Chapter

Airway Management in Head and Neck Pathology

Muayad M. Radi Al-Khafaji, Hossam Makki, Hassan Haider, Furat Abbas and Abhishek Menon

Abstract

Studies have demonstrated that poor assessment and planning contribute to airway complications and that current airway assessment strategies have a poor diagnostic accuracy in predicting difficult intubation in the general population. There is a higher risk for difficulties during airway management in patients with pathologies arising from the head and neck region and are more likely to need emergency surgical access. Therefore, thorough assessment and adequate knowledge about the various head and neck pathologies is mandatory. In this chapter, we will briefly go through the preoperative assessment and history & clinical assessment, the investigations. Also we will discuss the airway management at various pathologies involving the head and neck region whether benign/malignant pathologies, OSA (obstructive sleep apnea) and post head & neck operative airway management.

Keywords: head and neck, voice and swallowing, difficult airway, preoperative airway assessment

1. Introduction

Working with our anesthesia colleagues at one place which is the upper airway passages is one of the most important (and often neglected) aspects of successful laryngeal operation. Lack of cooperation and pre-surgical planning with the anesthesiology team can make simple micro-laryngoscopy case into an airway crisis [1]. Airway management for head and neck tumors surgery demands special consideration and high focus. A planned approach and thorough communication across multidisciplinary teams will help in reducing any unwanted outcomes.

2. Preoperative assessment

A thorough pre-operative assessment is the mainstay of any successful anesthetic management of onco-surgery of the head and neck. Appropriate control of any co-morbidity is of paramount importance. A considerable number of these patients may have a difficult airway, which may require utilization of advanced airway management techniques. A planned approach and thorough communication across multidisciplinary teams will help in reducing any unwanted outcomes. A step by step approach is essential during the Preoperative assessment of such patients.

2.1 History and clinical examination

An ideal pre-operative assessment starts with a complete history & physical examination, requisite investigations, analysis of the extent of lesion, considerations for concurrent radio-and/or chemotherapy and a multidisciplinary team discussion on the plan for airway and pain management.

Symptoms suggestive of airway obstruction should be checked during history taking:

- Hoarseness: it can be an early manifestation of glottic carcinoma but is often delayed with supraglottic or subglottic tumors.
- Stridor: inspiratory stridor could be suggestive of a subglottic lesion, expiratory stridor a supraglottic lesion, and biphasic stridor a glottic lesion.
- Dysphagia, or odynophagia: may indicate pharyngeal problem.
- Dyspnea: flow volume loops are very helpful in differentiating between dyspnea caused by upper airway obstruction or due to pulmonary disease.

Some important questions that must kept in mind for every patient coming to the operating room:

1. Mouth opening: mouth opening of around 5–6 cm is considered with in normal limits at least 3 cm mouth opening is required for successful laryngoscopy.
2. Mallampati test: has been correlated with ease of laryngoscopy. This assessment alone can provide valuable and important information about the size of tongue in relation to oral cavity size and is a useful predictor of intubation difficulty (**Figure 1**).
3. Size of the mandibular space: it is the space from the inner side of the submentum to the hyoid bone. A distance greater than 6 cm means that there will

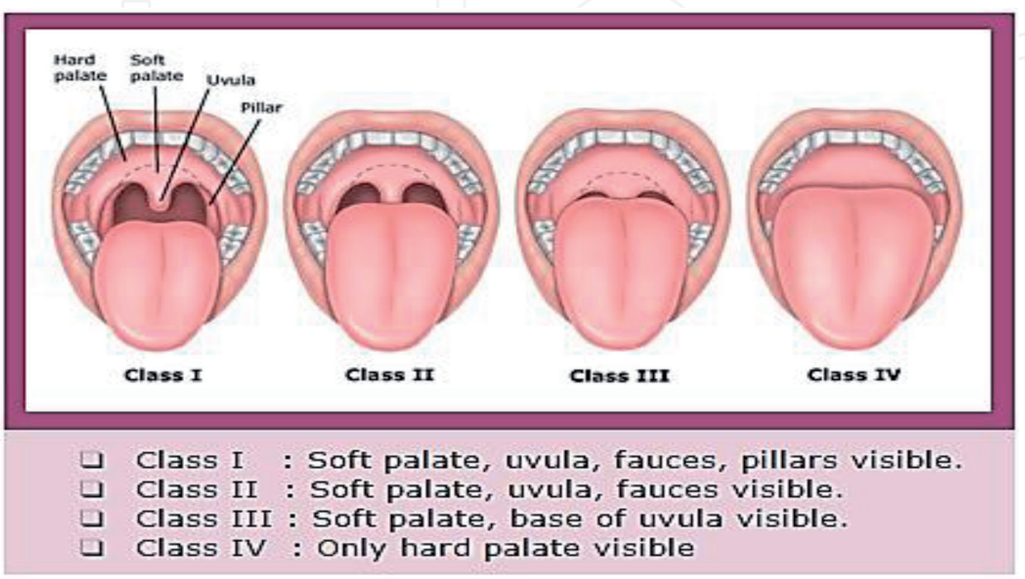

Figure 1.
Mallampati classification.

be enough room for the tongue to move into the mandibular space and direct laryngoscopy will be easy. If this space is small, the larynx is usually located anteriorly, and intubation will be more difficult. In general, 2 fingerbreadths or more indicate easy intubation.

4. Ability to assume sniffing position is a predictive indicator for a relatively straight axis to the glottis. The sniffing position is considered as a moderate flexion of the patient neck on his chest and extension of his neck about the atlantoaxial junction.

A meticulous physical examination of the patient must be done to check for vital parameters, pallor, icterus, and features suggestive of fluid overload, raised jugular venous pressure, generalized lymphadenopathy, metastasis, body mass index and any tenderness in the spine. Appropriate work-up must be done to rule out distant metastasis in the most common sited such as lungs, lymph nodes, spine, brain and liver.

Routine preanesthetic assessment clinic (PAC) tests such as a complete blood workup, ECG, echocardiography, chest radiography, liver & renal function tests and serum electrolytes must be done for all patients. Patient should also be advised for smoking cessation as a high number of patients with head and neck cancer (HNC) have smoking history.

Patients should also be evaluated for any pre/concurrent radio - chemotherapy. Preoperative radiotherapy, this can give rise to difficult laryngoscopy, difficult intubation (**Figure 2**).

2.2 Pre-operative imaging and endoscopy

Computerized tomography (CT) is a very good diagnostic tool with excellent Risk–Benefit Ratio. It is readily accessible, with faster image acquisition. One of the advantages of CT is that it can also be extended to include other sites of the body for staging purposes especially in cancer cases. Thin Slices, high resolution image acquisition allows high quality multiplanar reconstruction (**Figure 3**). Drawbacks of CT include exposure to ionizing radiation, inferior soft tissue contrast when compared to MRI, renal failure secondary to injection of iodinated contrast medium (**Table 1**).

Classification	Description
ASA 1	Healthy patients
ASA 2	Mild to moderate systemic disease caused by the surgical condition or by other pathological processes, and medically well controlled
ASA 3	Severe disease process which limits activity but is not incapacitating
ASA 4	Severe incapacitating disease process that is a constant threat to life
ASA 5	Moribund patient not expected to survive 24 hours with or without an operation
ASA 6	Declared brain-dead patient whose organs are being removed for donor purposes

Figure 2.
AS a grading used for predicting anesthesia risk.

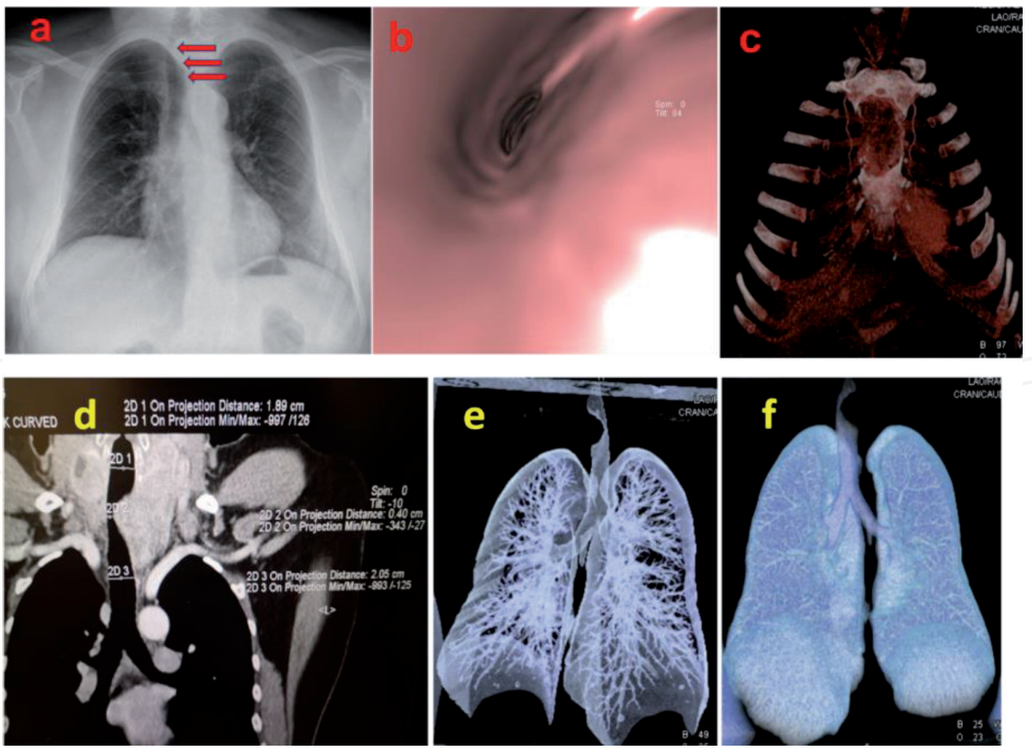

Figure 3.
(a) Chet X-ray showing tracheal deviation at T4-T5 level. (b) 3D reconstruction of MDCT with virtual endoscopy showing tracheal stenosis. (c) Sternum eroded by thyroid cancer metastasis. (d, e, f) coronal cut contrast enhances MDCT showing narrowing at level T4-T5 along with enlarged thyroid.

2.3 CT virtual endoscopy

Virtual endoscopy is an excellent tool used to obtain an anatomically similar representation of the intraluminal geography of the airway, including supraglottic, glottic and subglottic structures without the risk of exposure to ionizing radiation. Compared to conventional 3D reconstructions, the images obtained through virtual endoscopy give a perspective which, when rendered, creates the impression of a true endoscopic image allowing for a tailored approach towards the airway management (**Figure 3b**).

One of the limitations of virtual endoscopy, especially in airway pathologies, is that dynamic airway studies cannot be assessed. Hence, conventional airway endoscopy remains the "gold standard" in most airway assessment and pathologies. Virtual endoscopy can be used to supplement conventional airway endoscopy to help in planning the management of such cases [2].

2.4 MRI

MRI gives excellent contrast resolution compared to CT and is a useful in identifying specific characteristics pertaining to soft tissue masses and complex soft tissue lesions [2]. Even though the unwanted risks of ionizing radiation are absent with the use of MRI as compared to CT, images can be prone to motion artifact due to increased acquisition times that often require the patient to stay still for at least several minutes at a time.

Dynamic MRI is a useful tool in diagnosing certain uncommon airway pathologies such as in diagnosis of tracheo-broncho-malacia in pediatric population, in sleep studies for visualization of upper airway dynamics etc.

Mass effect leading to airway compromise from benign and malignant lesions such as hemangioma and lymphomas are more conspicuous on MRI, with high T2 signal intensity, compared to CT [3].

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USG	X-ray	CT	CT reconstruction and virtual endoscopy	MRI	3D-printing
• It is currently one of the most explored and utilized radiological modality. • It is relatively cheap and easily. Accessible. • Can be performed in a non teritiary setting. • It has certain limitation such has in deeper lesions.	• Useful in emergencies for quick diagnosis. • Lateral views are most commonly used. Flexion, extension and frontal views can also be used. • Used for Prediction of difficult airway, size and depth of left double lumen endotracheal tube (DLT). • Used for confirmation of ET tube position. • For diagnosing tracheal lesions.	• Has been used extensively in evaluation and planning of pediatric airway. More precise and superior compared to X-ray. • Tracheal lesions are characterized better compared to X-ray. • Conditions such as tracheomalacia, fistula, etc. not seen in X-ray can be picked up on CT. • Study of static and dynamic airway anatomy possible with CT. • Can also be used for Evaluation of airway narrowing and deviation, for predicting left DLT size and difficult airway	• Images are reconstructed using data from helical CT. • Virtual endoscopy can be compared to real airway endoscopic evaluation as it saves administration of local or general anesthesia and improves patient compliance. • One of the drawbacks of virtual endoscopy is that it is not useful in dynamic airway studies. • Then can also be easily extended to involve the bronchus.	• Limited use due to increased cost and time consuming. • Defines soft tissue lesions better when compared to CT. • It is non ionizing when compared to CT hence can be considered for certain pediatric conditions. • Dynamic MRI is a Useful tool in diagnosing certain uncommon airway pathologies such as in diagnosis of tracheobronchomalacia in pediatric population, in sleep studies for visualization of upper airway dynamics etc.	• It is upcoming revolutionary technology in which 3D models are printed using 3D printers with the data acquired from CT scans. • Can be used in simulation of airway for precision Preoperative planning. • Has potential for vast applications in anesthesia training, planning and management. • The technology is presently in its nascent stage and hence not a viable option for a majority of cases.

Table 1.
Comparing the different radiological modalities.

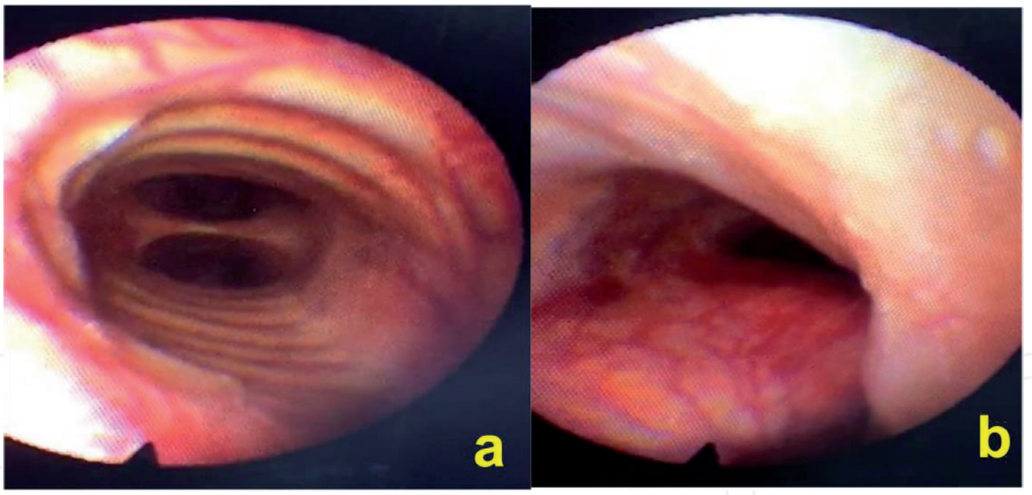

Figure 4.
Example of fiber optic tracheoscopy on a tracheal stenosis patient under local anesthesia showing the carina (a) and stenosed part of the trachea (b).

2.5 Airway endoscopy and trans-nasal tracheoscopy (TNT)

It is a form of indirectly visualizing the airway and larynx in which the clinician does not directly view the lower part of the airway or larynx [4]. Instead, it is visualized with fiber optic or digital laryngoscopes inserted trans-nasally.

The images from the scope can be displayed on a monitor for the clinician, patient and others to view at the time of the procedure; it can also be recorded. Experienced clinicians can also perform it on a wake tracheoscopy using local anesthesia on cooperative patients. They are an essential tool for identifying and planning strategies for management of difficult airway cases [5] (**Figure 4**).

3. Airway management for benign laryngeal surgery

3.1 Introduction

Working with our anesthesia colleagues at one place which is the upper airway passages is one of the most important (and often neglected) aspects of successful laryngeal operation. Lack of cooperation and pre-surgical planning with the anesthesiology team can make simple micro-laryngoscopy case into an airway crisis [1]. Benign laryngeal tumors are more common than the malignant one. Phono-surgery is used to excise most of those tumors whether is a vocal cord cyst, polyp, nodule, etc.

3.2 General important points should always be noticed

1. **Different plans + proper equipment's**: A good management plan for taking care of the patient's airway should be negotiated with the anesthetist before going to the surgery. An excellent plan (plan A), also another strategy (plans B and C) must be ready so that the airway management is algorithmic and automatic, as opposite to unplanned reaction. Before taking the patient into the operating theater, both the operating surgeon and the anesthesia team must have the right equipment in the room, opened, and "ready to use" if another plans become necessary.

2. **Positioning**: for optimal laryngoscopy exposure the patient put in the "sniffing positioning," head extended on the neck, and the neck flexed on the chest [6].

3. **In case of using surgical LASER:** a LASER-protected tube must be used. In case we use jet ventilation or apneic technique (both are safe for the LASER with some special FiO_2 settings).

4. **In case of the patient has a tracheostomy tube:** 5.5–6.0 mm Endo Tracheal Tube (ETT) inserted at the tracheal stoma into the trachea, **LASER** protected ETT should be used in case we use LASER. Using (apneic technique) if airway surgery is performed distal to the tracheal stoma site, applying frequent (reinsertion technique) of stomal ETT to give Oxygen in between the treatment.

5. Mask induction with anesthetic agents is the suitable method of airway management for endoscopic treatment of **subglottic/tracheal stenosis**, or using total intravenous anesthesia (TIVA) then using jet ventilation. Avoid using ETT intubation in those cases.

6. In case of scar formation because of **tracheostomy** was done in a patient with subglottic/tracheal stenosis, then the airway interning should be done at least 1 cm down to the level of the stenosis.

3.3 Anesthesia technique used in case of micro-laryngoscopy (MLS)

In general, lesions present at the anterior 2/3 (membranous vocal folds) of the larynx can be easily exposed and treated with size 5.5 mm or smaller micro laryngeal ETT. Lesions at the posterior 1/3 (vocal processes and posterior commissure/arytenoids region) of the larynx we can use one of those techniques (**Figure 5**):

A. **Oral intubation** using a small long ETT size: 5.0 mm or 5.5 mm micro-laryngoscopy tube (MLT) with a length (30 cm length) with adult tube's balloon that makes good airway sealing. Or using Tritube (**Figure 3**), an ultra-thin endotracheal tube (outer diameter 4.4 mm/inner diameter 2.4 mm).

B. **Jet Venturi ventilation:**

1. Supra-glottic jet Venturi needle (**Figure 6**) Applied through port within laryngoscope or attached to laryngoscope.

2. Tracheal Jet ventilation (where the tip of the jet is near the tip of the laryngoscope) or infra glottic jet ventilation.

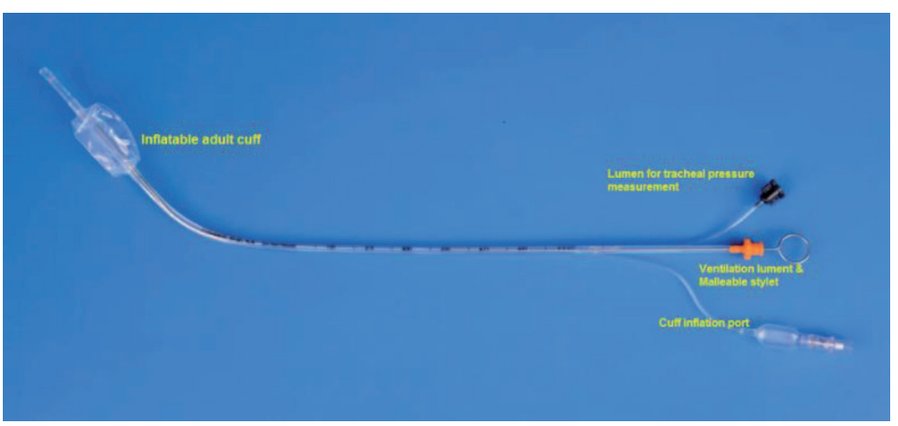

Figure 5.
Tritube: (Tritube, Ventinova medical, Eindhoven, the Netherlands).

Tracheal jet ventilation is better than supra-glottic jet ventilation [7], because tracheal jet ventilation helps the operating surgeon with less movement of the vocal cords. This is very important while performing phono-microsurgery. Also, it allows for better end-tidal CO_2 monitoring. On the other hand, Jet ventilation (supra-glottic, as opposed to subglottic) is safest when used proximally. However, movement of the vocal cords due to jet air will effect on the perfection of the surgical technique.

3. Tracheal Jet ventilation using plastic catheter inside the trachea: for example: Hunsaker Mon-Jet infra-glottic ventilation catheter (**Figure 7**) or tri-lumen catheter with Twin-stream jet ventilator.

C. **Apneic technique using high flow nasal cannula (HFNC)**

In our center we use this technique in 95% of the benign laryngeal lesion's surgery (**Figure 8**). High flow nasal cannula (HFNC) has been shown beneficial in pre-oxygenation, oxygenation after extubation & in the treatment of respiratory failure and heart failure. Recently HFNC proved to provide a very good oxygenation & ventilation for the patients who performing various upper airway surgeries without the need for the jet ventilation or endotracheal intubation. Delivery of O_2 via (HFNC) is an exciting & emerging therapy in acute adult medical practice. Humidified and worm O_2 is delivered at flow rate of up to 60–80 L/min.

D. **STRIV-Hi technique**

Spon**T**aneous **R**espiration using **I**ntra **V**enous anesthesia & High flow nasal oxygenation. By using this way of anesthesia, we apply the concept of spontaneous ventilation according stepwise Target – Controlled Infusion (TCI Marsh technique) of Propofol applying the formula CP – Ce = 1.
Cp = the expected Propofol concentration at the plasma.
Ce = the predicted Propofol effect site concentration.

Benefits For all: (Patient, Surgeon, Anesthetist).

The use of STRIV-Hi technique decreases stress of endotracheal tube on cardio vascular system (CVS), respiratory system. Eventually it decreases post intubation complications. Because of the surgeon & the anesthetist are working at the same site there will be a high risk of affection on the ventilation, oxygenation and loss of airway.

It provides (wider field) for the surgeon & at the same time it can facilitate oxygenation during the induction of anesthesia in cases of severe laryngotracheal

Figure 6.
Jet ventilation probe.

Figure 7.
Hunsaker Mon-Jet catheter.

Figure 8.
HFNC in use.

stenosis which cannot be intubated conventionally. Also, it facilitates dynamic airway assessment & prevents risk of barotrauma (compared to jet ventilation).

3.4 Limitations of HFNC in MLS surgery

Duration of surgery: Operation less than 30 minutes so it is not suitable for junior staff both anesthetist and operating surgeon. It leads to CO_2 accumulation. It cannot be used in case of complete nasal obstruction, bleeding inside the airway & in case of Infection: opened abscess or COVID 19 patients. Also, not used in morbid obesity and predicted difficult airway.

3.5 In case of difficult exposure of the larynx

1. Difficult laryngeal exposure because of underlying anatomy which affect on the performance of micro-laryngoscope using rigid laryngoscopy/bronchoscopy. We may expect a "difficult exposure" per-orally in the following conditions:

A. Limited neck extension

B. Big tongue/difficult palatal visualization

C. Retrognathia

D. Short, thick neck

E. Trismus/reduced inter-incisor opening

3.6 Alternative techniques to get an airway in case of "difficult exposure"

A. Awake, flexible laryngoscopy with naso-tracheal intubation.

B. Tracheostomy done with local anesthesia.

C. Intubation by using specialized "anterior" laryngoscope.

D. Use of a curved ETT with stylet and Sliding Jackson laryngoscope.

E. Ossoff–Pilling laryngoscope.

F. Laryngeal Mask Airway (LMA).

G. Use of laryngoscopy and intubation without seeing of vocal cords.

4. Airway management techniques in head and neck cancer surgeries

4.1 Synopsis

Airway management for surgery of head and neck cancer (HNC) patients is a challenge for the otolaryngologist and anesthesiologist. Appropriate assessment and planning are mandatory for successful airway management. In this chapter, we will review the most common head and neck cancer imposing difficult airway and discuss the strategies of airway management in these patients undergoing head and neck cancer surgery.

4.2 Introduction

Head and neck tumors and malignancies are prominent and relatively frequent. Squamous cell carcinoma represents 90% of head and neck malignancies. (11).

Airway management for head and neck tumors surgery demands special consideration and high focus.

The difficulties and challenges in the airway management of surgical patients with head and neck malignancies are primarily secondary to distortion of normal anatomy (like mass effect) and alteration of the normal physiology (like trismus) of upper airways. In addition, any previous surgery or radiotherapy (neck stiffness and inadequate neck extension) add more difficulty to airway management in these patients. Also, head and neck malignancies resection surgeries are long and extensive procedures which usually lead to significant postoperative swelling and thus the risk of secondary iatrogenic upper airway compromise.

Detailed knowledge of tumor type and localization, size, and vascularity is essential for definitive planning of proper airway management and to avoid any complications during intubation or ventilation [8].

4.3 Recognition of the difficult airway

It is essential to identify any possible airway difficulty management preoperatively. During history taking, any obstructive symptoms should be noted.

Symptoms suggestive of airway obstruction:

- **Hoarseness:** an early symptom of glottic carcinoma; late with supra-glottic carcinomas.

- **Stridor**: biphasic one is suggestive of glottic narrowing, inspiratory one of a subglottic narrowing, and expiratory of a supra-glottic narrowing.

- **Dysphagia**: suggestive of a pharyngeal problem

There are other essential points to be checked as well:
Mouth opening: of at least 3 cm is necessary for successful laryngoscopy.
Mallampati classification can provide valuable and essential information about the size of the tongue in relation to the oral cavity and is a useful predictor of ease of intubation.
Size of the mandibular space: 2 fingerbreadths or more suggest easy intubation.
Can the patient assume the sniffing position? Ability to assume this position is predictive of a relatively straight axis to the glottis.
Endoscopic examination: to localize any narrowing and assess its significance.
CT scanning with 3D reconstruction and virtual bronchoscopy: is especially valuable in evaluating the size and extent of lesions. Three-dimensional reconstruction with virtual endoscopy improves the ability to more fully assess head and neck tumors and its extension and encroachment on the airway [9].

4.4 Common airway pathology that indicates difficult airway

Hypopharyngeal tumors:
The hypopharynx extends from the level of hyoid bone superiorly to the level of cricoid cartilage inferiorly and consists of three parts: pyriform sinus, post-cricoid area, and posterior pharyngeal wall. Tumors arising in the hypopharynx are most often localizing in the piriform sinus. Hypopharyngeal cancers are usually silent and grow to a significant size to cause symptoms; the central core can be necrotic.
Presentation: it is usually very late. Progressive dysphagia and late onset hoarseness.
Airway Management: given the potential for airway obstruction with apnea, a wake intubation is the most appropriate course.

- *A wake fiberoptic intubation* is the gold standard.

- *A wake oral laryngoscopy* is an acceptable alternative.

- Blind intubation techniques are relatively contraindicated because of the possibility of tumor disruption and significant bleeding (**Figure 9**).

Large goiters
Thyroid cancers or large goiters can be threatening to the upper airway by external airway compression, deviation, distortion, or even local invasion of the trachea. Long term compression may lead to softening of the trachea (tracheomalacia).
Involvement of the recurrent laryngeal nerve may jeopardize an already compromised airway by causing additional narrowing of the glottis. The status of the recurrent laryngeal nerve and glottis opening can be assessed by a routine preoperative flexible laryngoscopy.

Figure 9.
Obstructive cancer of the hypopharynx.

Airway Management: Large extra-tracheal lesions should engender caution concerning airway management. In these cases, with a suspected difficult airway, a wake intubation is the most appropriate. The possible options: blind nasal, awake oral laryngoscopy, fiberoptic intubation or a wake tracheotomy.

- *Fiberoptic tracheoscopy provide perhaps the highest reliability*

- *A wake* oral *laryngoscopy* is unlikely to be successful in the presence of big goiter and significant airway distortion.

- *Blind nasal intubation* could be performed, but with the mass causing some compression and distortion of the airway, it may be unsuccessful (**Figures 10** and **11**).

Oropharyngeal cancers:

Airway Pathology: The oropharynx extends from the level of the hard palate superiorly to the level of the hyoid bone inferiorly. Laterally it houses the tonsils and faucial pillars.

Airway Management: The main concern is the conversion of a partially obstructed airway (by the tumor) to a completely obstructed (by swelling and/or bleeding) with upper airway or tumor manipulation. In cases of big oropharyngeal tumors, secure airway management requires the need to guarantee the airway before trying a definitive airway and avoidance of any instrumentation or manipulation of the pathology. Trans-tracheal puncture and block techniques are secure means to ventilate and oxygenate patients while more definitive maneuvers are performed (**Figures 12–14**).

Base of Tongue Lesion:

Airway Pathology: large midline tumors of base of the tongue can certainly present real difficulty for airway management. All of these patients should have preoperative fiberoptic nasal pharyngoscopy and CT scan. A CT scan shows the depth of tumor infiltration and involvement of epiglottis and pharynx.

Airway Management: Rigid tissue fixation and/or bleeding from the tumor often preclude successful oral laryngoscopy and intubation. Intubation with standard laryngoscopy in this situation is predictably difficult. A wake

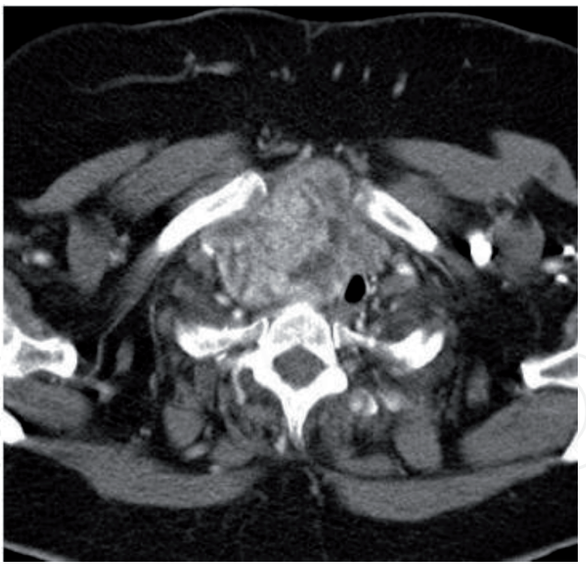

Figure 10.
Large thyroid goiter with tracheal compression and deviation.

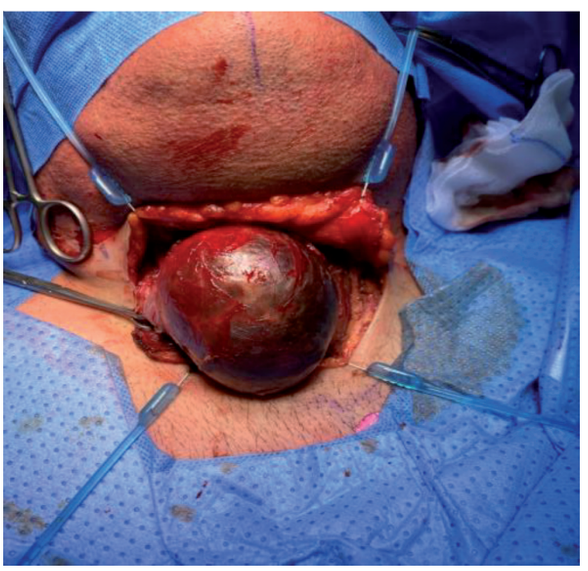

Figure 11.
Large goiter removal.

fiberoptic-trachesoscopy and intubation with the patient spontaneously ventilating is the most appropriate technique.

Vocal cord tumors for LASER cordectomy:

Symptoms range from mild dysphonia to marked stridor and severe respiratory distress. For T1 and T2 glottic cancers, **LASER** cordectomy is the standard treatment option. Inserting a laryngoscope and using **LASER** beam to resects the involved vocal cord with sufficient margin (**Figure 15**).

Airway management: Endoscopic excision of laryngeal vocal cord tumors requires adequate surgical exposure and thus special airway management, many options exist: Intubation with a special **LASER** tube, jet ventilation catheter, or spontaneous breathing with nasopharyngeal oxygen insufflations.

LASER use mandates that no combustible materials come in the field to avoid airway fires. *If fire occurs, the following urgent steps should be done immediately: stop ventilation, stop oxygen, remove the hot endotracheal tube, and wash with sterile saline to extinguish the fire.* Bronchoscopy should be next done to remove any debris and to determine the extent of the damage.

Figure 12.
Large oropharyngeal tumor with almost complete obstruction of the oropharynx.

Figure 13.
Another example of a large oropharyngeal tumor arising from the right tonsil.

Supra-glottic Tumors

Airway Pathology: Laryngeal supra-glottic tumors present obvious and serious airway risk. In these tumors, with apnea airway obstruction may occur. In addition, these cancers are friable and can easily fragment and bleed with instrumentation which can convert partial obstruction into a complete obstruction. Therefore, a supra-glottic tumor presents definite intraoperative and postoperative airway risks.

Airway Management: *A wake oral fiberoptic laryngoscopy* is the gold standard.

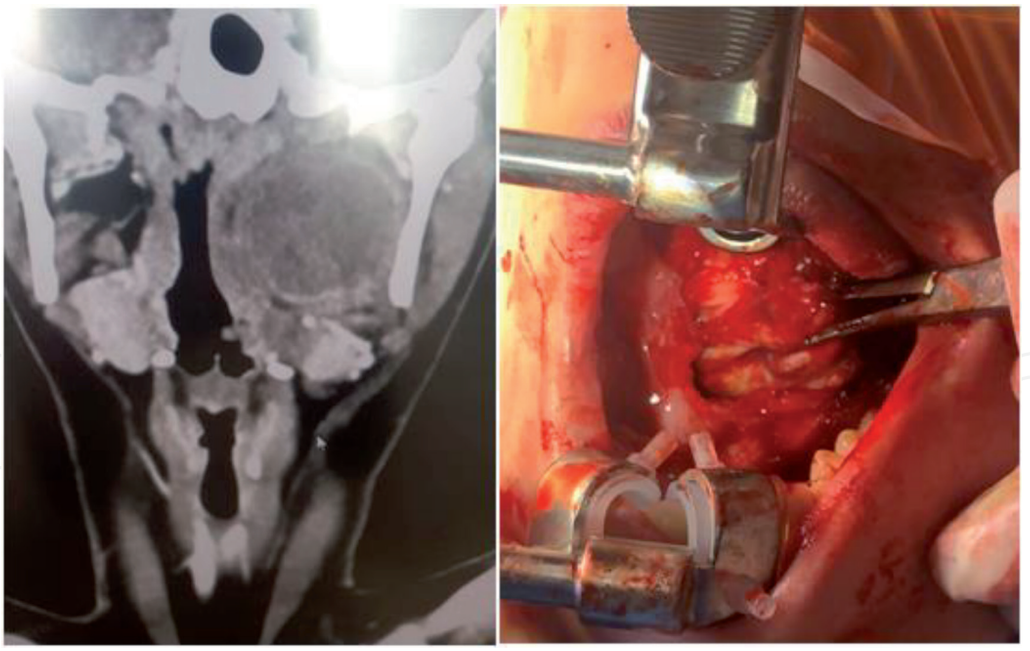

Figure 14.
Huge infra-temporal fossa encroaching on the oropharynx removed trans-orally.

Figure 15.
*Left vocal cord cancer for **LASER** resection.*

The extent of postoperative edema should be properly assessed before extubation. In case extubation was decided, proper planning should be taken. These include the use of a fiberoptic bronchoscope, jet stylet catheter, or a tube changer (**Figure 16**).

4.5 Key points

- Patients with head and neck tumors usually present airway management challenges as difficult as any we confront.
- The situation cannot intubate/cannot ventilate episodes are best avoided because of the high associated morbidity.
- The history and physical examinations are essential in preoperative identification of the cases with a difficult **airway** that may need a wake intubation.

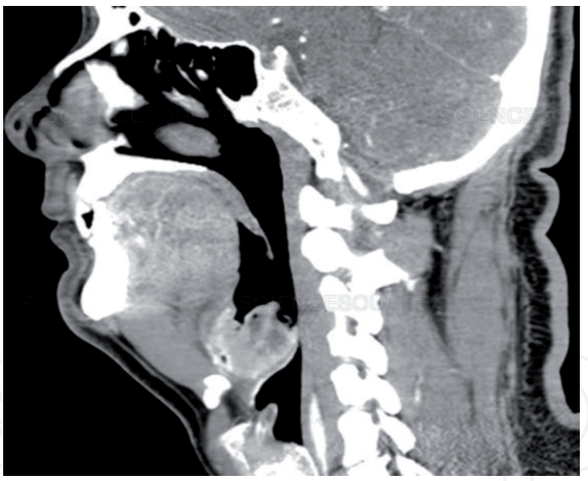

Figure 16.
Large supra-glottic cancer with airway obstruction.

- Symptoms of upper airway obstruction, findings on physical exam, and use of imaging enable us to properly evaluate head and neck tumors and alert us to the potential for airway management difficulty.

- A wake fiberoptic intubation is the most preferred technique in the management of a difficult airway.

5. Airway management post head and neck surgery

5.1 Introduction

There is a wide spectrum of head and neck surgeries ranging from major complex operations to simple minor day care surgical procedures [10].

It is not uncommon for head and neck surgery to affect the airway or to require changing the airway during the operation. For that reason, it is important to have a close and good cooperation between the theater teamwork (surgeons, anesthetists, anesthetic assistants, and nurses [10].

In the current practice now, there is wide range of diverse practice for post-operative airway management of head and neck patients. For example, some will do temporary tracheostomy for almost all head and neck free-flap reconstructions whereas others will manage the same case by overnight ventilation followed by extubation next day [11].

1. Laryngeal spasm	6. Haematoma of the neck
2. Oedema of the larynx	7. Bleeding in the airway
3. Paralysis of the vocal cord	8. Infection of the pharynx or larynx
4. Foreign body in the airway (as missed pharyngeal pack)	9. Reversal of neuromuscular blocking drug is inadequate
5. Obstructive sleep apnoea	10. Reduced venous drainage

Table 2.
Causes of postoperative airway obstruction.

5.2 Factors affecting the strategy of airway management

- A preoperative detailed history of the patient is very helpful to decide the best management of the airway post operatively. (Please refer to the pre-operative assessment).

- Careful preoperative examination of the face, mouth, pharynx, larynx and neck [12].

Causes of airway obstruction postoperatively are provided in **Table 2** [12].

5.3 How to predict postoperative airway difficulty

General factors:

1. If initial intubation is difficult then extubation may also be difficult.

2. Trauma to the airway will lead to oedema which may cause life-threatening airway obstruction postoperatively.

3. Obese patients and, or patient with obstructive sleep apnoea (OSA) are at high risk of postoperative airway obstruction.

4. Emergency patients or patient with gastro-esophageal reflux disease are at risk of aspiration postoperatively, a stomach decompression with nasogastric tube will be very useful [12].

5. Patients with unrelieved trismus (e.g. because of fibrosis) will need the use of an oropharyngeal airway or bite block (e.g. rolled gauze).

During induction:

If the mask ventilation at induction is difficult, this may predict difficulty during emergence [12]. The difficulty in mask ventilation at induction is mainly due to airway abnormality (tumor), OSA, facial asymmetry, Mallampati 3 or 4, receding mandible and age above 55 years old.

Surgical factors:

The airway in some of head and neck surgery can be changed from the pre-operative state due to surgical intervention [11]. e.g. Operations on the tongue, pharyngoplasty, palatoplasty, tonsillectomy, operations on the cervical vertebrae, oedema following maxillofacial surgery and any major head and neck surgery.

5.4 Management strategy for difficult airway

General management:

Before safe extubation of the difficult airway we should consider number of requirements that are necessary and should be met.

The following techniques are suggested for a wake extubation of the difficult airway [12] (**Table 3**):

Excessive use of opioid and incomplete reversal of neuromuscular blocking agents may result in airway obstruction leading to hypoxia [12].

Therefore, quantitative neuromuscular monitoring is recommended.

1. Patient in sit up Position	8. Ensure giving adequate analgesia
2. Give Oxygen 100%	9. Ensure the patient is cardiovascular stabile
3. Ensure continuity of regular breathing and adequate gas exchange	10. Apply positive pressure, deflate cuff and remove tube
4. Insert bite block as rolled gauze	11. Ensure airway is patent
5. Airway suction	12. Continue giving oxygen
6. Ensure patient is awake, obeying commands with open eyes	13. Transfer the patient with high flow oxygen and with close observation and monitoring
7. Reversal of neuromuscular blocking	

Table 3.
Techniques to ease awake intubation in a difficult airway case.

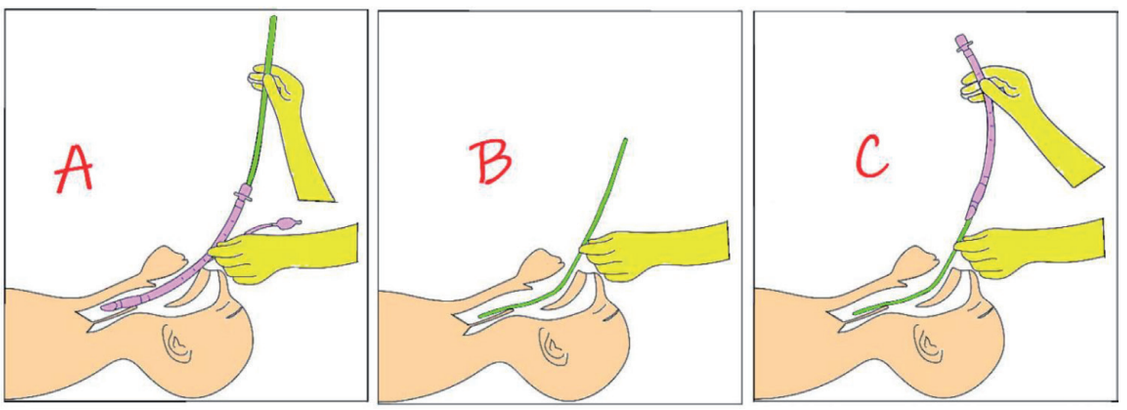

Figure 17.
(A) AEC introduced through the endotracheal tube. (B) AEC left inside trachea. (C) reintubation over the AEC.

Extubation:

Patient with expected difficult airway, extubation preferred to be on the operating table with all needed equipment are available. Patients with some degree of laryngeal oedema after extubation they will benefit from the use of humidified oxygen and nebulized Epinephrine [13].

But in case of total airway obstruction this treatment is not effective and there is a great possibility for re-intubation. Remifentanil used at the end of surgery to prevent coughing and facilitate a wake extubation.

Staged extubation with airway exchange catheters (AECs)

The AEC is usually used for patients known or suspected to have difficult airway, it is used to facilitate re-intubation if needed. The AEC (which is a long hollow boogie) introduced through the endotracheal tube (ETT) before extubation, and then the ETT can be safely removed (**Figure 17**).

In case the patient needs to be re-intubated, the AEC will be used as a guide for the ETT. The AEC can be left in place and tolerated for up to 72 H [14], but usually it is kept for few hours and removed after the patient is stable, fully awake and breathing normally.

Tracheostomy

Tracheostomy operation done within some of maxillofacial operations and in major head and neck operations where postoperatively the airway is expected to be compromised or the patient cannot protect his airway [15].

Usually the tracheostomy is temporary and patient can be weaned after healing of the wound, subsiding of the reactionary oedema and swelling and the patient is able to secure his airway.

Transferring the patient to intensive care unit (ICU)

If you are going to transfer the patient to the ICU with the endotracheal tube in, extra care to be taken to support the tube and avoid tube dislodgment [16].

5.5 Postoperative airway problems

Immediate stridor

Oedema from trauma to the airway is the most common cause for immediate stridor post extubation. This can be avoided by sitting the patient up, giving a dose of 8 mg Dexamethasone i.v. and also giving nebulized Epinephrine before extubation [17].

If the stridor persists and patient is deteriorating, you should examine the airway under anesthesia to rule out other causes as blood clot or retained throat pack.

Laryngeal compromise

This is due to oedema and malfunctions of the glottis and can lead to airway obstruction. It is usually happened after Ludwig's angina or dental abscesses drainage. It can start with postoperative sore throat and then progress to hoarseness of voice, weak cough, deep throat pain, and odynophagia, finally end with stridor, this situation usually will be associated with a difficult intubation. Close monitoring and early intervention are the key to early prediction and successful management of these patients [12].

Bleeding

In case of major bleeding as carotid blow out or rapidly expanding haematoma the patient requires urgent surgical and anesthetic intervention [12].

The removal of surgical skin clips may help to reduce airway deterioration. The patient should be immediately transferred to theater, and re-intubated with a small tracheal tube may be needed [12].

Obstruction or dislodgment of tracheal tube or tracheostomy tube

Usually the obstruction of either tube is due to thick secretion or clotted blood, regular suction and the use of humidified oxygen helps to prevent tube obstruction. Extra care to be taken to support the tube during moving or changing patient position. If there is a concern that the tube is obstructed or dislodged then immediate activation of documented action plan with early involvement of the surgical team if needed.

Post obstructive negative pressure pulmonary oedema

This commonly happened in the immediate postoperative time when the patient is trying to breathe while the airway is closed as he is biting on tracheal tube. This will create negative intrathoracic pressures, and this will lead to pulmonary oedema. Using bite blocks can reduce this risk. Deflating the cuff of the tube allowing the patient to breathe around it.

Using CPAP may help; but, if there is significant hypoxia, re-intubation should not be delayed.

Early management with re-intubation and ventilation will help for full recovery [12].

Laryngospasm

It usually happened due to stimulation during a light plane of anesthesia but may occur due to blood, secretions or foreign body in the larynx. The management is by clearing the oropharynx, applying CPAP with 100% oxygen, followed by deepening of anesthesia by an i.v. anesthetic agent. Also using short-acting muscle relaxant as Succinylcholine may be needed. But in case of significant laryngospasm, re-intubation will be the proper immediate action [12].

ICU Management of the difficult airway

Usually most of patients with head and neck pathology with high concern about the postoperative airway will be managed on the ICU. Suggestions for successful

management includes good communication between all of the multidisciplinary team, handover to be written and verbal with clear description of the problem and how it was managed, the current state of the airway, what is the ongoing plane of management and whom to call in case of airway deterioration.

The decision to whether manage postoperative difficult airway interventions in ICU or in theater will depend on the clinical problem, availability of equipment, the urgency of the situation, and the relative proximity to theaters [12].

5.6 Key points

- Airway management continues from pre and peri-operative period to the postoperative period [11, 12].
- Postoperative airway obstruction usually leads to high incidence of morbidity if not managed in proper time.
- Close monitoring for patients with high risk of airway deterioration postoperatively is highly important.
- A plane of management of the difficult airway postoperatively should be agreed by the multidisciplinary team.
- Cooperation and harmony between anesthetists and surgeons are of extreme importance as both are working in the same field (shared airway).
- If expecting airway problem postoperatively, then the patient should be remained intubated or to do tracheostomy before extubation.
- Using the trans-nasal high-flow rapid insufflation ventilator exchange ("THRIVE") makes intubation and extubation less stressful and less traumatic.
- Staff dealing with patients either intubated or tracheostomized should receive proper training and to be aware of the relevant guidelines.
- A planned protocol should be developed for urgent airway management.

6. Airway management in obstructive sleep apnea (OSA) patients

6.1 Introduction

OSA is considered one of the important challenges in the peri-operative airway management. Obstructive apneas are defined as complete or near-complete cessation of airflow lasting for at least 10 sec. Obstructive hypopneas are characterized by at least 30% reduction in airflow for a minimum of 10 sec and are associated with a 4% oxygen desaturation [18].

The difficult airway in OSA patients is considered to be a main contributing factor to the higher rate of adverse respiratory and cardiovascular events, so to reduce the peri-operative complication [19], it is better to divide the management approach of OSA patients into: preoperative, intraoperative, and postoperative strategies.

6.2 Pre-operative assessment in suspected OSA patients

- A detailed history includes: loud snoring, observed apnea, daytime sleepiness, and morning headaches, with emphasis on airway examination and identifying comorbidities.

- Physical examination: characteristics predicting a difficult airway (highly modified Mallampati score, reduced thyromental distance) [19].

- OSA screening and diagnosis (results of screening tools/questionnaires such as those with STOP-BANG scores ≥5 with co-morbidities, full attended polysomnography (PSG) should be done prior to any major elective surgery and reviewed by sleep physician, while the other suspected OSA patients without co-morbidities and undergoing minor surgery, appropriate risk reduction steps can be taken [20].

- All patients after diagnosis of OSA has been established who use CPAP preoperatively (compliant and noncompliant) should be advised to bring the device to the hospital for use in the postoperative period, so that it is readily applicable whenever under the influence of narcotics or sedatives [21].

6.3 Intra-operative assessment and impact of anesthesia on OSA patients

During anesthesia; alteration of muscle activity results in upper airway collapse more at the level of retro-lingual. Such obstructive events require active intervention to arouse spontaneously, which is an important defense mechanism that occurs during natural sleep to overcome airway obstruction.

The administration of anesthetic agents exacerbates the upper airway collapse, alter the tone of the pharyngeal musculature, result in delay of the restoration of airway patency, therefore, in general the tendency for airway obstruction occurs out of proportion to the level of achieved sedation [22].

6.4 Post-operative assessment

Patients with OSA undergoing upper airway surgery are at high risk for difficult airway management and increased incidence of postoperative complications. These complications include higher re-intubation rates, hypercapnia, oxygen desaturations, cardiac arrhythmias, myocardial injury, delirium, unplanned ICU transfers, and longer hospitalization stays.

Several perioperative and anesthetic factors may contribute to these complications [22]:

1. *Medication*: drugs commonly used during general anesthesia (hypnotics, opioids and muscle relaxants).

2. The *patient's position* during anesthesia can negatively affect the traction forces in the trachea, leading to increased pharyngeal closing pressure and collapse of the upper airway.

3. Prolonged intubation may lead to pharyngeal edema and narrowing of the upper airway.

4. Decreased airway stability caused by prolonged postoperative patient's supine position.

5. Perioperative discontinuation of continuous positive airway pressure (CPAP) therapy.

6. Surgical stress and post-operative sedation may lead to disruption of sleep and apneic events at night affected by increased periods of rapid eye movement (REM) following surgery.

6.5 Highlights and pearls for upper airway mangament with elective surgery in adult OSA patients

1. Focused history, physical examination and implementing screening tool in the (pre-operative care) are crucial in studying high risk OSA cases to reduce post -operative complication [19].

2. In *mild OSA or low risk cases*, surgery can be proceeding with minimizing peri-operative complication risk.

3. In *high risk and diagnosed OSA* cases should have the following [23]:

6.6 In intra-operative care

- Consider minimal sedation or regional anesthesia if appropriate
- Prepare for difficult airway management, 25-degree head position, use short acting anesthetic drug.
- Consider invasive monitoring for respiratory & hemodynamic parameters.
- Extubate after the patient is completely awake

6.7 In recovery room

- Close observation for oxygen saturation and hemodynamic for at least 2 hours, with head position 30 degree.
- Consider use non-opioid anesthetic drug.
- Early use of positive airway pressure (PAP) in case of desaturation.

6.8 In-ward management

- Close monitoring and continuous supplemental oxygen therapy until they can maintain their oxygen saturation on room air.
- Continue PAP therapy in case needed.
- Discharged patient should follow with sleep physician for re-assessment.

7. Conclusion

- Patients who present with head and neck pathology are more likely to have difficult airways, are at increased risk of difficulties during airway management,

and they are also more likely to require an emergency surgical airway when difficulties arise.

- Proper Preoperative assessment and Multidisciplinary planning is required for successful management.

- Virtual endoscopy can be used to supplement conventional airway endoscopy to help in planning the management of difficult airway cases

- Awake intubation is preferred in difficult airway cases where typical intubation may not be guaranteed.

- Using the trans-nasal high-flow rapid insufflation ventilator exchange ("THRIVE") makes intubation and extubation less stressful and less traumatic.

- OSA patients are becoming increasingly identified in the surgical population, therefore appropriate measures are needed in order to treat patients at the highest risk for OSA to reduce the perioperative complications.

- Obesity and obstructive sleep apnea increase the risk for anesthetic and sedative complications, including post -operative cardiorespiratory complications [20].

The lack of recognition of OSA cases pre-operatively poses significant challenges result from difficulties during airway management. To reduce encountered complication an appropriate anesthetic regimen including choice of medication, airway management and adequate postoperative monitoring should be optimized [24].

Author details

Muayad M. Radi Al-Khafaji[1,2*], Hossam Makki[1,2], Hassan Haider[2], Furat Abbas[1,2] and Abhishek Menon[1]

1 Department of Otolaryngology - Head and Neck Surgery, Hamad Medical Corporation, Doha, Qatar

2 Clinical Otolaryngology - Head and Neck Surgery, Weill Cornell Medical College in Qatar, Doha, Qatar

*Address all correspondence to: mradi@hamad.com

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