SOUBORNÝ REFERÁT

Difficult Airways – prediction and management

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Abstract

Difficult intubation is uncommon and fortunately the "can't ventilate can't intubate" scenario is extremely rare (1 : 5000). However both remain important causes of anaesthesia-related mortality and morbidity. The ability to predict problems results in improved outcome but sadly our methods remain to date disappointing in accuracy. A number of algorithms have now been developed to guide the physician meeting a difficult airway in predicted or unexpected circumstances. There are many basic and advanced techniques of airway management that anaesthetists should be competent to perform after training. Fibreoptic intubation remains probably the "gold standard" for management of the anticipated difficult airway.
Key words: **intubation endotracheal – difficult airway management – laryngeal mask – fibreoptic intubation**

Souhrn

Obtížné zajištění dýchacích cest – predikce a klinické postupy

Obtížná intubace není častým jevem při úvodu do anestezie. Nejhorší varianta, kdy není možné pacienta ani ventilovat, ani intubovat, je naštěstí velice raritní záležitost (1 : 5000). Přesto selhání zajištění průchodnosti dýchacích cest zůstává významnou příčinou mortality a morbidity v souvislosti s anestezií. Předvídání problému může významně snížit závažné komplikace, ale skórovací systémy bohužel zatím nejsou zcela přesné. Pro zajištění dýchacích cest v elektivních i urgentních situacích bylo vytvořeno velké množství algoritmů. Anesteziolog si může také vybrat ze širokého spektra pomůcek pro zajištění dýchacích cest. Fibroskopická technika je pravděpodobně „zlatým standardem" pro tracheální intubaci v obtížném anatomickém terénu.
Klíčová slova: **endotracheální intubace – obtížné zajištění dýchacích cest – laryngeální maska – fibrooptická intubace**

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Introduction

We still have little understanding of why airways may not remain patent with loss of consciousness [1]. However airway problems still remain an important cause of anaesthesia related deaths and serious perioperative morbidity.

The aim of this review is to conclude the incidence of difficult airways, and influence of predictive tests, airway management plans and equipment with special focus on learning and teaching of difficult airway management.

Historical notes

The first airway manoeuvre – the jaw thrust – was described by Jacob Heiberg in 1874 during chloroform anaesthesia to relieve partially obstructed airway (noisy spontaneous breathing). Tracheal intubation had been documented by Kite for a drowning victim already in 1788. The first fibreoptic intubation was preformed with a flexible choledocoscope to intubate a patient with a large goitre in1967 [2].

In recent years formation of specialist airway societies such as the Difficult Airway Society – DAS (UK) and the Society for Airway Management (USA) have help the anaesthetic community formulate novel techniques for dealing with intubation and airway maintenance problems.

Incidence and importance of Difficult Airways

Failed intubation is rare in general surgical practice with an estimated incidence of 0.43% [3] a recent meta-analysis suggests difficult intubation has reported incidence of 5.8% [4]. However in relation to general anaesthesia for caesarean section the problem is more common. In the Confidential Enquiry in the UK into maternal deaths in 1985–1987, 4 of the 6 deaths attributed to anaesthesia were related to failed intubation.

The incidence of failed intubation in obstetric population is 1 : 250 [2].

In the North American closed claims study in 1991 intubation problems accounted for 23% of deaths associated with obstetric general anaesthesia.

In the USA difficult mask ventilation is more com-

Table 1. Patient factors associated with difficult mask ventilation and difficult intubation

Difficult mask ventilation	Difficult intubation
Elderly men	Elderly men
Obesity	Obesity
History of snoring	History of difficult intubation
(sleep apnoe)	Facial/maxillary/laryngeal
Toothless patients	trauma or tumour
Full beard	Limited mouth opening
	(less than 2 fingers)
	Thyromental distance less
	than 3 fingers
	Limited neck extension
	Difficult anatomical
	orientation in hypopharynx
	when performing
	laryngoscopy

mon than failed intubation with an estimated incidence 1 : 20 (Table 1). Difficult ventilation is defined as the inability of an experienced single anaesthetist to maintain the oxygen saturation above 90 percent using 100 percent oxygen and positive pressure mask ventilation (this definition assume saturation was above 90 percent before anaesthetic intervention) [3]. Failed mask ventilation after the induction to anaesthesia has estimated frequency 1 : 3000 [3].

The incidence of difficult mask ventilation associated with failed intubation ("cannot ventilate, cannot intubate situation") is fortunately very rare with an estimated incidence lower than 1 : 5000 [4, 5].

Prediction of difficulty – definitions

Lack of anaesthetic assessment is a contributory factor in anaesthesia related mortality. Prediction is important because it alters not only mortality but morbidity.

Difficulty with intubation particularly when unexpected is associated with increased incidence of damage to the airways (Table 2) [6].

Prediction of difficulty is therefore desirable. In order to study and deal with difficult airways we need to have clear definitions of what a difficult airway is. The Practice Guidelines for Management of Difficult Airway produced by the American Society of Anesthesiologists (ASA) in Oct 2002 stress consideration should be given to not only potential to difficult intubation but also difficult face mask ventilation (Fig. 1). The latter definition is more important but unfortunately hardly any studies have addressed this issue.

Most investigations have tended to study the incidence of difficult intubation but definitions vary. Common approaches define difficult intubation as a grade

Table 2. How prediction of a difficult airway can reduce airway damage (chipped teeth, trauma to mucosa)

	Incidence of airway damage (%)
Easy intubation	5
Predicted difficult intubation	17
Unexpected difficult intubation	63

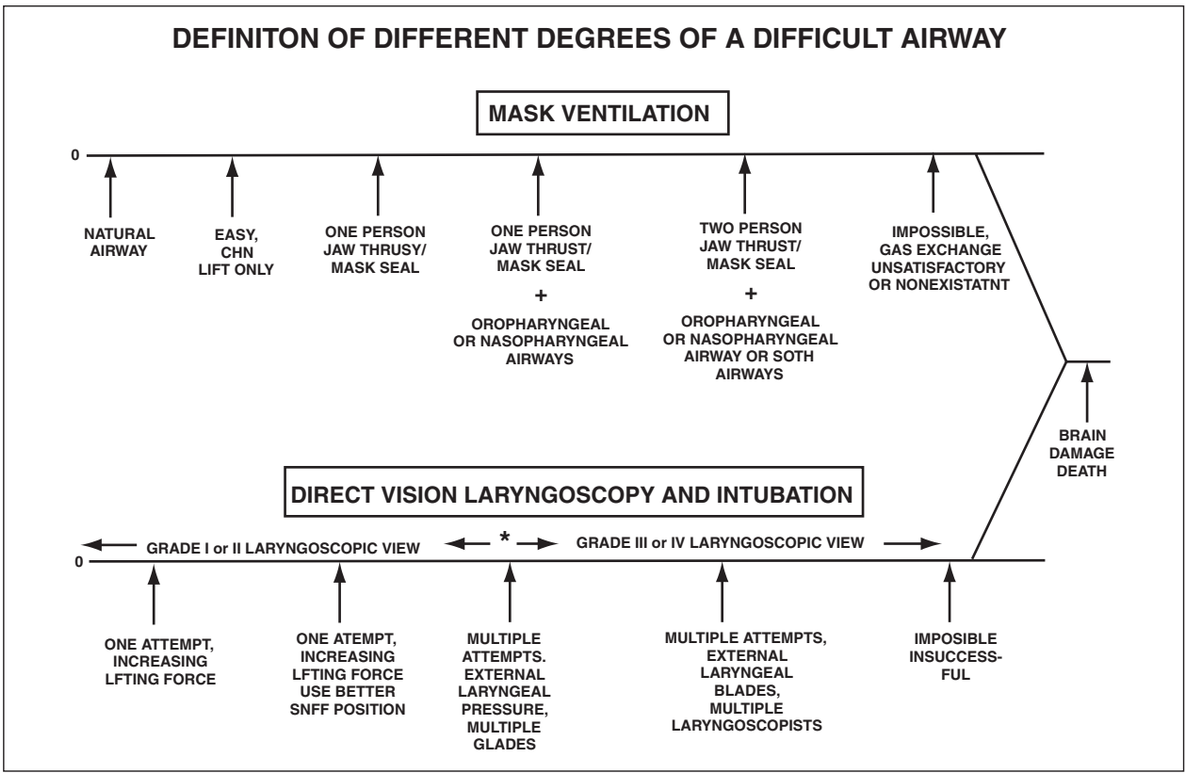


Fig. 1. Definition of different degrees of difficult airways

III/IV laryngoscopic view (Fig. 2) or the requirement for repeated laryngoscopy [7]. Grade III and IV views occur in about 4–10% and 1–2% of cases respectively. More than three attempts at laryngoscopy occur in about 2% of intubations.

The percentage of glottic opening (POGO) and Intubation Difficulty scales have not really found a place in routine practice [8].

How to spot the difficult airway

We are all easily alerted to patients with obvious head and neck pathology such as seen in genetic syndromes (Klippel-Feil syndrome, craniodysostosis, Pierre-Robin syndrome, etc.) and with previous surgery (dental abscess, tumours). The challenge lies in

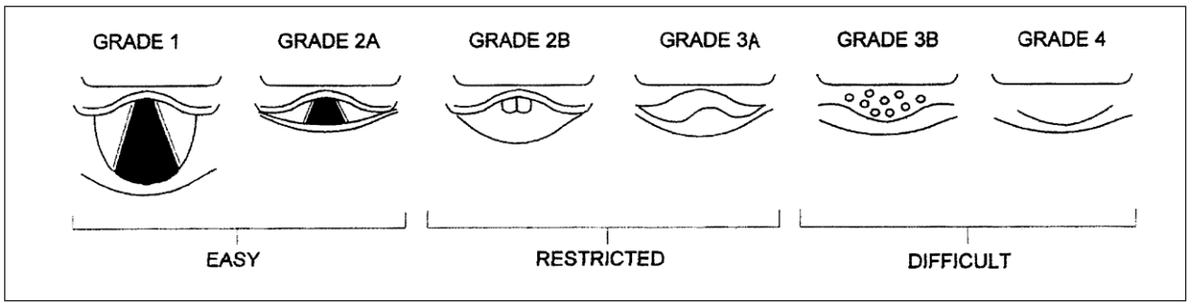


Fig. 2. Difficult intubation as a grade III/IV laryngoscopic view

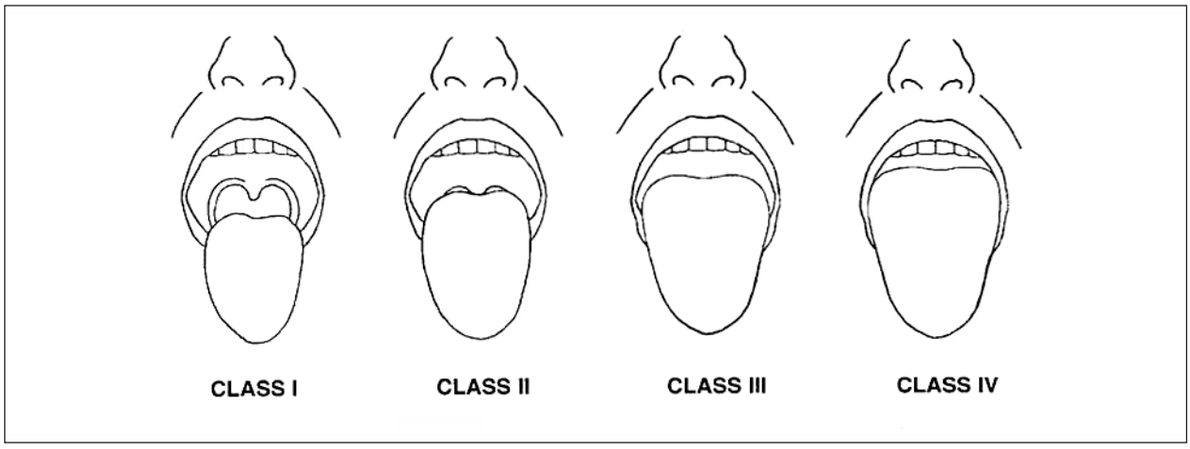


Fig. 3. Mallampati grading of tongue relative to pharyngeal size

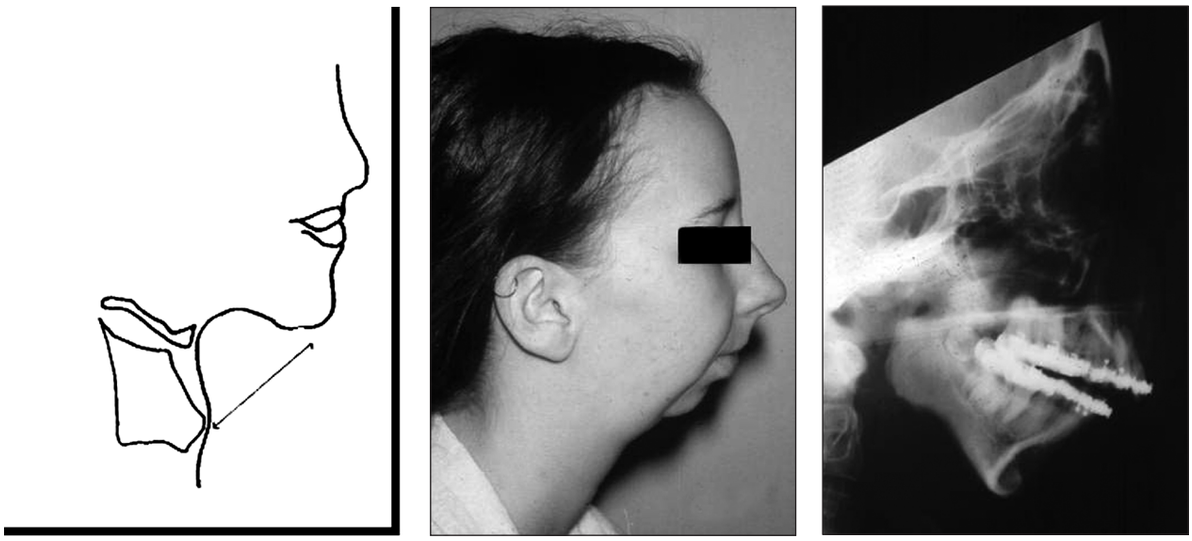
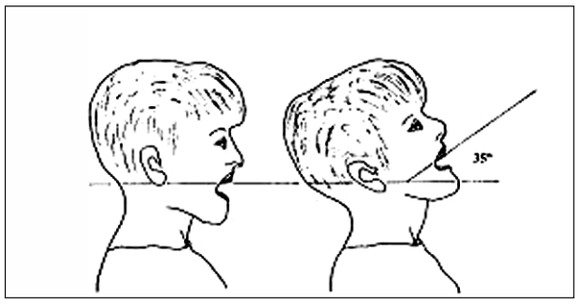


Fig. 4. Patil's assessment of submandibular space



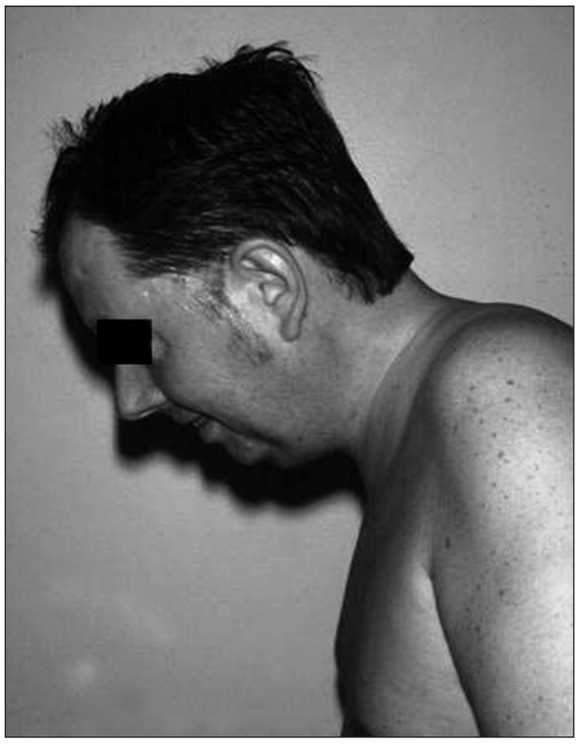


Fig. 5. Belhouse and Dores' evaluation of neck extension

predicting the difficult airway in the normal looking population – this applies particularly in obstetrics.

The ASA "Practice Guidelines for Management of the Difficult Airway" suggest that there is "insufficient evidence that routine history and examination predict difficult airways but that a focused anaesthesia history and airway examination may help". We should play particular attention to previous documentation in anaesthetic records and note a history of X-Ray therapy to the neck that may make submandibular tissues stiff to move with a laryngoscope despite the patient having a normal appearance. One should also consider whether airway tissues are liable to bleeding or swelling upon contact with the laryngoscope. We should also be alerted that pre-existing trauma may render the cervical spine unstable – limiting airway

Fig. 6. Calders teeth relationship grading

manoeuvres. Basal skull fractures will contraindicate nasal intubation and use of a bag and mask apart from at the lowest of inflation pressures. Assessment of the liability for aspiration is essential.

It should also be routine for any patient to undergo the following airway investigations:

1. Mallampati grading of tongue relative to pharyngeal size (Fig. 3).
2. Patil's assessment of submandibular space (Fig. 4).
3. Belhouse and Dores' evaluation of neck extension (Fig. 5).
4. Calders teeth relationship grading (Fig. 6).

How accurate are our assessments?

Tests such as the Mallampati score, Patil's thyromental distance (particularly when indexed to height) [12, 13] and Bellhouse and Dore's measure of cervical flexion initially look predictive on small selected populations with high incidences of intubation difficulties (eg. patients with fractured spines), but fare worse when subject to the whole population.

An editorial by Yentis in 2002 explains why for each test findings do correlate with difficult intubation but if we analyse the tests in terms of how accurate they are in terms of sensitivity, specificity and positive predictive value they are seen to be less helpful [14] (Table 3).

Even though the tests are 80% sensitive this means we shall miss 1 in 5 difficult intubations. Because difficult intubation is rare specificity (how accurate is a negative result) is high – it just happens to be right most of the time.

Table 3. How do our tests perform in the general population?

Test	Sensitivity (%)	Specificity (%)	Positive predictive value (%)
Mallampati	42–81	60–90	4–20
Thyromental distance	60–90	25–80	15–20

However the positive predictive value (how accurate is a positive result) is very low when the test is applied to the population of patients at large. Therefore although the test may have a low false positive rate in small selective studies it will mean in the overall population the false positive rate will be high when compared to the number of true positives.

The LMA has reduced the number of intubations performed. The LMA works in 98.6% of cases, unfortunately predictive tests relating to the efficacy of the LMA and relationship to intubation difficulties are lacking.

How can we utilize the tests?

Whilst the individual tests are disappointing combining the above to "get a feel" that intubation may be difficult is useful. In statistical terms combining tests improves the sensitivity and positive predictive value but with some loss of specificity.

Rocke in 1992 effectively did this in the obstetric population when he produced relative risk values of anatomical features (such as short neck, Mallampati and Patil grades) associated with difficult intubation [15].

A convenient table detailing combinations of abnormalities and the effect on intubation (not just on laryngeal view) was constructed.

What can we do when confronted with a predicted difficult airway?

A number of helpful algorithms have been developed to assist us in formulating plans for anaesthesia in patients with difficult airways. Some are over complicated but key components involve the development of:

a) "back up plans"
b) consideration of the need to preserve spontaneous breathing
c) consideration of the preservation of consciousness until the airway is secured.

Of course consideration should be given to whether intubation or even anaesthesia is necessary – it may be possible to proceed with a LMA or regional anaesthesia technique!

If intubation is deemed essential then based upon our airway assessment we will have to decide upon the degree of difficulty likely to be encountered and reach a provisional initial technique.

This 'Plan A' may be basic eg. using a short acting muscle relaxant and the gum elastic bougie, or more advanced if we feel that paralysis may be dangerous eg. gas induction. Indeed if we feel airway maintenance is at risk awake intubation may be necessary.

In the last 10 years some 15 airway devices have surfaced onto the market [16].

What ever we use, we should use a device we are familiar with and have formulated back up plans B and even C!

One should always avoid repeated attempts to intubate and be prepared to move on to the next predetermined technique. Exceeding two attempts at laryngoscopy can cause a deterioration in the airway, aspiration, bradycardia with hypoxia leading to cardiac arrest [17]. The US Recent Closed Claims analysis would suggest that patients die from lack of oxygen not lack of intubation [18].

Table 4. Additional manoeuvres for optimizing of laryngoscopic view 12

External laryngeal manipulation (ELM) on the thyroid cartilage
Backward upward rightward pressure (BURP) on the thyroid cartilage
Lever-tip (McCoy-type) laryngoscope
Head-elevated laryngoscopy position (HELP) – neck flexion 35°, head extension 15°
Straight blade (the patient with small chin, protruding upper teeth, large epiglottis)

Sometimes the laryngoscopic view is not quite ideal. Benumoff in his article described some tips and tricks for finding an "optimal" laryngoscopic view [19] (Table 4).

Whatever technique we choose we should always give similar consideration of our plan for extubation. Once again we should consider a backup plan B and C predetermined for unexpected difficulty. Failure to do so has resulted in deaths [18].

Airway problems can be present not only during induction to general anaesthesia. It is well known that obstructive sleep apnea syndrome (OSAS) is a complicating factor in the administration of general anaesthesia. The lingering sedative and respiratory depressant effects of anaesthetic drugs can pose difficulty in the postoperative period. The situation can be further complicated by upper airway swelling secondary to intubation and extubation. Therefore it is necessary to perform close monitoring and airway support during the early postoperative period as well as to develop plans for postoperative airway management.

Airway management techniques

Basic Airway Devices

1. The Gum Elastic Bougie

Developed in the 1970s the angled soft tip is essential for its effectiveness.

The feeling of tracheal clicks as it is passed indicate tracheal placement.

The following are essential for correct technique:

– retention of MacIntosh blade in vallecula with continuing elevation of tongue,
– laryngeal pressure (the BURP – backward upwards and right pressure – technique will reduce grade 3 views from 9.2% to 1.6%) [20],
– anticlockwise rotation of the tube during insertion.

A 94.3% success rate when the cords could not be seen has been described [21]. Disposable bougies

are now available however the Portex ones show an increased failure rate. This is because the material lacks plasticity when bent into shape by the anaesthetist. The Cook product developed by Frova retains its shape better.

Only one case of pharygeal perforation post glossectomy/radical neck dissection has been documented in the literature despite extensive use of the original Eschmann model [22].

2. Rapid Sequence induction

The suggested force of cricoid pressure has been revised. Traditionally 44N was advised but ventilation problems due to airway obstruction is now recognised [23, 24] and 30N is now recommended [25].

Surveys reveal often an inaccurate amount of cricoid pressure is given and that after training anaesthetic assistants provide the correct force more often.

3. Special laryngoscope blades

Several different laryngoscope blades have been developed to date [26]. The MacIntosh blade is the classical one and most commonly used. However the use of MacIntosh blade does not always result in satisfactory exposure of the larynx especially if the epiglottis is large. The McCoy laryngoscope has flexible distal tip on the blade. The tip is flexed upward thus raising the epiglottis without a change in handle position. Another option is to use a straight blade (risk of epiglottis damage). The Magboul laryngoscope is extremely useful for intubation of obese patients. Its blade can be locked in four different positions (in relation to the handle). The Viewmax laryngoscope allows visualization of the vocal cords in even the most difficult cases. Patented lens system refracts the image approximately 20° from horizontal, allowing visualization of even the most anterior larynx [27].

Advanced Airway techniques

Intubating Laryngeal Mask Airway (ILMA)

The ILMA is now well established. It is included in the DAS algorithm as an acceptable “Plan B” once the gum elastic bougie has failed (for elective scenario only). The device is as easy to insert as the LMA. Success rates with blind intubation approach 88% (98% using the fibrescope) [28].

Fibreoptics

This is probably the gold standard for very difficult intubation and its use is supported in the ASA guidelines to reduce adverse airway outcomes. Video systems and battery powered scopes now can make complicated techniques easier to teach and perform.

Use in the awake patient is easiest, however extreme caution is advised in the presence of stridor. Some would contraindicate awake intubation in these circumstances [29]. Good topicalisation of the airway and avoidance of oversedation is paramount. Abolition of the gag response to intubaton is generally achieved with local anaesthetics delivered by sprays or specific nerve blocks. Nasal intubation is technically easier but awake intubation via the mouth can easily be achieved with minimal coughing or discomfort for the patient [30]. When used asleep it is important to create and maintain the airspace so the scope can pass. Use of airway adjuncts helps delivery of gases eg. via the other nostril to keep the patient asleep. Oral asleep fibreoptic intubation can be facilitated by using of special facial mask with the entry for fibrescope. Desaturations occur in 30% of uses in asleep patients.

Back up plans are essential.

What can we do when confronted with an unexpected difficult airway?

The LMA

There are now more than 2400 papers on the LMA. It has been used in 150 million cases. We all have personal experience of it saving our skin! The LMA can generally be inserted during cricoid pressure [31]. However it may be necessary to temporarily release cricoid pressure during insertion [32]. The new ProSeal LMA offers more protection against aspiration [33]. But a case of aspiration has been described during a mastectomy with the ProSeal LMA [34].

Combitube

This dual tube is easy to insert. It has found a place in cardiopulmonary resuscitation (CPR) and pre hospital use and appears in the European Resuscitation Council guidelines since 1996 [35].

It does protect against aspiration and has been used in failed intubation including one case where mouth opening prevented LMA insertion [36]. But four cases of barotrauma have been documented to date [37].

Transtracheal Jet Ventilation

This life saving technique is generally reserved as a “last resort technique”. The availability of high quality equipment (Patil’s set, Cook Cricothyrotomy set, Quick Trach, Manujet etc.) has now rendered ‘home made’ kits obsolete. It is important to create an open glottic airway for expiration and allow a long expiratory time to prevent barotrauma. Experience of cricothyroid puncture is gained at awake intubation and whilst performing percutaneous tracheostomy on the ICU [38].

Retrograde intubation

This technique is not recommended for use in neither DAS (Fig. 7) [39] or ASA algorhitms.

Training in airway management

Airway skills have appeared on FRCA (UK) syllabus since 1997 but only recently have core competencies been defined [40].

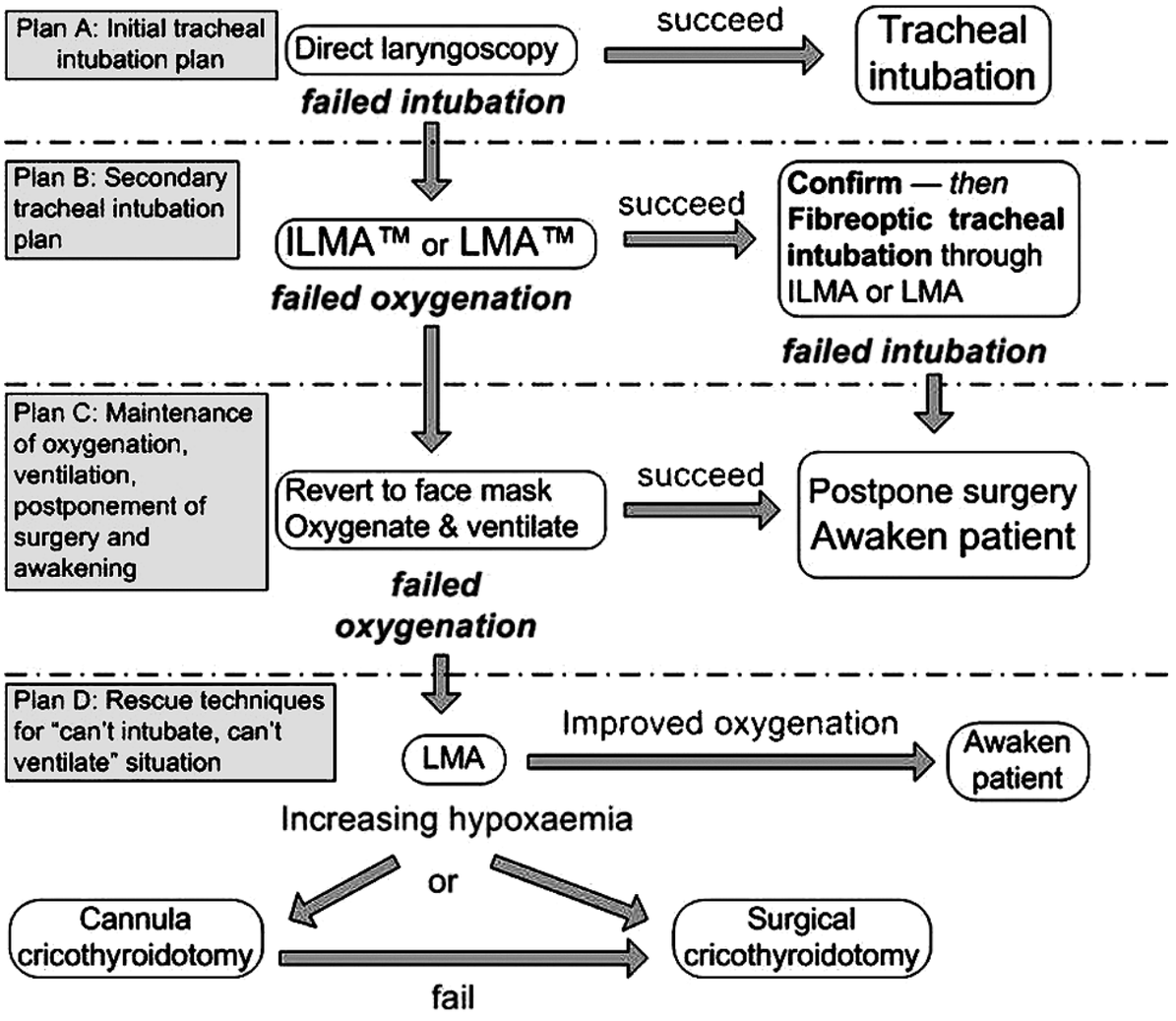


Fig. 7. DAS algorhitm

Concerns have been expressed that we are neglecting the basics such as optimal laryngoscopic techniques (the choice of laryngoscope blade and bougie usage) [40].

About 10% and 27% of hospitals in the UK and US run airway modules. However training, imparting confidence and experience remains poor. Only 25% of anaesthetists feel confident to use fibreoptics [41].

One of the largest hurdles is developing the culture of awake fibreoptic intubation within a department. However the evidence suggests that patients will generally consent to awake intubation even if only for training purposes – lack of cases should therefore not be a barrier to learning. Surveys have shown patients do prefer informed consent though [42].

Bench simulator models and workshop courses are also available. Further hands – on experience is available in ENT clinics, bronchoscopy lists. One course in the UK uses the candidates as patients [43]. The order of learning fibreoptics awake or asleep does not seem to matter.

Notes:

- Difficult Airway Society Websites: www.das.uk.com.
- Practice Guidelines for Management of Difficult Airways (ASA): www.asahq.org.

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