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Multiview Scope Versus Fiberoptic Laryngoscope For Anticipated Difficult Oral Intubation

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Abstract

Background: judicious airway management is one of the greatest challenging issues in peri-operative practice. Awake intubation with videolaryngoscopy (VL) is a novel modality offered an alternative to awake intubation using fiberoptic bronchoscope (FOB). Video laryngoscope systemes incorporated with are rigid and sometimes semirigid devices allow indirect laryngoscopy, or visualization of the glottis area without a direct line of sight.

Key words: Difficult airway management, airway block, awake fiberoptic intubation, airway assessment, Videolaryngoscopy, MultiView scope, flexible fiberoptic larygeoscope.

Introduction: For decades, airway management has remained a challenging issue for clinical anesthesiologists. Direct laryngoscopy is usually performed for routine tracheal intubation *(Burkle et al, 2004)*. However, performing this technique may prove difficult or even impossible under certain situations, such as in patients having tongue edema, cervical immobilization, and limitation of mouth opening *(Hastings and Kelley, 1999)*. This can result in airway trauma or sever complications. Failed or difficult intubation is an important cause of mortality and morbidity during anesthesia *(Jimmy Ong et al, 2016).*

Fibreoptic intubation is indicated for patients with anticipated difficult airway because of airway pathology, anatomical variations, airway trauma, morbid obesity or unstable cervical spine *(Artime et al, 2013).*

the American Society of Anesthesiologists (ASA) recommends that videolaryngoscopy should be considered both as an initial approach to intubation and following failed intubation in which face mask ventilation is adequate.A number of devices have been developed to solve the difficult airway problems typically encountered with direct laryngoscopy. These devices include the flexible fiber optic bronchoscope, rigid optical stylet, lightwand, rigid fiberscope, and many types of video laryngoscopes *(Apfelbaum et al, 2013).*

Videolaryngoscopy represents a significant improvement in endotracheal intubation and thus an improvement in airway safety. Namely, it is well known that to increase airway safety, it is necessary to apply the appropriate concept of airway visualization on which airway strategies and airway algorithms are based *(Yang GZ et al, 2016).*

The MultiViewScope (MVS) (MPI, Tokyo, Japan) is a video laryngoscope system, in which the video monitor handle can be attached to a stylet scope, Miller blade, Macintosh blade, or fiberscope *(Mukaihara et al, 2016).*

Upper airway anantomy:

The airway, or respiratory tract, describes the organs of the respiratory tract that allow airflow during ventilation. They reach from the nares and buccal opening to the blind end of the alveolar sacs. They are subdivided into different regions with various organs and tissues to perform specific functions.**(Wani et al., 2019 & Benner & Sharma 2020).**

The airway is a continuous passageway but can be further categorized into the upper and lower airway. The upper airway begins from the nares and oropharynx to the vocal cords (**Fig. 1a and b).** The lower airway is located below the level of the vocal cords and extends distally **(Fabiano and Lema. 2015).**

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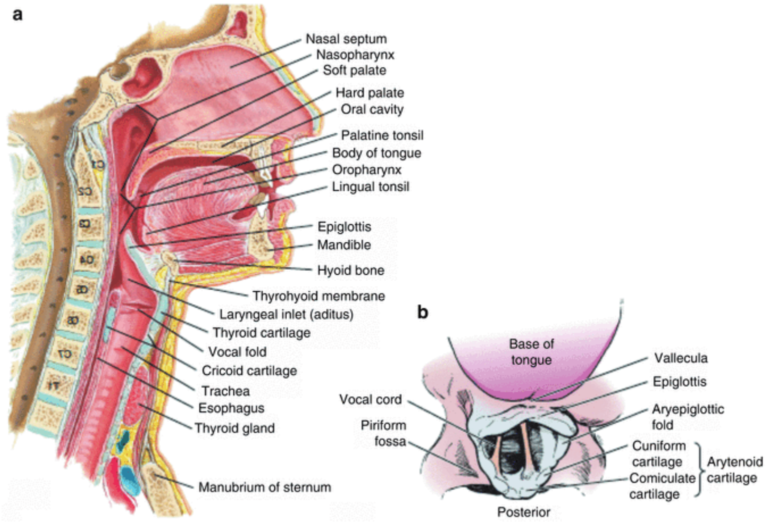

Fig. 1 :Airway Anatomy, (**a**) Sagittal view of the upper airway anatomy. (**b**) Anatomy of the larynx and vocal cords as seen through laryngoscopy **(Papadakos & Gestring 2015).**

Upper Airway Anatomy

- ***Pharynx*****:** The pharynx is a conductive structure located in the midline of the neck. It is the main structure, in addition to the oral cavity, shared by two organ systems, i.e., the gastrointestinal tract (GIT) and the respiratory system. It is funnel-shaped with its upper end being wider and located just below the lower surface of the skull, and its lower end is narrower and located at the level of the sixth cervical vertebra (C6) where the commencement of the esophagus posteriorly and the larynx anteriorly takes place. Its muscular-membranous integrity allows it to mediate several vital functions related to either organ system, e.g., food swallowing, air conduction, and voice production. **(Kimoff, 2005).**
- ***Piriform sinus*****:** Forms the recesses on both sides of the aryepiglottic folds and medial to the thyroid cartilage and thyrohyoid membrane. The inferior portion of each *piriform sinus* is called the piriform recess and is located at the level of the true vocal cord **(Pawha et al., 2013).**
- ***Larynx*****:** Larynx (voice box) is situated in the anterior portion of the neck above the trachea. Its location anterior to the inferior portion of the pharynx allows it to play an important role in deglutition. Primary function of larynx is protection of airway from food particles and secretion of oropharynx **(Pawha et al. 2013).**
- The larynx is located within the anterior aspect of the neck, anterior to the inferior portion of the pharynx and superior to the trachea. Its primary function is to protect the lower airway by closing abruptly upon mechanical stimulation, thereby halting respiration and preventing the entry of foreign matter into the airway. Other functions of the larynx include the production of sound (phonation), coughing, the Valsalva maneuver, and control of ventilation, and acting as a sensory organ **(Inamoto et al; 2015).**

  The larynx is composed of 3 large, unpaired cartilages (cricoid, thyroid, epiglottis); 3 pairs of smaller cartilages (arytenoids, corniculate, cuneiform); and a number of intrinsic muscles (see the image and video below). The hyoid bone, while technically not part of the larynx, provides muscular attachments from above that aid in laryngeal motion **(Merati & Bielamowicz 2006 & Standring, 2015).**

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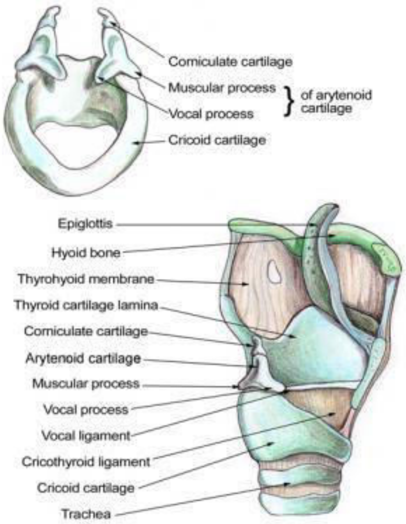

Fig 2: Larynx anatomy **((Standring, 2015).**

- ***Thyroid cartilage***: Appears as an inverted V-shaped structure that is composed of two alae that merge in the midline and indents superiorly to form the superior thyroid notch. The *thyroid cartilage* articulates with the *cricoid cartilage* inferiorly at the cricothyroid joint. *Cricoid cartilage:* Located beneath the thyroid cartilage, forms a ring around the trachea. *Laryngeal inlet:* The opening to the larynx. It is bordered by the epiglottis anterosuperiorly, the aryepiglottic folds laterally, and the arytenoid cartilage posteriorly **(Roberts, 2005).**
- ***Arytenoid cartilage***:
  The arytenoid cartilages form the part of the larynx to which the vocal ligaments and vocal folds attach. They are pyramidal in shape and have 3 surfaces, a base, and an apex. They are located superior to the cricoid cartilage in the posterior part of the larynx, with the base of the arytenoid cartilages articulating on either side with the posterior aspect of the upper border of the cricoid lamina. The anterior angle of the base of the arytenoid cartilage is elongated to form a vocal process for attachment of the vocal ligament, while the lateral angle is elongated to form a muscular process for attachment of the posterior and lateral cricoarytenoid muscles.
  The posterior surface of the arytenoid cartilage gives attachment to the arytenoid muscle. The anterolateral surface has 2 depressions for attachment to the false vocal cord (vestibular ligament) and the vocalis muscle. The medial surface has a mucosal lining that forms the lateral aspect of the respiratory part of the glottis. The apex of the arytenoid cartilage is pointed and articulates with the corniculate cartilage.
- ***Glottis*:** The vocal apparatus of the larynx. It includes the true and false cords. **(Roberts, 2005).**
- ***Vallecula*:** A groove located between the tongue base and the epiglottis **(Roberts, 2005).**

Airway block:

Expertise with regional anaesthesia of the airway allows intubation in awake patients with suspected difficult intubation in the presence of certain anatomical variants or airway pathology, where visualization of the glottis by direct laryngoscopy can be difficult or impossible. Furthermore, in the presence of upper airway trauma & cervical spine injury, neck movement must be minimized if neurological injury is to be avoided. Therefore, it is essential that every regional anaesthesiologist be skilled enough to administer general anaesthesia and especially in the management of the difficult airway with the knowledge of recent development in the field of regional anaesthesia of the upper airways **(Gómez-Ríos et al., 2018).**

Relevant Anatomy

Three major neural pathways supply sensation to airway structures **(Fig 9)**

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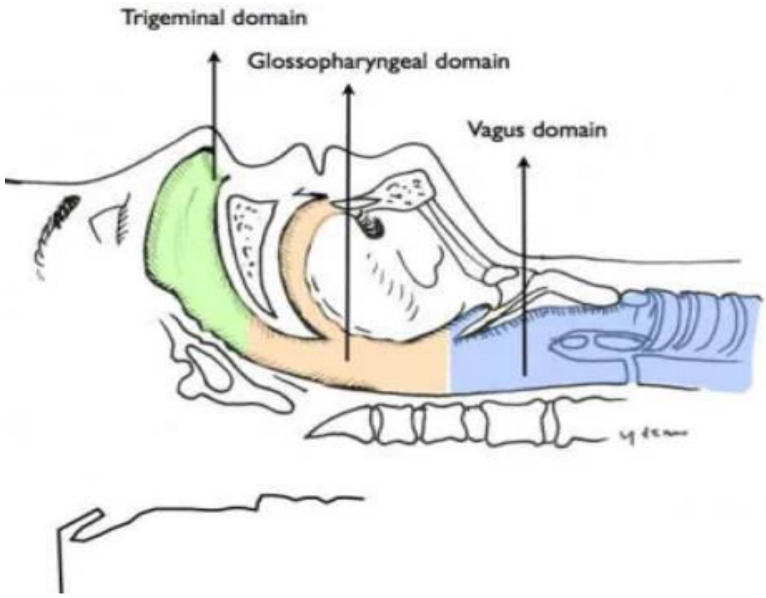

Fig 3: Three major neural pathways supplying sensation to airway structures **(Pani & Rath 2009).**

1. **Terminal branches of the ophthalmic and maxillary divisions of the trigeminal nerve supply the nasal cavity and turbinates**. (Fig 3).
 (The greater and lesser palatine nerves arising from the pterygopalatine ganglion innervate the nasal turbinates and most of the nasal septum.. The anterior ethmoidal nerve arises from the olfactory nerve (CNI) and innervates the nares and the anterior third of the nasal septum.) **(Morris, 1988).**

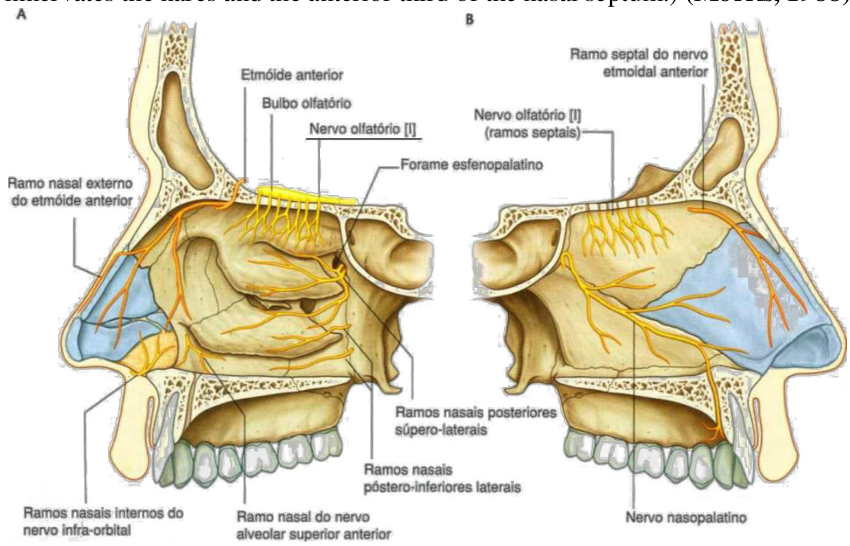

Fig 3: Sensory supply of nose **(Pani & Rath 2009).**

2. The oropharynx and posterior third of the tongue are supplied by the glossopharyngeal nerve.

(The sensory innervation of the anterior two thirds of the tongue is provide by the trigeminal nerve i. e. lingual branch of the mandibular division. it is not a part of the reflex arcs controlling gag or cough, its blockade is not essential for comfort during FOI.) (**Sakamoto, 2019).**

3. Branches of the vagus nerve innervate the epiglottis and more distal airway structures. (Fig 4)

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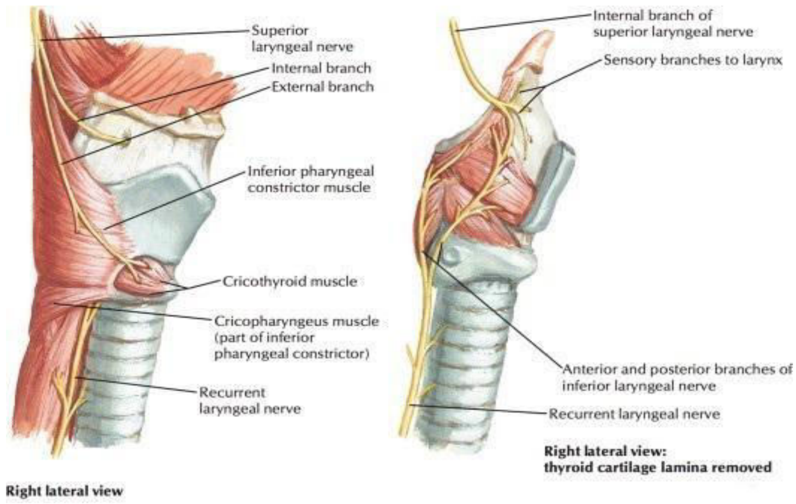

Figure 4: Branches of the vagus nerve innervating the epiglottis and more distal airway structures **(Pani & Rath 2009).**

The airway reflexes important for awake intubation **(Leslie & Stacey 2015).**

The aforementioned nerves participate in several brainstem-mediated reflex arcs.

1. Gag reflex – triggered by mechanical and chemical stimulation of areas innervated by the glossopharyngeal nerve, and the efferent motor arc is provided by the vagus nerve and its branches to the pharynx and larynx **(Yuan & Silberstein 2016).**

2. Glottic closure reflex – elicited by selective stimulation of the superior laryngeal nerve, and efferent arc is the recurrent laryngeal nerve. – exaggeration of this reflex is called laryngospasm **(Ludlow, 2015).**

3. Cough – the cough receptors located in the larynx and trachea receive afferent and efferent fibers from the vagus nerve **(Mutolo et al., 2020).**

Techniques for Block Individual Nerves of the Airway

Often more difficult to perform, and carry a higher risk of complications than the above mentioned methods. The common complications of nerve blocks are: bleeding, nerve damage, and intra-vascular injection **(Kessler et al., 2015)**.

Nerve blocks

There are 3 blocks used for upper airway anesthesia **(Pani & Rath 2009)**:

1. Glossopharyngeal block – for oropharnyx.
2. Superior laryngeal block – larynx above the cords.
3. Translaryngeal block – larynx and trachea below the cords.

- **Blockade of the Glossopharyngeal Nerve**

It provides sensory innervation to the posterior third of the tongue, the vallecula, the anterior surface of the epiglottis (lingual branch), the walls of the pharynx (pharyngeal branch), and the tonsils (tonsillar branch) **(Netter, 1989).**

Facilitates endotracheal intubation by blocking the gag reflex associated with direct laryngoscopy as well as facilitating passage of a nasotracheal tube through the posterior pharynx. Glossopharyngeal nerve block is not adequate as a solo technique to facilitate intubation, but in combination with other techniques it is highly effective **(Fukui, 2019).**

Blockade of the Glossopharyngeal Nerve

It can be blocked using one of three methods **(Fukui, 2019)**:

1. Topical spray application,
2. Direct mucosal contact of soaked pledgets, or
3. Direct infiltration by injection.

- **Glossopharyngeal block**

There are two way to approach **(Chien & Cheng 2016)**:

1. Intra-oral – need enough mouth opening(**Fig 5**)

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Fig 5: Glossopharyngeal block (Intraoral approach) **(Pani & Rath 2009)**:
It is most easily blocked Intraorally by instilling 5 mL LA submucosally (by a 22-gaugue needle) at the caudal aspect of the posterior tonsillar pillar (where it crosses the palatoglossal arch) **(Chien & Cheng 2016)**.
2. Peristyloid – require the ability to distinguish the bony landmarks (**Fig 6)**

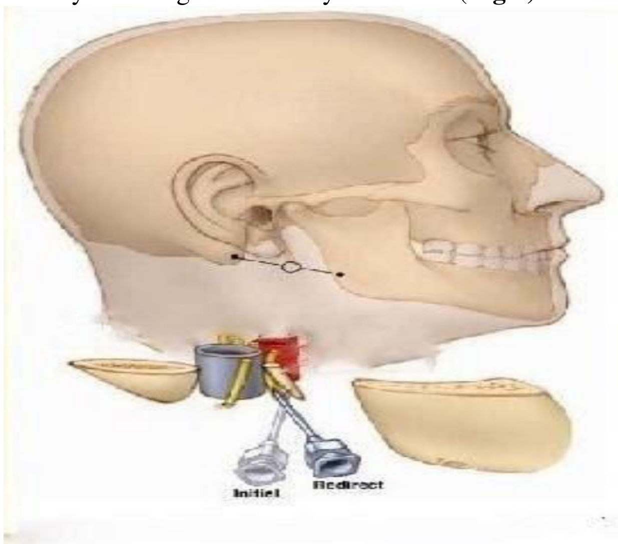

Fig 6: Glossopharyngeal block (Peristyloid approach) **(Pani & Rath 2009)**.
Patient is placed supine and a line is drawn between the angle of the mandible and the mastoid process. Using deep pressure, the styloid process is palpated just posterior to the angle of the jaw along this line, and a short, small-gauge needle is seated against the styloid process. The needle is then withdrawn slightly and directed posteriorly off the styloid process. As soon as bony contact is lost, 5–7 mL of local anesthetic solution are injected after careful aspiration for blood **(Fukui, 2019)**.
For both approaches, careful aspiration for blood must be carried out prior to injection (to prevent inadvertent intravascular injection) because the glossopharyngeal nerve is closely associated with the internal carotida. & palatoglossal arch is highly vascular and even a very small amount of local anesthetic can cause seizures **(Chien & Cheng 2016)**.
Contraindicated in patients with coagulopathies or anticoagulation.

- **Superior laryngeal block (Fig 7)**

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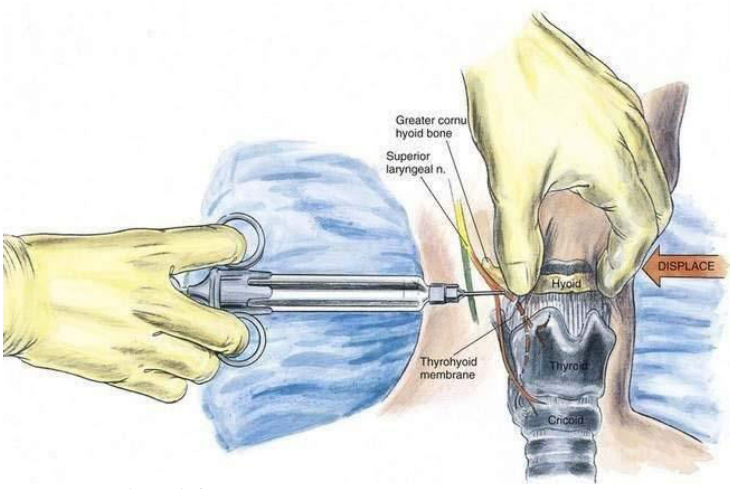

Fig 7: Superior laryngeal block **(Pani & Rath 2009)**.

Internal branch **(Morris, 1988),** (originates from the superior laryngeal nerve lateral to the greater cornu of the hyoid bone. The nerve should pass approximately 2–4 mm inferior to the greater cornu of the hyoid bone. where it pierces the thyrohyoid membrane and travels under the mucosa in the pyriform recess.) innervates the base of the tongue, posterior surface of the epiglottis, aryepiglottic fold, and the arytenoids **(Netter, 1989).**

Blockade is usually inadequate as a solo technique for intubation. The superior laryngeal nerve can be blocked in the piriform fossa where it runs just deep to the mucosa by using Kraus or Jackson forceps to hold a cotton pledget soaked in lidocaine 2–4% against the mucosa for about 60 see **(Reed & Han 1991)**. Alternatively, this block can be performed using an external approach to the nerve as it penetrates the thyrohyoid membrane near the greater cornu of the hyoid **(Gotta & Sullivan 1984).** Direct infiltration is accomplished by a 25G needle at the level of the thyrohyoid membrane inferior to the cornu of the hyoid bone. A reliable block with a definite endpoint is effected by retracting the needle marginally after contacting the greater cornu and injecting2mLofLA (2%lidocaine) after negative aspiration in extended neck position **(Wheatley et al., 1991)**.

The hyoid bone can be easily fractured if excess pressure is applied. 2 ml of LA should reliably bathe the internal branch of the superior laryngeal nerve, given at its proximity to the hyoid bone. If this volume is injected outside the thyrohyoid membrane, it is likely to block the external branch of the superior laryngeal nerve as well. Isolated external branch blockade may result in cricothyroid muscle weakness, which eliminates its function as an airway dilator. The motor input of the recurrent laryngeal nerve is spared, however, and therefore does not result in clinically significant change in laryngeal inlet diameters **(Pani & Rath 2009)**.

In case of contraindications, unwillingness or distorted anatomy noninvasive blockade can be accomplished by placing anesthetic-soaked cotton pledgets into the pyriform fossae bilaterally(for 10–15 min) **(Pani & Rath 2009)**.

- **Recurrent Laryngeal Nerve Block (Fig 8)**

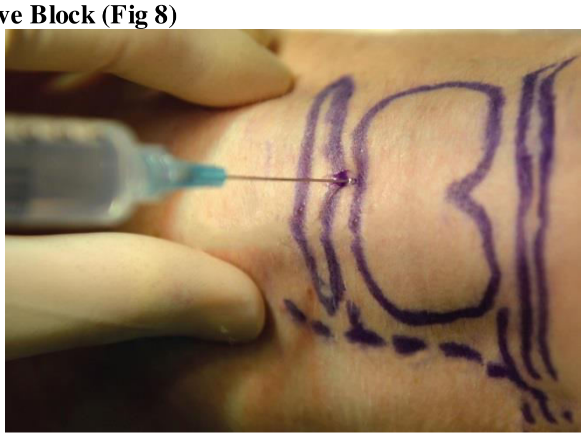

Fig 8:Recurrent Laryngeal Nerve Block Translaryngeal block of the recurrent laryngeal nerve at the level of the cricothyroidmembrane **(Pani & Rath 2009)**.

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Recurrent laryngeal nerve provides sensory innervation to the trachea and vocal folds. Blockade facilitates comfortable passing of the endotracheal tube into the trachea **(Orestes & Berke 2016).**

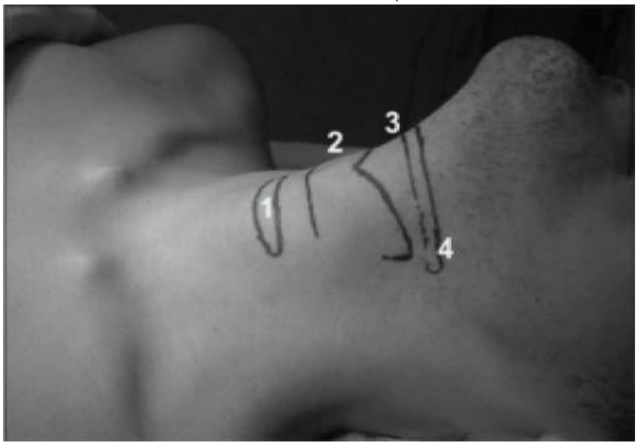

Fig 9: Normal surface anatomy of Larynx:1) cricoids cartilage 2) thyroid cartilage 3) hyoid bone 4) cornu of hyoid **(Pani & Rath 2009)**.

This nerve can be blocked by using topicalization techniques described previously **(Stopar Pintarič, 2016).** Translaryngeal block of the recurrent laryngeal nerve is easily accomplished at the level of the cricothyroidmembrane. A 10-mL syringe with a 22- or 20-gauge needle is advanced until air is aspirated into the syringe. 4ml of LA (4%lidocaine) are then injected, inducing coughing that disperses the local anesthetic **(Jankovic & Cheng 2015).**

The recurrent laryngeal nerve can also be blocked by spraying local anesthetic via the injection port of the fiberoptic bronchoscope. Motor function remains completely unaffected. Direct infiltration of recurrent laryngeal nerve is contraindicated as it may cause upper airway obstruction since all motor supply to larynx except cricothyroid is by recurrent laryngeal nerve **(Pani & Rath 2009)**.

Fiberoptic intubaion:

The intubating fibreoptic bronchoscope (FOB) was first described in 1967 by Peter Murphy(**Murphy, 1967**). Some authors still consider it to be the gold standard in anticipated difficult airway management **(Heidegger and Gerig, 2004)** The introduction of newer equipment, such as supraglottic airway devices, and indirect laryngoscopy has dramatically changed airway management and resulted in a decline in the use of fibreoptic intubation **(Wanderer et al, 2013).**

The technology of fiberoptics is based on the optical characteristics of very thin (diameter of 8–25 μm) flexible glass fibers that are capable of transmitting light over their length **(Mitschke & Mitschke 2016).** Insulation of these fibers by a glass layer with a different optical density enables transmission by internal reflection of light. An image is transmitted through the length of the scope by an organized coherent bundle of fibers that have the exact orientation at both ends of the scope **(Collins & Blank 2014).** A separate fiberoptic bundle is attached to a light source to provide illumination, and lenses at the tip of the scope and eyepiece provide an image that can be focused by the user. In brief, the fiberoptic bronchoscope consists of an eyepiece atop a control handle with a focusing ring that is attached to a thin flexible fiberscope **(Mitschke & Mitschke 2016).** A thumb control lever allows the distal tip of the scope to be flexed or extended. A separate port that travels the distance of the scope can be utilized for suction, injection of saline or local anesthetic, oxygen insufflation, or passage of brushes or forceps for diagnostic purposes **(Collins & Blank 2014).**

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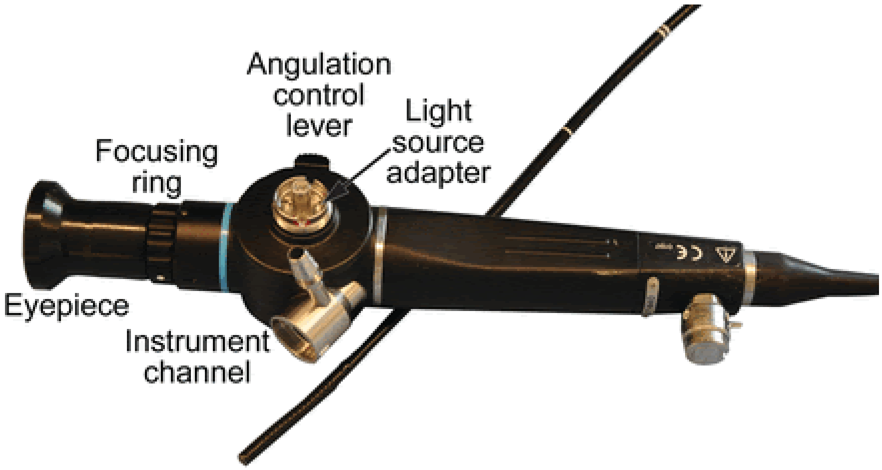

Fig 10. Flexible bronchoscope (Olympus LF-GP) **(Collins & Blank 2014).**

The need for FOI may be anticipated based on a history of difficult intubation and various anatomic and anthropometric features that may predict difficult laryngoscopy. These include limited mouth opening, limited thyromental distance, reduced neck mobility, inability to prognath, oropharyngeal classification, and obesity **(El-Ganzouri et al., 1996)**. FOI may also be indicated for known or suspected cervical spine instability, anatomic malformations of the mandible or larynx, congenital deformities of the head and neck, and history of head, neck, and spine trauma. If a difficult airway is suspected, the ability to mask ventilate and the need for tracheal intubation should be assessed **(Collins & Blank 2014).**

Although rare in occurrence, patient refusal constitutes an absolute contraindication to oral or nasal intubation. Hemorrhage in the oral cavity is a relative contraindication to fiber-optic intubation because blood may obliterate the field of view through the instrument **(Miranda et al., 2018).** In general, patients requiring rapid-sequence intubation should not be intubated with the fiberscope except following failed attempts at standard laryngoscopy. A fungating laryngeal tumor may be a contraindication to oral or nasal intubation, with the preferred technique being early elective tracheostomy **(Miranda et al., 2018).**

In 1998, Markus Weiss incorporated fiberoptic fibers into a direct laryngoscope with a Macintosh blade **(Weiss. 1998)**. In 2001, John Pacey introduced the first videolaryngoscope called the Glidescope®, and since then the number of different devices using videolaryngoscopy has grown **(Treki and Straker. 2017)**. In 2013, the American Society of Anesthesiologists (ASA) suggested the use of videolaryngoscopy as the first choice in airway management in its algorithm of airway management **(Apfelbaum et al, 2013).** The Difficult Airway Society (DAS), in the 2015 algorithm, recognized the use of videolaryngoscopy as part of the airway management and suggested to all anesthesiologists the adoption of the videolaringoscopy skills **(Frerk et al; 2015)**. It is recommended that videolaryngoscope should be immediately available for all obstetric general anesthetics **(Mushambi et al; 2015)** .In 2017, DAS presented videolaryngoscopy as an equivalent technique to direct laryngoscopy in the first attempts of intubation in the airway managementalgorithm in intensive care units (ICUs) **(Higgs et al; 2018).**

The technique of videolaryngoscopy depends on the type of device used.

The division of videolaryngoscopes into the channeled and non-channeled devices has practical implications as the technique of videolaryngoscopy also differs significantly whether it is channeled or non-channeled one . Non-channeled devices are further divided depending on the type of blade, which can be of the Macintosh, Miller, or hyperangular type, which also further influences the choice of technique. Blades can be manufactured from plastic for a single use or from metal for a multiple use. The screen can be on the device itself or on a separate external monitor, which can be placed on the side or above the patient's chest. The position of the monitor does not significantly affect the technique, but it requires good eye-hand coordination like all endoscopic techniques **(Goranović. 2020)**.

It is important to note that videolaryngoscopy, in broader meaning, includes all devices that assist laryngoscopy by video technology. Besides the above described videolaryngoscopes, it includes different video intubating stylets and videoendoscopes, too. These devices are equipped with an inbuilt camera and light source **(Maldini et al; 2016) and (Hurford. 2010)**. Compared to the older versions of videostylets which were designed as rigid linear rods, the newer intubating stylets are often S-shaped and semiflexible with deflectable tips **(Setty et al; 2010) and (Biro. 2011)**. The devices can have an eyepiece at their end or can be attached to monitor to allow watching at the screen **(Goranović. 2020)**.

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Videostylets	Name	Manufacturer
With fixed tip	Bonfils®	Karl Storz, Tuttlingen, Germany
With flexible tip	Rigid and flexible laryngoscope (RIFL)	AI Medical Devices Inc., Williamston, MI, USA
	SensaScope® Acutronic	Medical Systems AG, Hirzel, Switzerland
	C-MAC® VS Video Stylet	Karl Storz, Tuttlingen, Germany

lists some video intubating stylets. **(Biro. 2011) and (Maldini et al; 2016)**

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