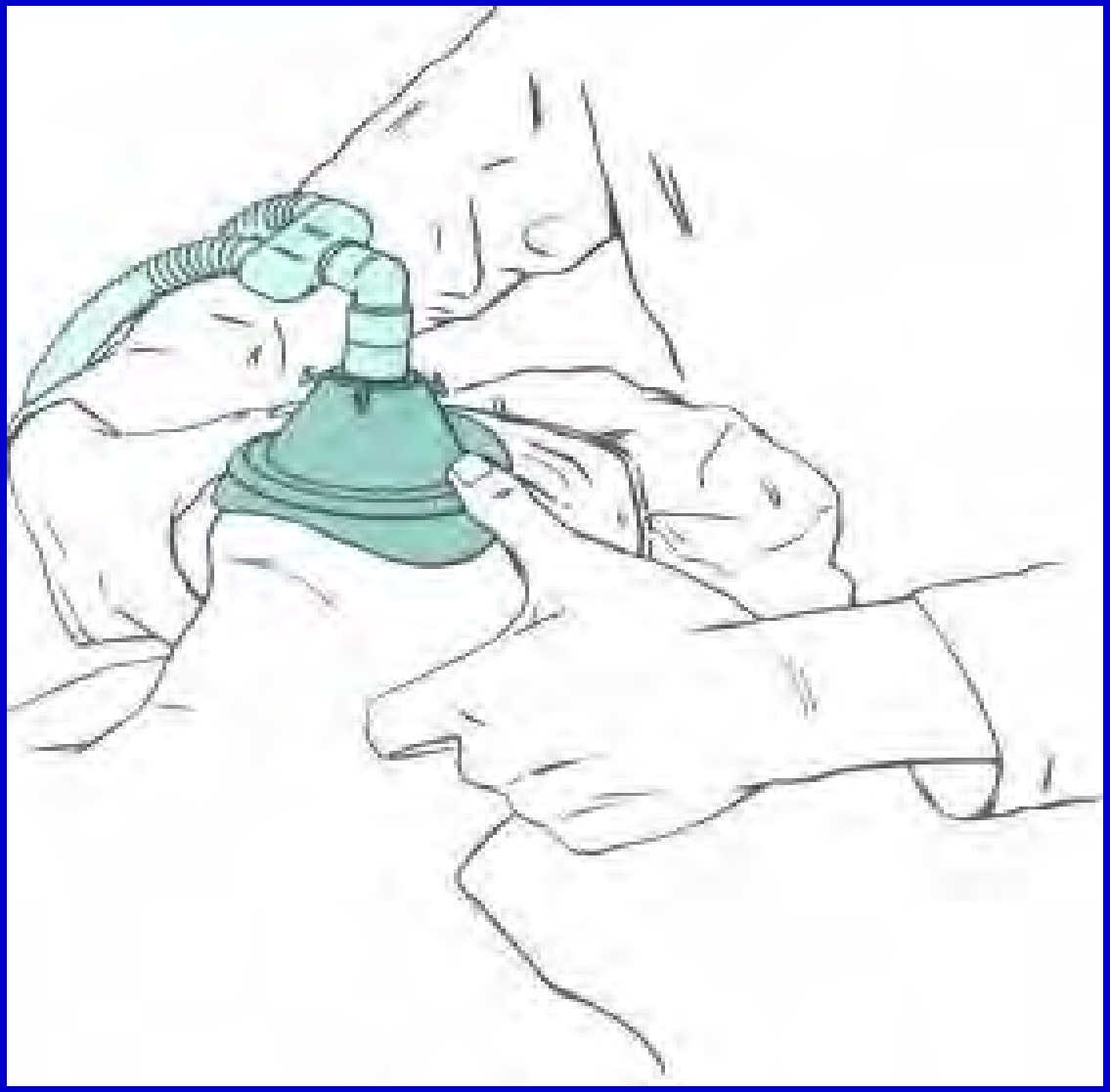
- maintenance using one hand -

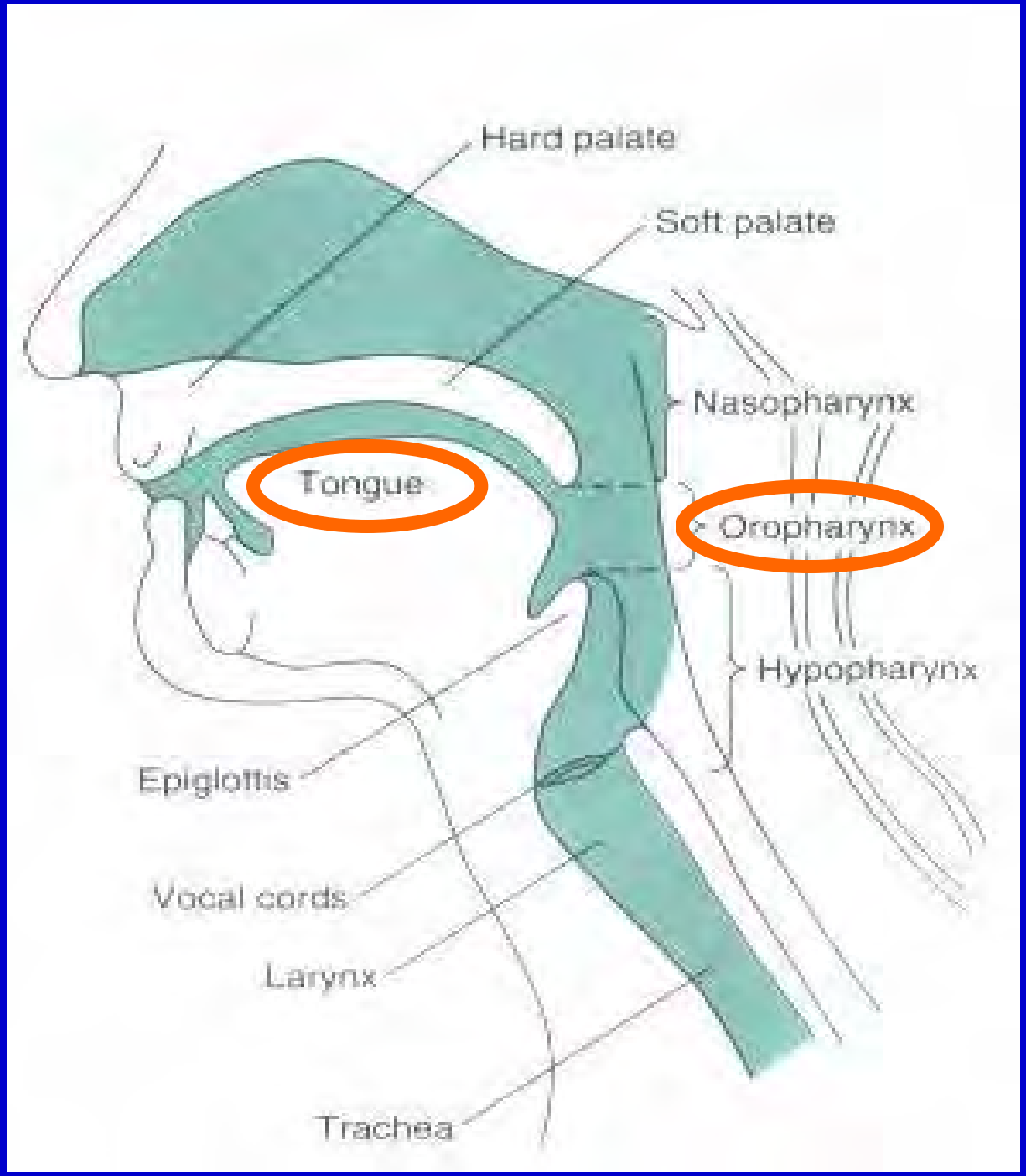
Head tilt
Chin lift
Jaw thrust
Sniffing position
Head tilt-chin lift



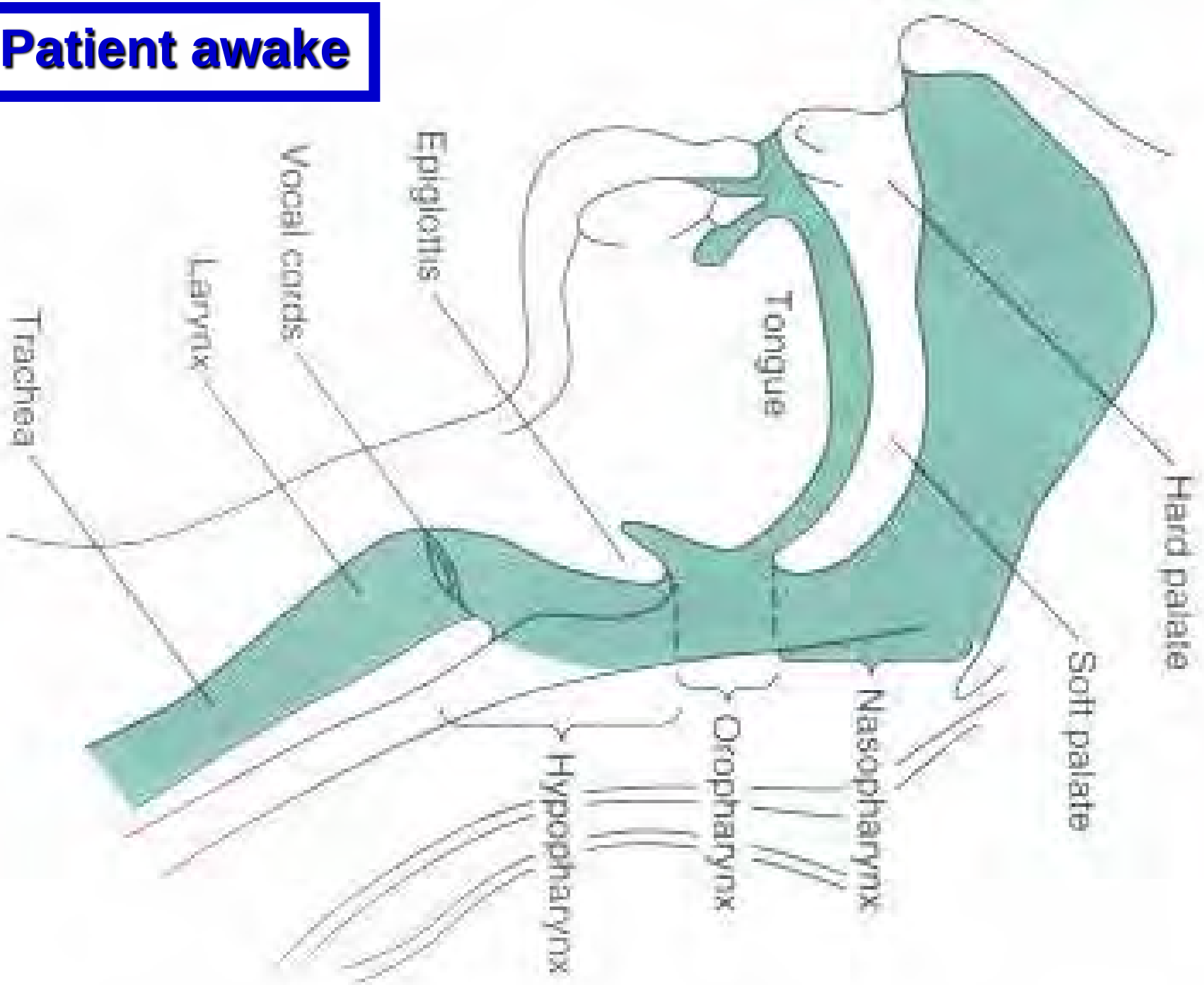
Face mask ventilation

- maintenance using two hands -

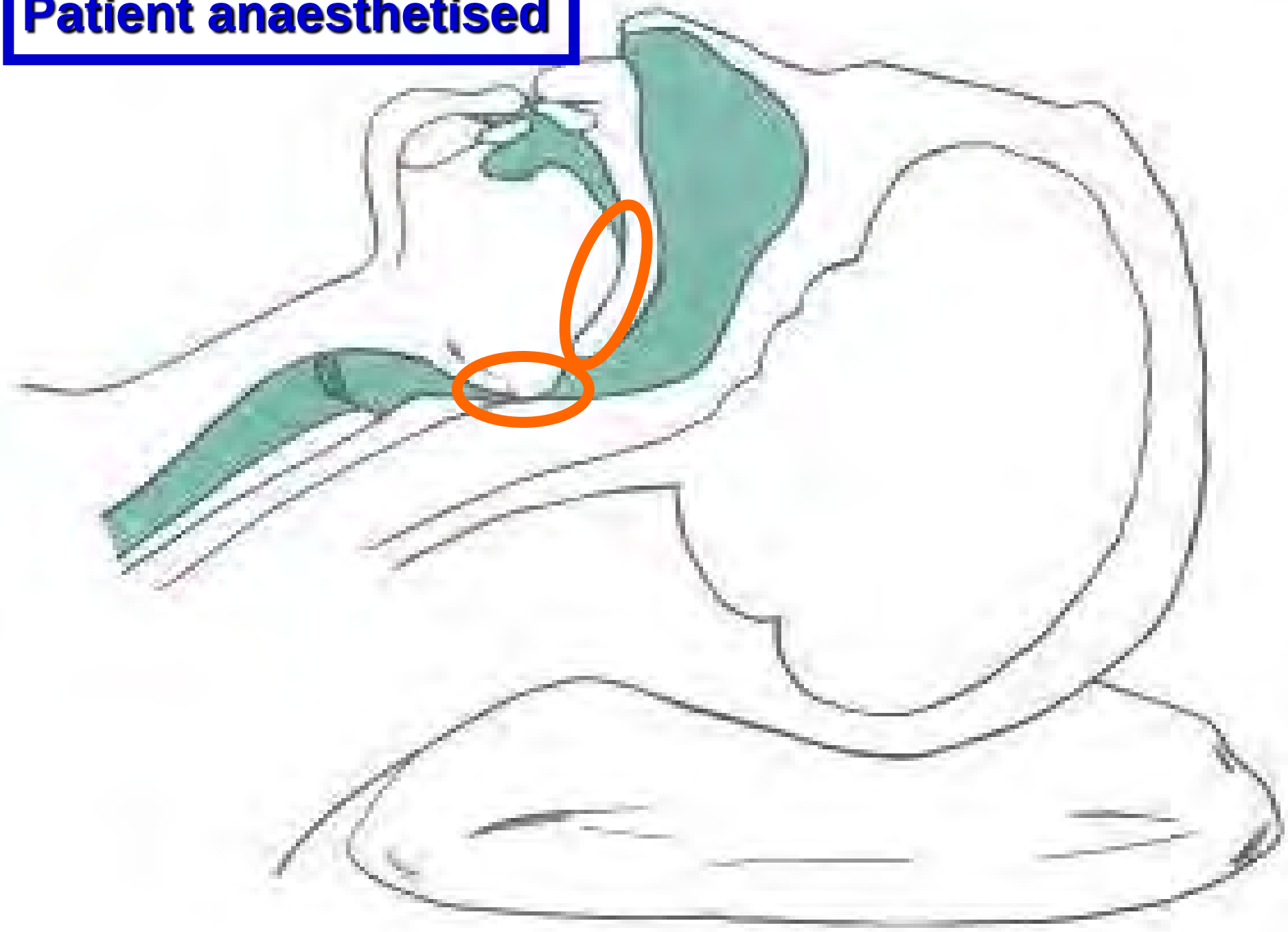


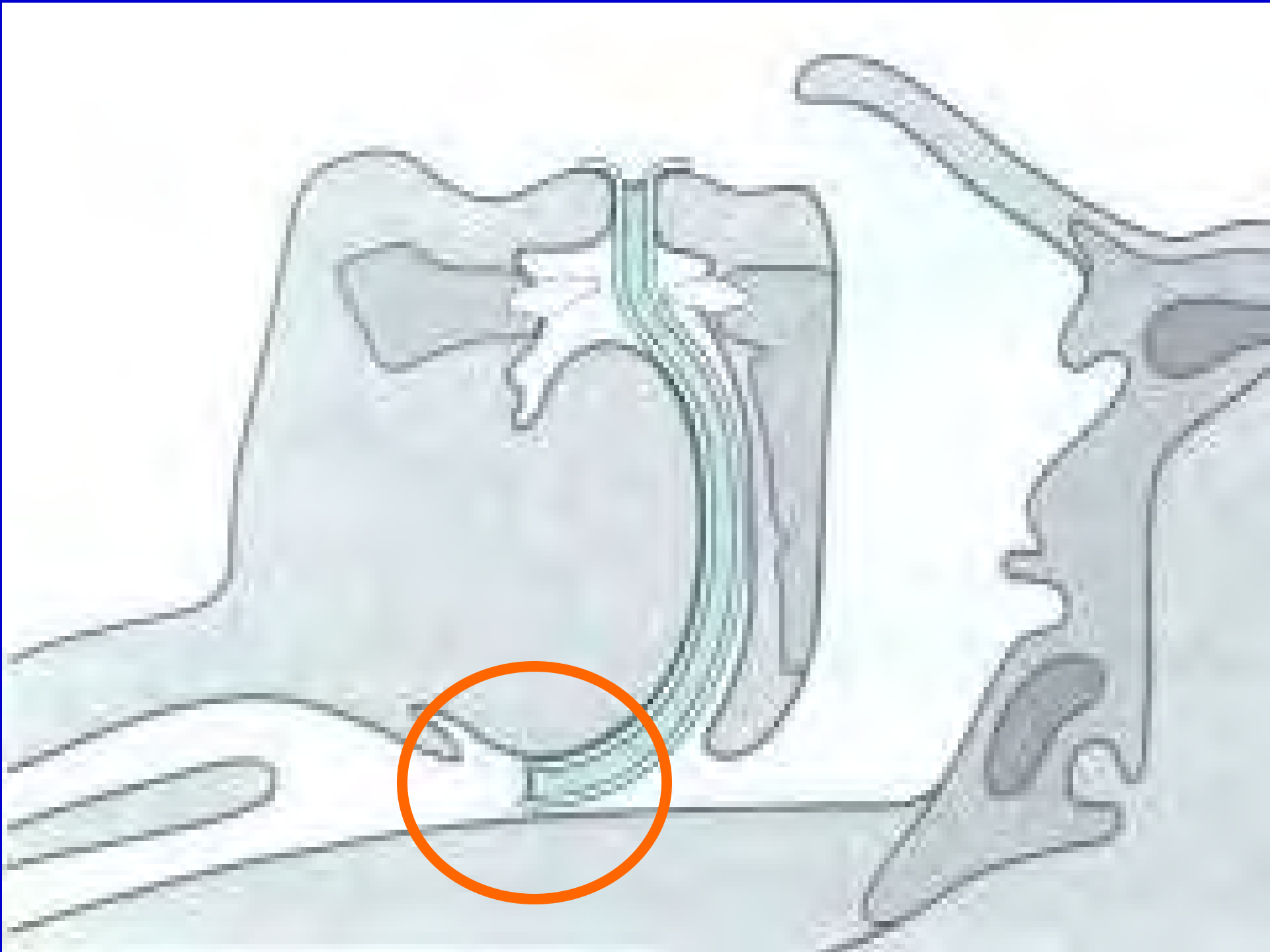

Hard palate
Soft palate
Nasopharynx
Tongue
Oropharynx
Hypopharynx
Epiglottis
Vocal cords
Larynx
Trachea

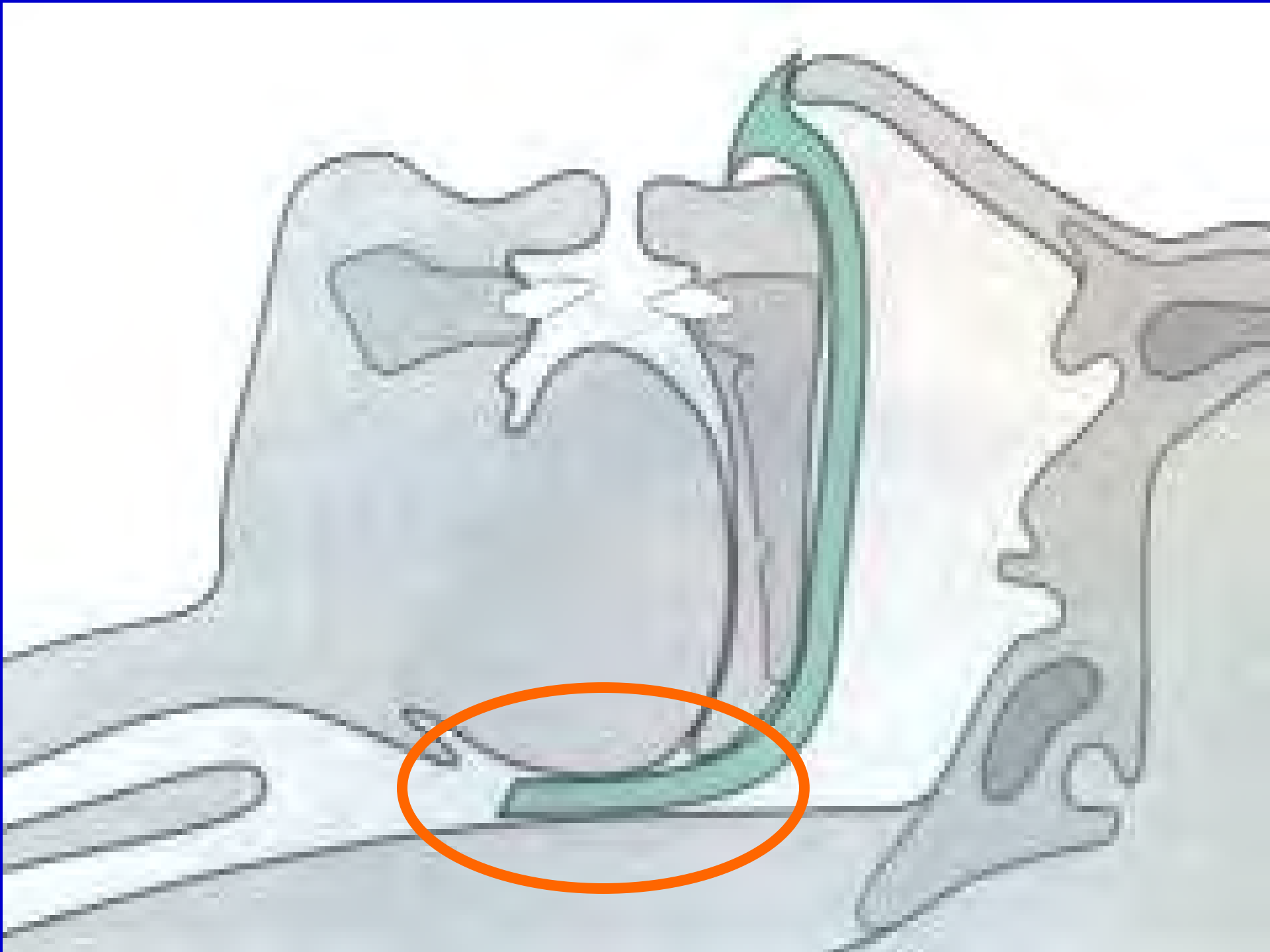
Patient awake

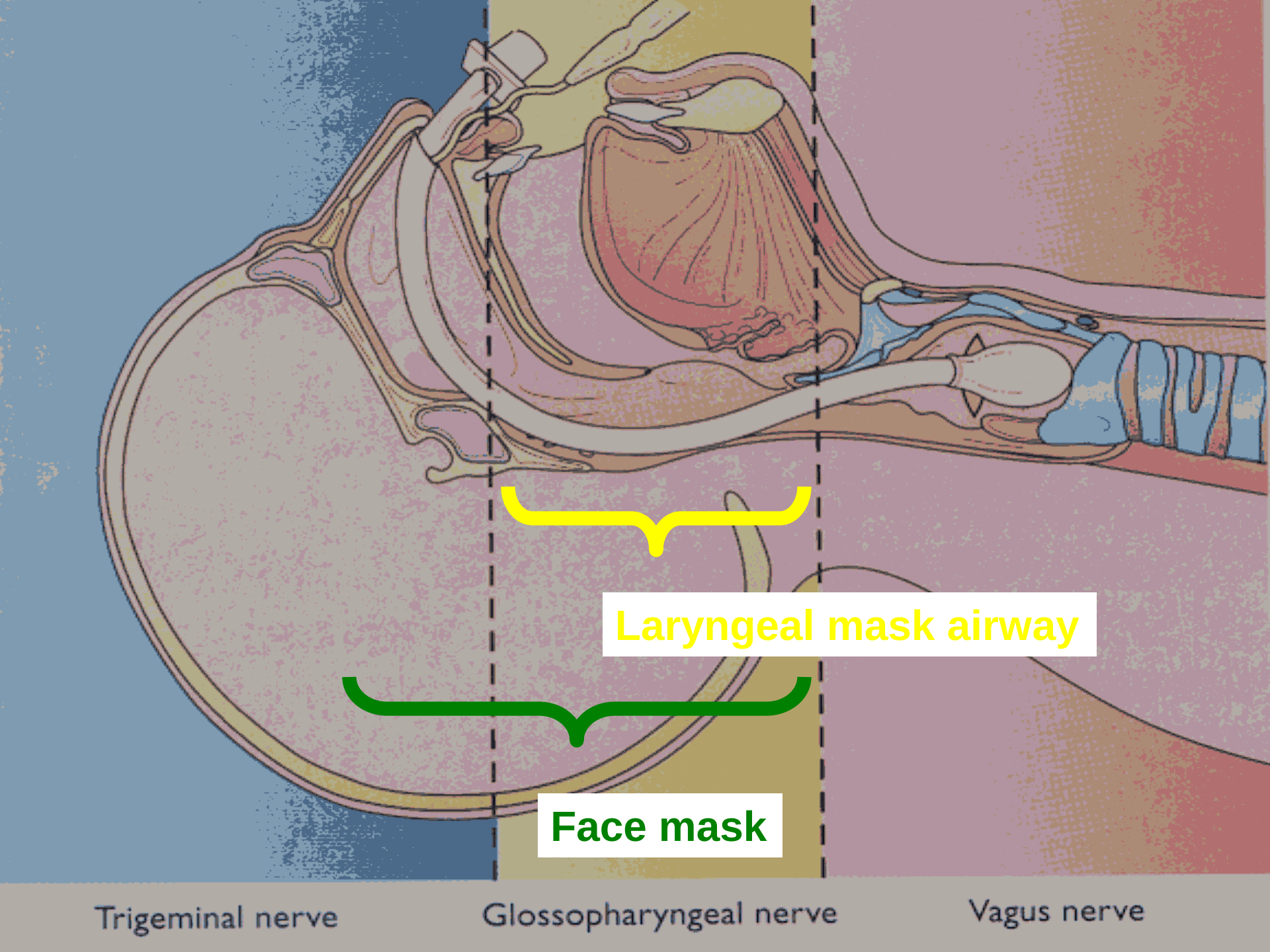


Patient anaesthetised








Laryngeal mask airway
Face mask
Trigeminal nerve
Glossopharyngeal nerve
Vagus nerve

Laryngospasm

Function of the muscles of the larynx:

- *Opening the rima glottidis during breathing by abduction of the vocal cords* (rotating the vocal processes of the arytenoids laterally): the posterior cricoarytenoids only.
- *Closure of the rima glottidis during swallowing by adduction of the vocal cords* (rotating the vocal processes of the arytenoids medially): the lateral cricoarytenoids, thyroarytenoids, and the arytenoideus.
- *Closure of the rima glottidis during swallowing by closing the vestibule from superior*: the thyroarytenoids tilt the arytenoids forward and constrict the vestibule, while the aryepiglottics and thyroepiglottics tilt the epiglottis backward over the rima glottidis.
- *Regulating the tension of the vocal cords for phonation*: during adduction of the cords, their tension is increased when the *cricothyroids* (tensor of the vocal cords) contract and tilt the thyroid cartilage forward and away from the arytenoid cartilages. All the muscles between the arytenoids and thyroid laminae as well as between the epiglottis and the thyroid laminae are stretched. The posterior cricoarytenoids stabilize the arytenoids on the cricoid facets. Therefore, during speech, the tension in the vocal cords increases, while the epiglottis is removed from the inlet to the vestibule. The *vocalis* do fine adjustments to the tension in the vocal cords.

Nerve supply to the larynx

The larynx receives its their motor, sensory, and autonomic innervation from the superior laryngeal and recurrent laryngeal branches of the vagus nerve:

- *Motor* to all the intrinsic muscles: *the recurrent laryngeal nerve. This nerve is sometimes injured during neck surgery, especially thyroidectomy*. If the *nerve is severed*, both the adductors and abductors are paralysed and the vocal cords are in a neutral position (*the rima glottidis is open*). If the *nerve is only injured*, the phylogenetically older muscles, the adductors, are spared and they contract (*rima glottidis closes*). If *both nerves are injured*, the adductors from both sides contract, and the rima glottidis closes and the *patient has stridor and can suffocate*. If only one nerve us severed or injured, the adductors from that side will relax or contract, respectively. The *patient will be hoarse*.
- *Motor* to the cricothyroids: the *external branch* of the superior laryngeal nerve.
- *Sensory* to the larynx *above the vocal cords*: the *internal branch* of the superior laryngeal nerve.
- *Sensory* to the larynx *below the vocal cords*: *the recurrent laryngeal nerve*.
- *Autonomic*: The vagus nerve carries *sympathetic (vasomotor) fibres* and is responsible for the haemodynamic response to airway management (hypertension and tachycardia).

Laryngospasm refers to prolonged intense glottic closure due to adduction, constriction and backward movement of the epiglottis. ***(Laryngospasm must be distinguished from bronchospasm; see Chapter 13.)*** Laryngospasm occurs in response (re[illegible] glottic or supraglottic stimulation by inhaled irritants, secretions, foreign bodies, or mecha[illegible] [illegible]ening, laryngoscopy during shallow levels of anaesthesia. Stimulation
from the periosteum, celiac plexus, or dilatation of the rectum o[illegible]
reflex. This reflex tends to persist even after t[illegible]

Laryngospasm must be *distinguished from los*
the upper airway are striated and very sensit
This obstruction is characterized by inspirato
the patient leans forward. This position mov
muscles also lose their tone when the *mucos*
Therefore, it is dangerous to apply topical an
sure that someone can perform a crico-thyro
obstructed.

The trachea

The trachea and oesophagus start where the pharynx a
front of C6, about 150 mm from the incisor teeth, abo
about 50 mm from the carina at the level of the sternal
and right main bronchi. In supine adults, the carina is al
of the trachea lies outside the thorax, and the other hal
is larger than the sagittal diameter. The diameter varies
correlation between tracheal calibre and body mass or h

The carina is at the plain between the superior and in
(Louis) and vertebrae T4/5 (in babies at T3/4). In the he
it moves more cephalic in the head-down position. Ther
trachea when the patient is put in the head-up position,
in the head-down position.

The right main bronchus is shorter (about 30 mm) and

- **Prolonged intense glottic closure due to adduction, constriction and backward movement of the epiglottis**
- **Occurs in response to stimulation (reflex)**
  - **Local**
  - **Remote**
- **The reflex persists after stimulation has been removed**

Features associated with difficult face mask ventilation

teeth, upper and lower teeth that are wired together, crowns, dentures
- Complex of receding mandible with protruding tongue and cleft lip and palate (Pierre Robin, Treacher Collins, Goldenhar)

The neck
- Thick neck: obesity, infection (Ludwig angina, deep neck space infection), venous congestion (superior vena cava syndrome), malignancy
- Masses, thyroid, scars of previous head and neck surgery, skin changes associated with radiotherapy
- Injury or burns
- Deformity of the neck due to, for example trauma, ancylosing spondylitis. Lesions involving vertebrae C1 and C2 are more predictive of difficult airway management than lower lesions.

To summarize, the following features occur commonly and may predict a difficult laryngoscopy:
- Pregnancy
- Morbid obesity
- Thick neck (circumference of > 44 cm)
- Large breasts.
- Any condition (congenital, traumatic, neoplastic, infective, surgical) that involves the head, neck, face, and airway
- Small mouth
- Receding chin (small mandible/micrognatia)
- Abnormal teeth (buck teeth), absent teeth, crowns, bridges
- Jewellery in the lips, or tongue
- Large tongue
- High arched palate
- Large hair pieces

*The following features are associated with difficult mask ventilation (**BONES**)*
Beard, **O**besity, **N**o teeth, the **E**lderly, and **S**leep apnoea or snoring, Severe pre[illegible]eceding mandible, or other facial deformities.
The following features are associated with difficult insertion of an LM:
- Limited access to the mouth (an inter-incisor distance < 2.5 cm)
- Intraoral tumours e.g. tongue tumours

The following features are associated with a difficult crico-thyroidotomy and tracheostomy:
- Fixed flexion of the neck, e.g. ancylosing spondylitis, scaring (radiotherapy, burns)
- Deviation of the larynx and trachea
- Tissue overlying the cricothyroid membrane and trachea, e.g. fat, goitre, sepsis
- Devices overlying the trachea, e.g. surgical collar

An entity that may involve several of the above airway features is obstructive sleep apnoea (OSA).
OSA occurs commonly and affects about 15% of the population. About 85% of patients are not diagnosed. OSA is defined as five or more apnoeic events (no airflow ≥ 10 s despite respiratory effort) per hour, or fifteen or more hypopnoeic events (airflow decrease > 50% for ≥ 10 s) during a study period of seven hours. OSA occurs during REM sleep (decreased muscle tone) causing hypoxaemia and arousal. Patients suffer from day time somnolence since sleep is fragmented and REM sleep is not sustained.

Complications of OSA:
Very sensitive to the effects of sedatives (including opioids)
- Control of breathing
- Decreased muscle tone – especially the airway.

Airway management
- Difficult mask ventilation
- Difficult laryngoscopy

Cardiovascular
- Sympathetic activation: Systemic hypertension, myocardial ischaemia, left heart failure, dysrhythmias, stroke
- Chronic hypoxia and hypercapnia: Pulmonary hypertension, right heart failure, polycythaemia

Cognitive
- Hypersomnolence
- Personality changes
- Cognitive deficits
- Accident prone

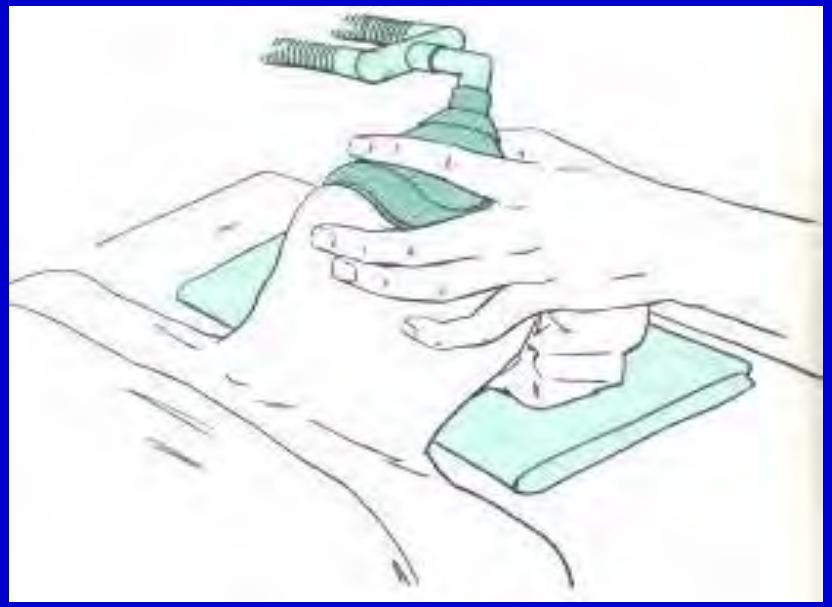
Some obese patients develop the obesity hypoventilation syndrome (OHS), consisting of a body mass index (BMI) > 40 kg m^{-2}, chronic daytime hypoxaemia, hypercapnia, and day time somnolence (Pickwickian syndrome). Hypercapnia in the absence of significant obstructive pulmonary disease in an obese patient is diagnostic of OHS.

- **Beard**
- **Obesity**
- **No teeth**
- **Elderly**
- **Sleep apnoea**

Features associated with difficult face mask ventilation

- **B** eard
- **O** besity
- **N** o teeth
- **E** lderly
- **S** nore

Remember “BONES”

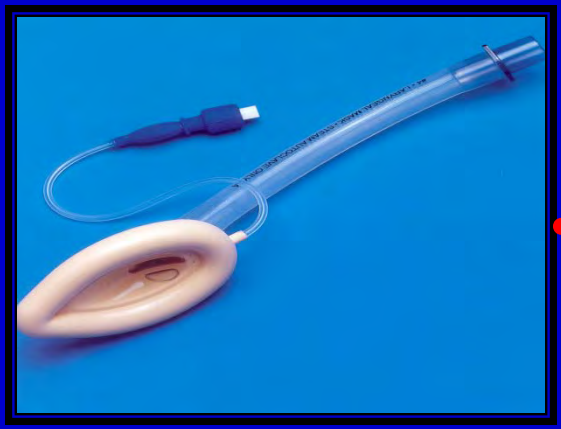


Failed face mask ventilation?

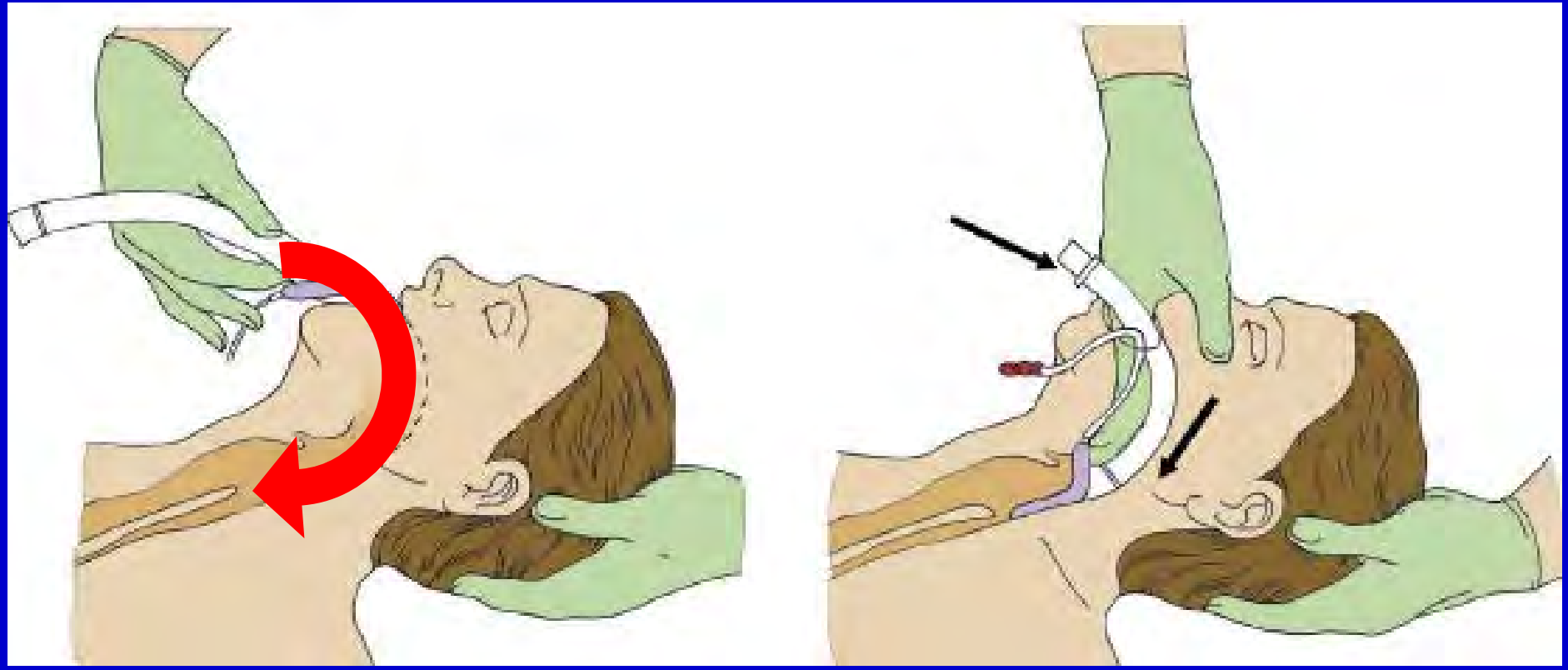
Attempt laryngeal mask ventilation

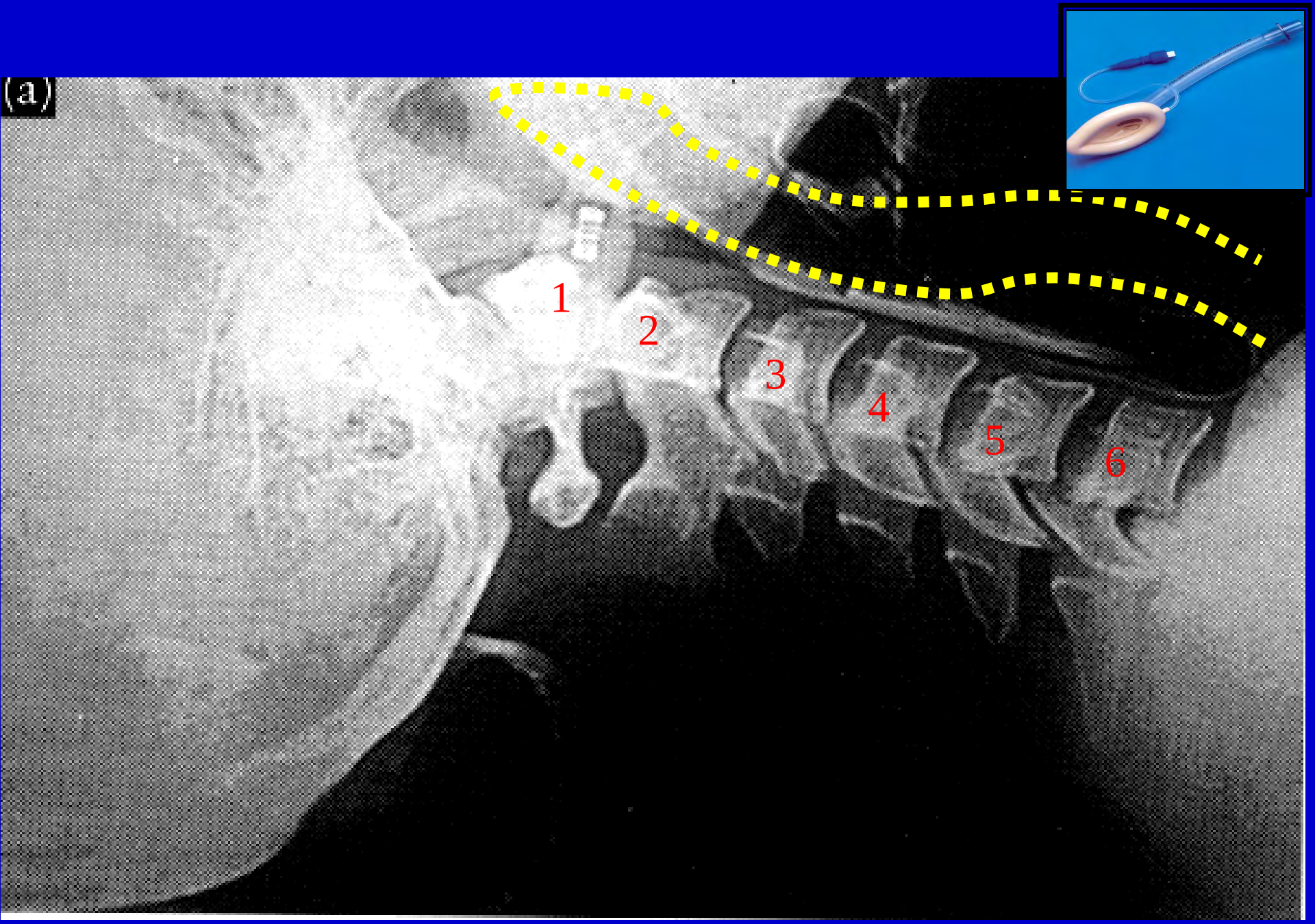
- **May the LMA be used in children?**
- **Is the LMA sometimes placed in the oesophagus?**
- **May the LMA be used for PPV?**

…see…



…think…




(a)
1
2
3
4
5
6

LMA (vs FM)

Advantages

- Hands free
- Better seal (beard)
- Easier to maintain airway
- Protects against airway secretions
- Less facial nerve and eye injuries
- Less operating room pollution

Disadvantages

- More invasive
- More risk of airway trauma
- Requires new skill
- Deeper anaesthesia required
- Some TMJ mobility required
- N_2O diffusion into cuff
- Multiple contra-indications

Features associated with difficult insertion of an LMA

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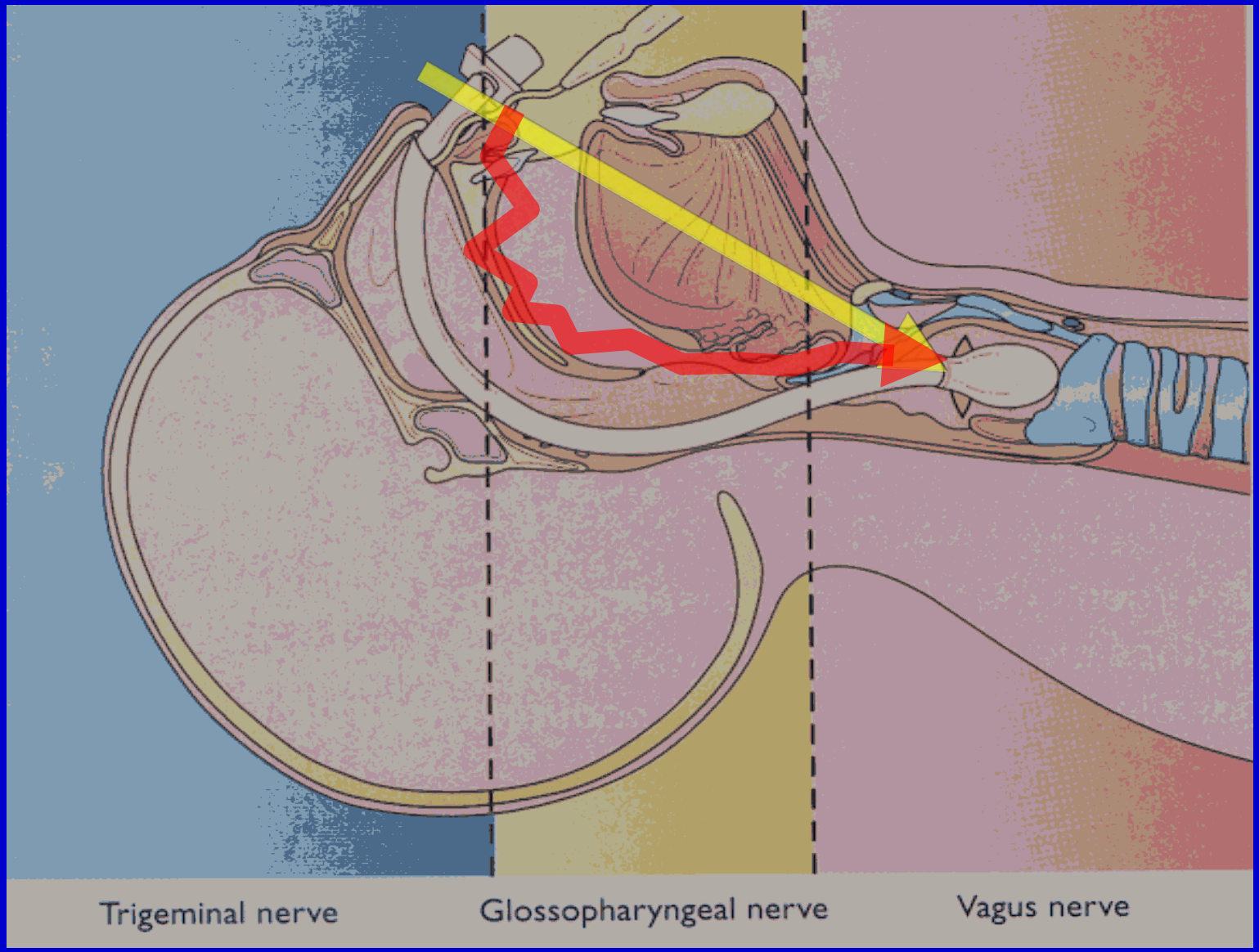
- ***Mouth opening***
- ***Intra-oral tumours***

When evaluating the airway think of 3 separate components

1. **Ventilation**
2. Laryngoscopy and **intubation**
3. **Rescue** airway

Direct laryngoscopy



Direct laryngoscopy

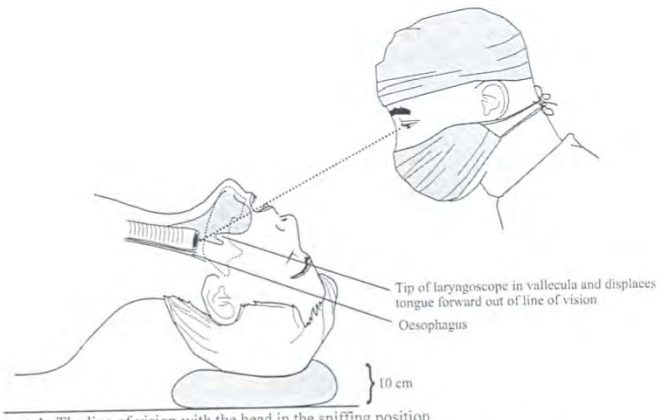


Figure 4a The line of vision with the head in the sniffing position

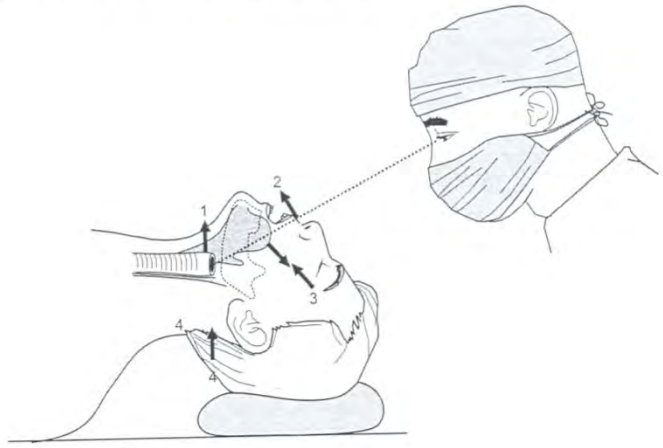
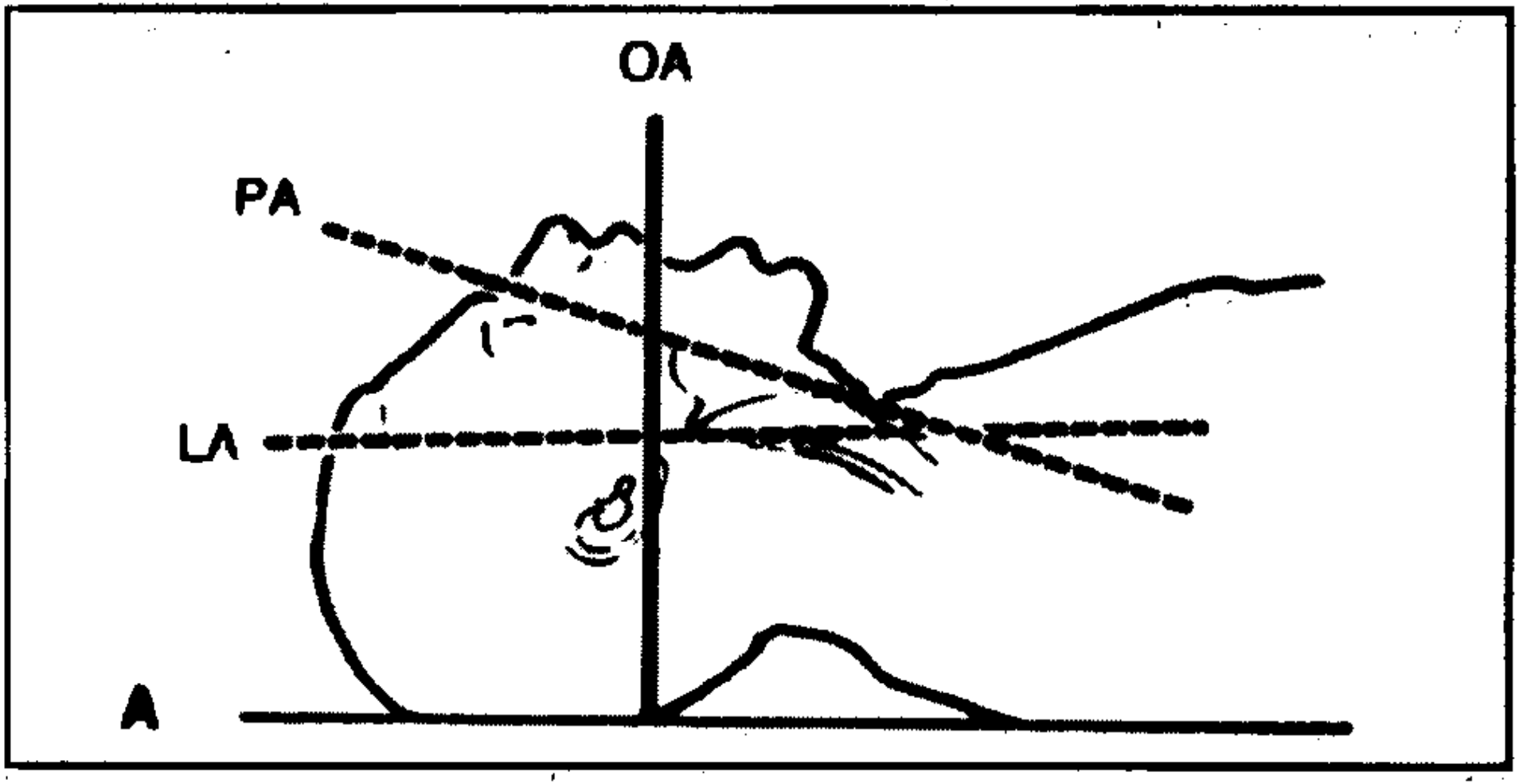


Figure 4b Interruption of the LOV by:

1. An anterior larynx
2. Inability to open the mouth; prominent teeth which shifts the line upwards
3. A large tongue, tongue tumours, supra- and inframylohyoide tumours or infection (Ludwig angina) immobile tongue, or small mandible (protruding tongue); palatal tumours
4. Retropharyngeal lesions (retropharyngeal haematoma, sepsis, Ludwig angina), prevertabral haematoma, sepsis)

1 to 4. Poor positioning; inability to open the mouth, flex the neck or to extend the atlanto-occipital joints (sniffing position)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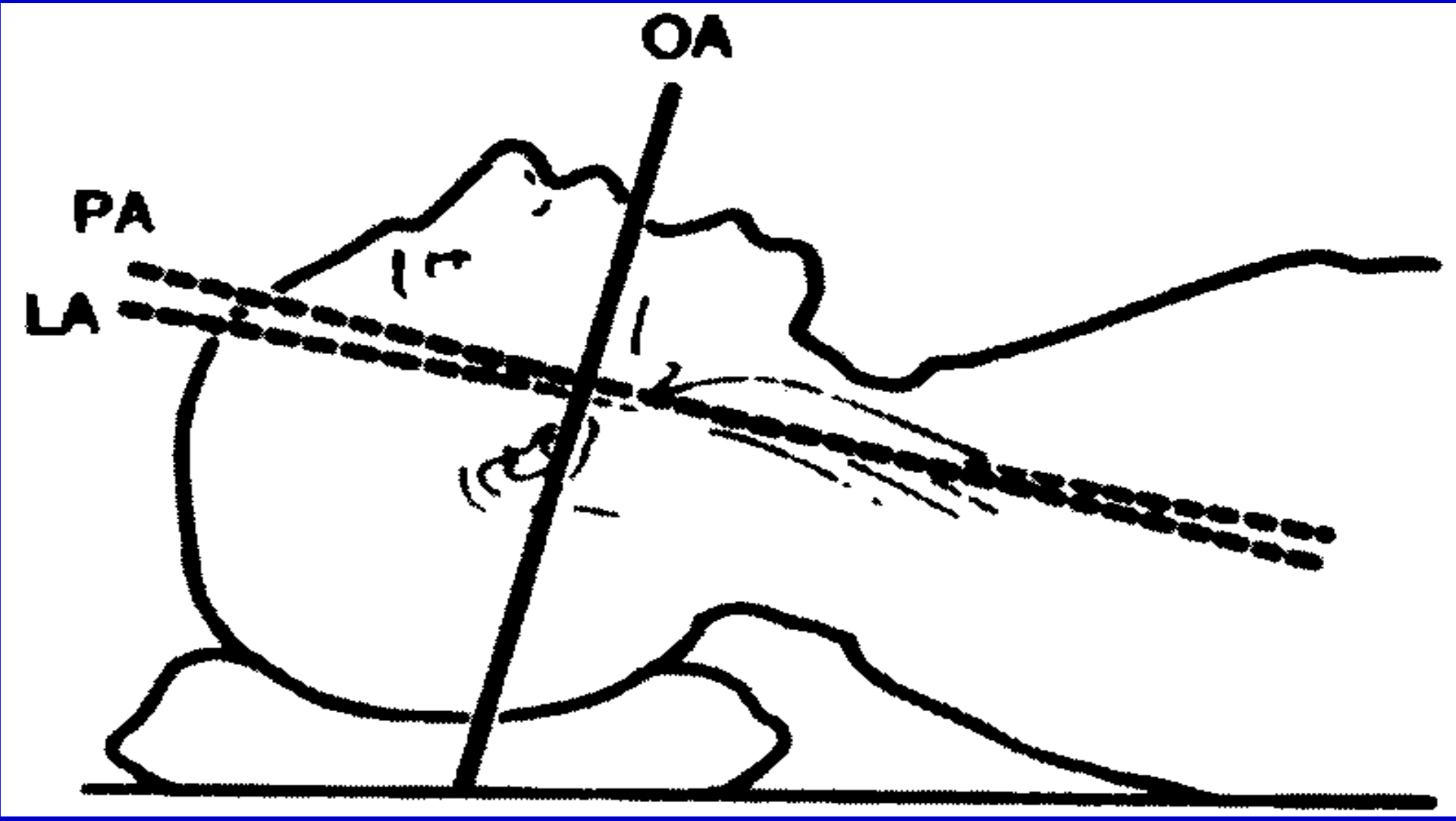
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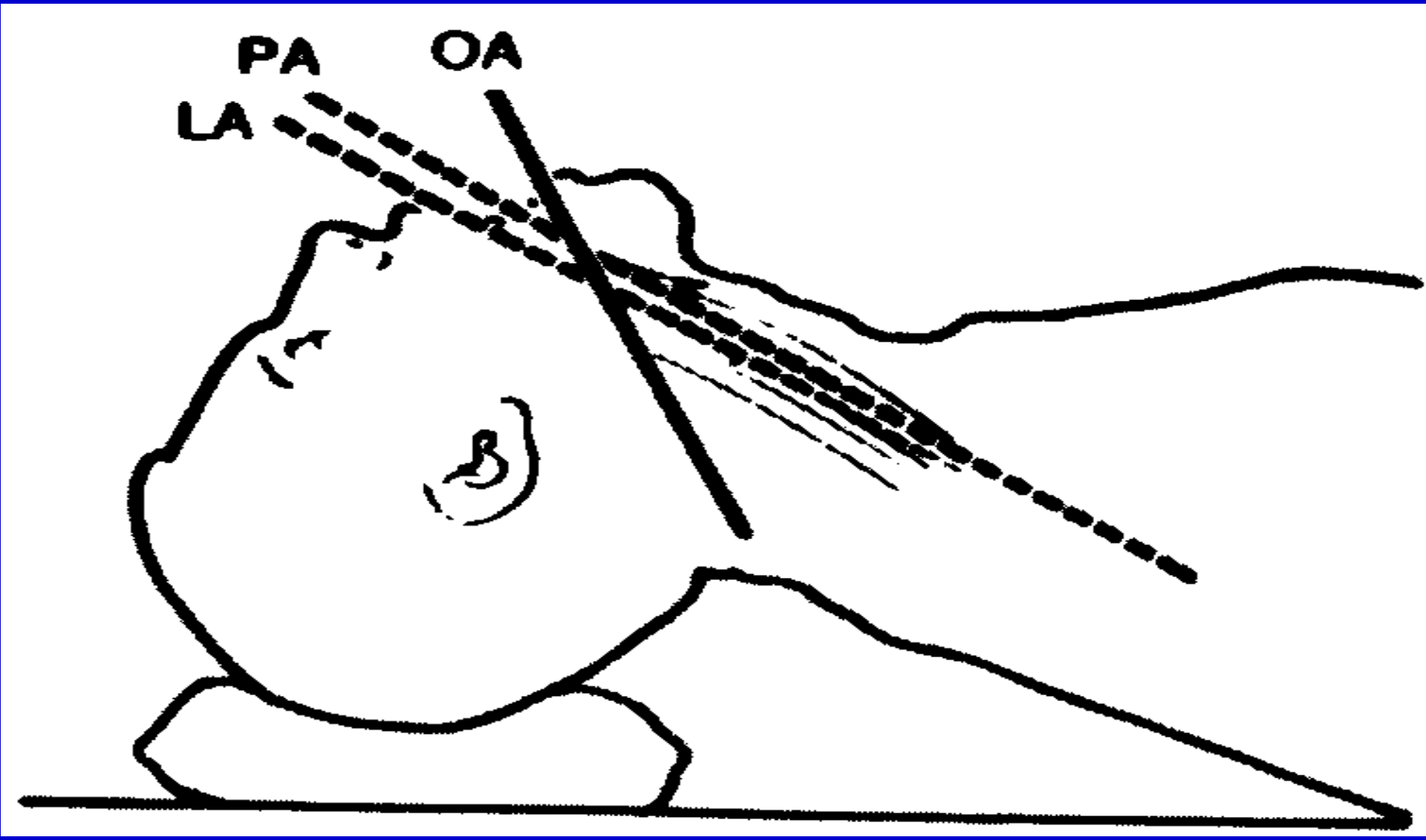
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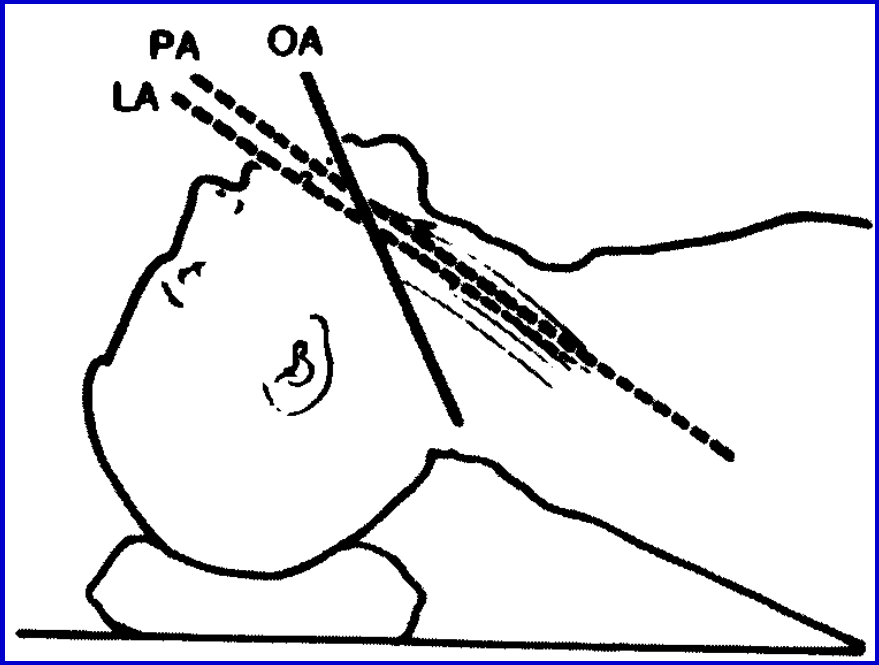
Prediction of difficult laryngoscopy and intubation

Any factor that interrupts direct visualization of the glottic opening.



Not immediately life-threatening airway obstruction

- Fell from bicycle
- Bruising anterior neck
- Immediate emhysema
- Pneumothorax

Pt with suspected neck injury
? Appropriate airway maneuver

Not immediately life-threatening airway obstruction

Spontaneous ventilation

Tear in lower trachea

Features associated with difficult direct laryngoscopy

The definitive diagnosis of OSA is made with polysomnography in the sleep laboratory. The test is cumbersome and can be predicted using the ***STOP BANG questionnaire.*** A count of ≥ 3/8 indicates a high risk of OSA:[1]
Do you **SNORE** loud enough to be heard through closed doors?
Do you often feel **TIRED**, fatigued, or sleepy during daytime?
Has anybody **OBSERVED** you stop breathing during your sleep?
Do you have or are you being treated for high blood **PRESSURE**?
BMI > 35 kg m^{-2}?
AGE > 50 years?
NECK circumference at cricoid > 40 cm?
GENDER male?

Clinical tests to predict the ease of laryngoscopy
Several clinical predictors of a difficult laryngoscopy have been described. However, the following factors confound their utility.

- On its own, each predictor has poor sensitivity and specificity.
- The tests are very subjective (large inter-observer variability).
- All anaesthetists do not define the "difficult airway" the same.

The *sensitivity and specificity of these tests improve when they are combined into a core*, e.g. the *Wilson score*.[2] The Wilson score takes into account five variables. They are graded subjectively (*!*) from 0 to 2 where 0 is normal and 2 abnormal. A count of ≥ 2 has a true positive value of 75% and a false positive predictive value of 12% (Table 4).

Table 4 The Wilson score2

Risk factor	Level	Criteria
Body mass	0	< 90 kg
	1	90 kg to 110 kg
	2	> 110 kg
Head and neck movement	0	> 90°
	1	About 90° (± 10°)
	2	< 90°
Jaw movement	0	IG ≥ 5 cm* or SL > 0
	1	IG < 5 cm and SL = 0
	2	IG < 5 cm and SL < 0
Receding mandible	0	Normal
	1	Moderate
	2	Severe
Buck teeth	0	Normal
	1	Moderate
	2	Severe

IG, inter-incisor gap; SL subluxation of the temperomandibular joint; *5 cm ≈ 3 fingers

If possible, the following clinical tests to predict the ability to do a successful laryngoscopy should be performed in all patients preoperatively:

1. Inter-incisor gap
Ask the patient to open their mouth as wide as possible. A distance of less than two fingers breadths (3cm) between the upper and lower incisors or alveolar ridges is associated with difficult laryngoscopy.

2. Protrusion of the mandible
Ask the patient to protrude their mandible. Inability to protrude the lower incisors in front of the upper incisors predicts a difficult laryngoscopy. This is called prognathia.

3. Mallampati score
The Mallampati score is done in an *awake*. The patient is asked to open the mouth and protrude the tongue. The patient must *not phonate* or extend the head. The *view of the uvula* is recorded (Figure 6). This score evaluates the ability to open the mouth, the size and mobility of the tongue, and any mass in the passage between the mouth and fauces:

- ***Disproportion***
- ***Distortion***
- ***Dysmobility***
- ***Dentition***

Features associated with difficult direct laryngoscopy

- **D** isproportion
- **D** istortion
- **D** ysmobility
- **D** entition

Remember the four "D^{s}"

<u>Approach to distorted airway ?</u>

- **Awake fibre-optic intubation**
- **Gas induction** *(Volatile induction with spontaneous breathing)*

Laryngoscopic view

Cormack and Lehane

using a mirror or a fibreoptic instrument. ENT surgeons often do this. This can also be done before induction of anaesthesia in theatre; using a laryngoscope, the anaesthetist may get an idea of the visibility of the vocal cords.

What the anaesthetist observes during laryngoscopy after induction of anaesthesia is often predictable from the preoperative airway evaluation. However, in about 2% of laryngoscopies this can be an unpleasant surprise.

The direct laryngoscopic view of the vocal cords in the anaesthetized patient is graded using the Cormack and Lehane Classification (Table 5 and Figure 7). The laryngoscopic view should be documented on the anaesthetic record. The anaesthetist must review previous anaesthetic records during the preoperative assessment. If a high Cormack and Lehane grade has been documented, steps can be taken to facilitate airway management during subsequent anaesthetics.

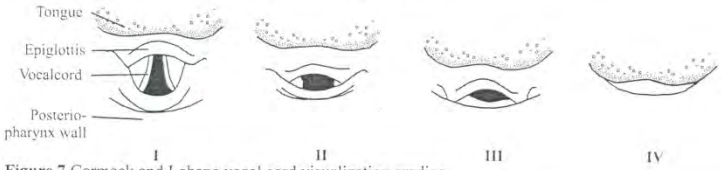


Figure 7 Cormack and Lehane vocal cord visualization grading

Table 5 Cormac Lehane grading of direct laryngoscopic view

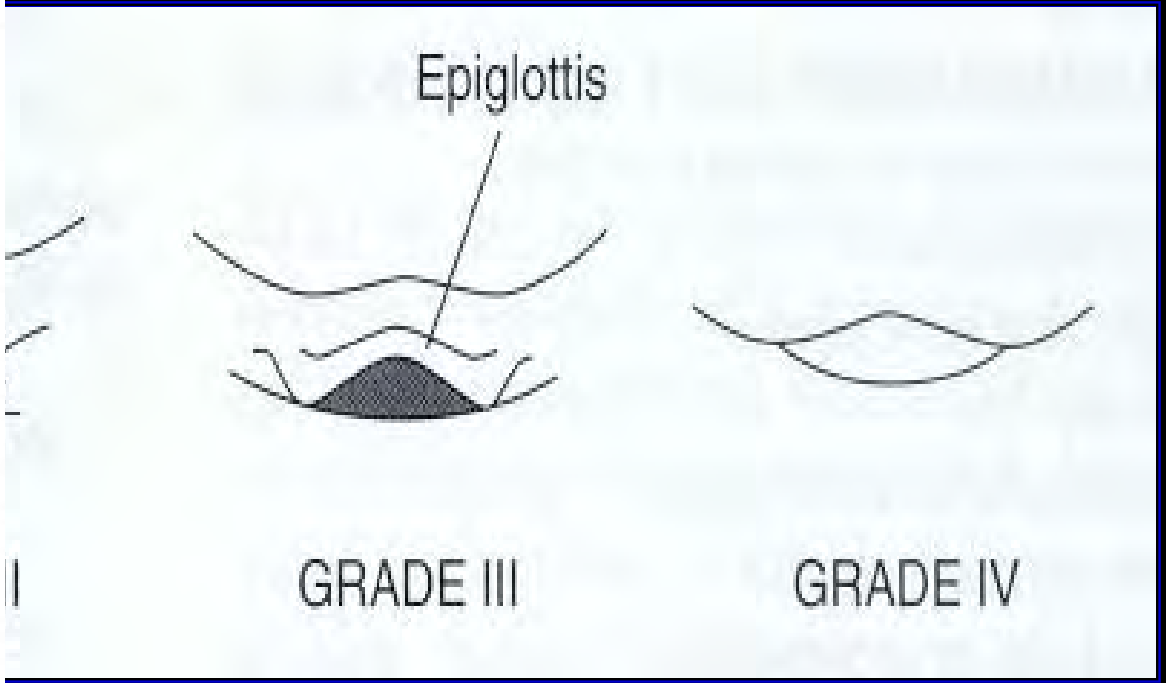
Grade	Vocal cords	Epiglottis	Base of tongue	Posterior pharynx wall	Oesophageal inlet	Remark
I	Whole	Whole	Yes	Hypopharynx	Yes	
II	Partially	Whole	Yes	Hypopharynx	Yes	
III	No	Tip only	Yes	Hypopharynx	Yes	Cannot get round the corner; the cords are high up behind the base of the tongue. These views improve with better positioning of the head and neck (sniffing position). The McCoy laryngoscope blade may be helpful. You will need a 'hockey stick" stylet inside the endotracheal tube to insert the tube. Intubation is difficult, blind, or may be impossible.
IV	No	No	No	Oropharynx only	No	

DIFFICULT AND FAILED AIRWAY MANAGEMENT

The aim of airway management is to fulfil the indication of the airway management in the particular case, namely creation, maintenance, protection, and ventilation. If one of these is not possible, there is failure of airway management.

Airway management can fail due to inability to insert the supraglottic, translaryngeal, or transtracheal airway device and/or failed laryngoscopy. These can result from anatomical factors (outside the wall, in the wall, in the lumen) from the nose or mouth to the trachea.

"Failed insertion and/or laryngoscopy" refers to, e.g. the situation where laryngoscopy is easy but one cannot insert an ETT. This occurs typically with infraglottic lesions such as tracheal stenosis or compression by a mediastinal mass, or when insertion of an ETT is temporarily contraindicated, e.g. in the presence of foreign body in the airway. If one cannot insert a supraglottic airway, e.g. an LMA, airway management has also failed.

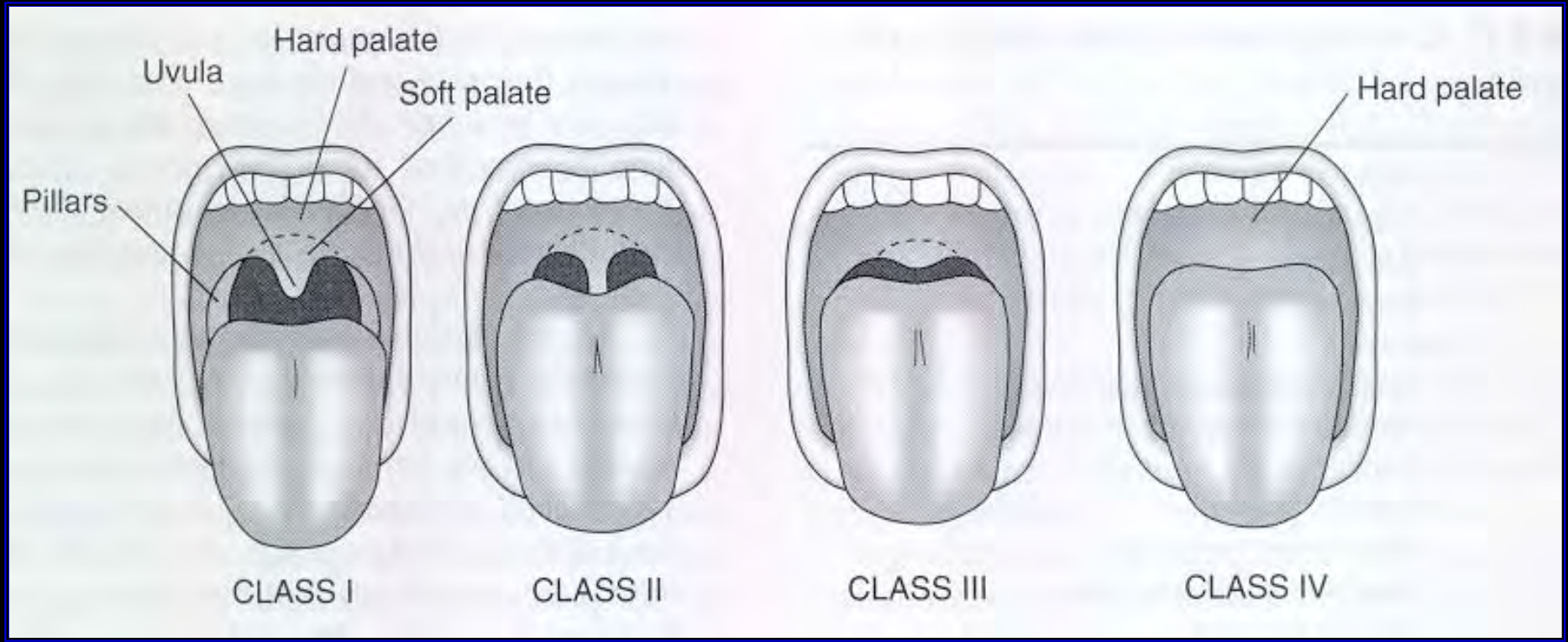


Evaluation for ease of laryngoscopy

- Inter-incisor gap
- Prognathia
- Mallampati score
- Craniocervical movement
- Patil’s test
- Sternomental distance
- Mandibular space
- NC / TM ratio

Mallampati score

[size of the tongue relative to the pharynx]



I and II predict easy intubation
III and IV predict potentially difficult intubation

Limitations during late stages of pregnancy

LMA (vs ETT)

Advantages

- Less invasive
- Less anaesthetic depth required
- Useful in difficult intubations
- Less tooth and laryngeal trauma
- Less laryngo- and bronchospasm
- Muscle relaxation not required
- Neck mobility not required
- Less effect on intra-ocular pressure
- No risk of esophageal or endotracheal intubation

Disadvantages

- Increased risk of pulmonary aspiration
- Prone or jackknife positions
- Unsafe in morbidly obese
- Limits maximum PPV
- Less secure airway
- Greater risk of gas leak and pollution
- Can cause gastric distention

When evaluating the airway think of 3 separate components

1. **Ventilation**
2. Laryngoscopy and **intubation**
3. **Rescue** airway

Rescue airway

Are you familiar with the surface anatomy of the cricothyroid membrane?

- Surgical cricothyroidotomy
- Needle cricothyroidotomy

If potential difficulty is recognized, the cricothyroid membrane should be identified and marked BEFORE any airway intervention is undertaken

Features associated with difficult cricothyroidotomy and tracheostomy

teeth, upper and lower teeth that are wired together, crowns, dentures
- Complex of receding mandible with protruding tongue and cleft lip and palate (Pierre Robin, Treacher Collins, Goldenhar)

The neck
- Thick neck: obesity, infection (Ludwig angina, deep neck space infection), venous congestion (superior vena cava syndrome), malignancy
- Masses, thyroid, scars of previous head and neck surgery, skin changes associated with radiotherapy
- Injury or burns
- Deformity of the neck due to, for example trauma, ancylosing spondylitis. Lesions involving vertebrae C1 and C2 are more predictive of difficult airway management than lower lesions.

To summarize, the following features occur commonly and may predict a difficult laryngoscopy:
- Pregnancy
- Morbid obesity
- Thick neck (circumference of > 44 cm)
- Large breasts.
- Any condition (congenital, traumatic, neoplastic, infective, surgical) that involves the head, neck, face, and airway
- Small mouth
- Receding chin (small mandible/micrognatia)
- Abnormal teeth (buck teeth), absent teeth, crowns, bridges
- Jewellery in the lips, or tongue
- Large tongue
- High arched palate
- Large hair pieces

*The following features are associated with difficult mask ventilation (**BONES**):*
Beard, **O**besity, **N**o teeth, the **E**lderly, and **S**leep apnoea or snoring, **S**evere prognathia, receding mandible, or other facial deformities.

The following features are associated with difficult insertion of an LM:
- Limited access to the mouth (an inter-incisor distance < 2.5 cm)
- Intraoral tumours e.g. tongue tumours

The following features are associated with a difficult crico-thyroidotomy and tracheostomy:
- Fixed flexion of the neck, e.g. ancylosing spondylitis, scaring (radiotherapy, burns)
- Deviation of the larynx and trachea
- Tissue overlying the cricothyroid membrane and trachea, e.g. fat, goitre, sepsis
- Devices overlying the trachea, e.g. surgical collar

An entity that may involve several of the above airway features is obstructive sleep apnoea (OSA).
OSA occurs commonly and affects about 15% of the population. About 85% of patients are not diagnosed. OSA is defined as five or more apnoeic events (no airflow ≥ 10 s despite respiratory effort) per hour, or fifteen or more hypopnoeic events (airflow decrease > 50% for ≥ 10 s) during a study period of seven hours. OSA occurs during REM sleep (decreased muscle tone) causing hypoxaemia and arousal. Patients suffer from day time somnolence since sleep is fragmented and REM sleep is not sustained.

Complications of OSA:
Very sensitive to the effects of sedatives (including opioids)
- Control of breathing
- Decreased muscle tone – especially the airway.

Airway management
- Difficult mask ventilation
- Difficult laryngoscopy

Cardiovascular
- Sympathetic activation: Systemic hypertension, myocardial ischaemia, left heart failure, dysrhythmias, stroke
- Chronic hypoxia and hypercapnia: Pulmonary hypertension, right heart failure, polycythaemia

Cognitive
- Hypersomnolence
- Personality changes
- Cognitive deficits
- Accident prone

Some obese patients develop the obesity hypoventilation syndrome (OHS), consisting of a body mass index (BMI) > 40 kg m^{-2}, chronic daytime hypoxaemia, hypercapnia, and day time somnolence (Pickwickian syndrome). Hypercapnia in the absence of significant obstructive pulmonary disease in an obese patient is diagnostic of OHS.

- ***Flexion***
- ***Deviation***
- ***Disease***
- ***Devices***

Evaluation of the airway

(KEEP IN MIND THE 3 SEPARATE COMPONENTS)

- **History**
  - Previous anaesthetics
- **Clinical examination**
  - General examination
  - Predictors of difficult
    - Face mask ventilation
    - Laryngoscopy
    - Rescue airway
  - Specific evaluations
    - Mallampati
    - Patil
    - Other

Explain the terms ***inspire*** and ***expire.***

”When you breathe you inspire, and when you don’t breathe you expire”

When you drink and drive you also expire

Which physician is best skilled for airway management?

The one that daily deals with it

Specialist anaesthetist

Thorough knowledge of

- Applied physiology
  - And changes due to disease processes
- Applied pharmacodynamics / pharmacokinetics
  - And changes due to disease processes
- Applied physics
  - Gases / fluids
- Technical skills – numerous
  - Most important = ***airway management***