"COMPARISON OF THE GLOTTIC VIEW OBTAINED BY THE C-MAC VIDEOLARYNGOSCOPE AND DIRECT LARYNGOSCOPE IN PATIENTS WITH A SIMULATED DIFFICULT AIRWAY-A ONE YEAR HOSPITAL BASED CASE SERIES STUDY"

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This is to certify that the dissertation entitled "**COMPARISON OF THE GLOTTIC VIEW OBTAINED BY THE C-MAC VIDEOLARYNGOSCOPE AND DIRECT LARYNGOSCOPE IN PATIENTS WITH A SIMULATED DIFFICULT AIRWAY-A ONE YEAR HOSPITAL BASED CASE SERIES STUDY"** is a bonafide research work done by **REG. NO. BA0111004.**

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ABBREVIATIONS

µg	-Microgram
IV	-Intravenous
Kgs	-Kilograms
Mg	-Miligram
Yrs	-Years
CL GRADE	-Cormack Lehane Grade
IPPV	-Intermittent Positive Pressure Ventilation
PVC	-Polyvinyl Chloride
ASTM	-American Society of Testing and MATERIALS
VL	-Videolaryngoscope
ETT	-Endotracheal Tubes
ASA	-American Society Of Anesthesiologists
BURP	-Backward Upward and Rightward Pressure
DVL	-Difficult Visualisation of Larynx
MPG	-Mallampati Grade
POGO	- Percentage of Glottic Opening
LMA	-Laryngeal Mask Airway
RCT	-Randomised Clinical Trial
SGA	-Supra Glottic Airway

ABSTRACT

TITTLE: Comparison of the glottic view obtained by the C-MAC Videolaryngoscope and direct laryngoscope in patients with a simulated difficult airway-a 1 year hospital based case series study.

OBJECTIVE: To compare the glottic visualisation by Cormack Lehane grading between Direct Laryngoscope and C MAC Videolaryngoscope in patients with a simulated difficult airway posted for surgeries under general anesthesia.

METHODS: Sixty patients of either sex, between 18-60 years, undergoing elective surgeries in whom endotracheal intubation was required, were included in the study. After preoxygenation with 100% oxygen, patients were induced with IV thiopentone 5 mg kg^{-1} and succinyl choline 2 mg kg^{-1}. The rigid neck collar was then placed in position. The laryngeal view was assessed using Cormack and Lehane grading system. Laryngoscopy was performed with Macintosh laryngoscope first and glottic view was noted. After the withdrawal of the Macintosh blade, the grading was noted with the C-MAC videolaryngoscope. Intubation was done with the C-MAC with collar in situ, and subjectively graded as easy (E) or difficult (D).

RESULTS: It was found that grade III and IV (RESTRICTED VIEW) with Macintosh laryngoscope was 76.7% (46/60) compared to 23.3% (14/60) with the C-MAC. With the use of CMAC Videolaryngoscope, glottic view improved by 1 CL grade in 43.3% (26pts), by 2 CL grades in 21.6% (13pts) and by 3 CL grades in 1.6% (1pt) of patients.

For intubation with C-MAC with the neck collar in situ, intubation was easy (E) in 44 cases (73.3%) and difficult in 16(26.7%).

CONCLUSION: C-MAC videolaryngoscope significantly improved the glottic view in simulated difficult airways compared to the conventional Macintosh laryngoscope.

Keywords: Equipment; laryngoscope, Macintosh, videolaryngoscope, C-MAC

- Anesthesia; laryngoscopy, intubation
- Intubation; difficult, simulated difficult airway.

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INTRODUCTION

The literature in Anaesthesiology abounds with anecdotal reports dealing with difficult intubation. There are moments, when the skills of an anaesthesiologist are challenged by difficult airway scenarios.

Inability to view the larynx adequately during laryngoscopy is a major problem encountered during endotracheal intubation. The ability to pass an endotracheal tube under direct vision of the glottic structures is of utmost importance to the anaesthesiologist. Difficult laryngoscopy and failed intubation result in severe morbidity related to anaesthesia. This has forced the anaesthesiologists to persue their interests in developing newer gadgets to facilitate successful and safe endotracheal intubation.

Although fiberoptic laryngoscope remains the gold standard in the management of anticipated difficult airways, there is a huge gap between direct laryngoscopy and the fiberoptic laryngoscopy. Efforts have been made to bridge this gap by various modifications of the standard Macintosh laryngoscope blades, different type of laryngoscopes, various adjuncts used in difficult airway like the gum elastic bougie, stylet etc.

Off late there have been significant advances in the field of difficult airway. The invention of the video assisted laryngoscopes, commonly called the 'videolaryngoscopes' has definitely decreased the gap between direct and fiberoptic laryngoscopy, with relative simplicity of usage and smaller, easier learning curve. A wide range of such devices are now available to the anaesthesiologists worldwide.

One of the many devices in this category is the C-MAC videolaryngoscope which is conceptually and structurally different from many other videolaryngoscopes. Rather than using blades with acute angles, like the glidescope, the CMAC incorporates a conventional Macintosh type blade, with the addition of a micro video camera on the distal portion of the blade. It carries the advantage of being used as both, direct and indeirect laryngoscope.[1.]

However, it is imperative to subject these newer gadgets to thorough scientific evaluation regarding their usefulness in safe endotracheal intubations, in patients with normal and difficult airway.

Simulation of a difficult airway can be instrumental in evaluation of the new gadget as well as help in better training of personnel and in achieving expertise in the difficult airway management.

Hence an attempt is being made to evaluate the glottic view provided by the CMAC as compared to the standard Macintosh laryngoscope in patients with a simulated difficult airway, using a rigid cervical immobilisation collar under general anesthesia.

OBJECTIVES

The objective of the study was to compare the glottic visualisation by Cormack Lehane grading between Direct Laryngoscope and C MAC Videolaryngoscope in patients with a simulated difficult airway posted for surgery under general anesthesia.

REVIEW OF LITERATURE

Control of airway was one of the defining moments in the field of Anaesthesiology. Medical history abounds with occasions where in the trachea was intubated either with a tracheostomy or through the larynx in an attempt to provide an airway for an asphyxiated animal or human.

John Snow in 1858 had accomplished administration of chloroform through tracheostomy tubes in animals. Fredrick Trendelennberg in 1871 used the same technique in humans. Sir William Macewan in 1878 was the first physician to intubate the trachea orally for the sole purpose of administering anaesthesia. The cuffed endotracheal tube was promoted by Arthur Guedel and Ralph M Waters in 1928 and this allowed true isolation of the airway, paving the way for closed circuit anaesthesia.[2.]

Alfred Kirsten in 1895 and Gustav Kellian in 1912 pioneered direct laryngoscopy for the purpose of endotracheal intubation. Chevalier Jackson published a book in 1907 that popularized direct laryngoscopy.[2.]

In 1984, Cormack and Lehane introduced grading system for the degree of glottic exposure upon direct laryngoscopy.[3.] This grading system became the basis for documenting difficult laryngoscopy.

Mallampati and colleagues in 1985 emphasized the importance of the base of the tongue in predicting the difficulty laryngoscopy and proposed Mallampati classification.[3,4.] In 1987 it was modified by G.L.T Samsoon and J.R.B Young by adding class IV to the above classification.[5.]

There have been many reports about the anatomical characteristics for predicting a difficult laryngoscopy,[3-7.] but no anatomical factor can be used to predict difficult laryngoscopy precisely. Some studies have combined several variables but with relatively little success in predicting the problematic cases.[8,9.] For these reasons a successful technique for dealing with unpredictably difficult intubation was desirable.

In recent years, technique of videolaryngoscopy is being used in management of patients with an unanticipated difficult or failed laryngoscopic intubation.[10.]

In situations of patient with multiple injuries, particularly when damage to cervical spine is suspected, tracheal intubation is to be performed with great care. The patient with unstable cervical spine requires a neck collar in pre hospital setting, and medical personnel may be required to perform tracheal intubation.[11.]

The cervical collar effectively reduces mouth opening from >4.5 cm up to ~2 cm, limits neck extension, and worsens the Cormack-Lehane laryngeal views by 1-2 grades.[12.]

The C-MAC video laryngoscope is a novel device that can be used with Macintosh laryngoscope blades of different sizes. It allows for both direct and indirect laryngoscopy, and the low profile of the Macintosh blades may prove advantageous in patients with limited mouth opening.[13.]

The C-MAC laryngoscope has an original Macintosh steel blade shape with a closed blade design with no edges and gaps for hygienic traps. The C-MAC blade is flattened, resulting in a very slim blade profile and the edges are slanted to avoid damage to the mouth and teeth. The C-MAC incorporates the smallest possible (2mm) digital camera and a high power light emitted diode, located laterally in the distal

third of the blade. The view obtained includes the tip of the blade and, therefore allows visual guidance of the blade tip into the vallecula. The image may be recorded as a single picture or a video stream.[1.]

Combining the benefits of conventional direct larygoscopy and video laryngoscopy in one device, the C-MAC may serve as a standard intubation device for both routine airway management and educational purposes.[10.]

The previously evaluated videolaryngoscopes like the Glidescope, are associated with significant airway injury due to the blind insertion and the indirect view of the glottis.

However, C-MAC appears to reduce this complication while improving the chances of successful tracheal intubations because of its design being similar to the Macintosh direct laryngoscope and the combined direct and indirect view of glottis.

Byhahn C. et al conducted a study done in patients with limited inter incisor distance, and observed that video laryngoscopic techniques enhanced laryngeal view,(failed glottic view 14% with C-MAC compared to 70% failed view with direct laryngoscopy) yet in few of the cases, despite a good view, endotracheal tube placement was unsuccessful.(successful tube placement in 88% cases)[13.]

A study by Piepho T. et al, to evaluate the performance of C-MAC Videolaryngoscope in patients after a limited glottic view using Macintosh laryngoscopy observed that the glottic view improved in 94% patients using the C-MAC. (In 31% patients by one CL grade, in 62% patients by two CL grades, and in 2% cases by three CL grades)compared with the Macintosh blade.[14.]

A study to evaluate C-MAC video laryngoscope by Cavus E. et al, showed that it provided a good view of the glottis, specially after a suboptimal view with direct laryngoscopy(CL>IIa). CL classes improved by 3 grades in 5 patients(20%), by 2 grades in 2(8%) and by one grade in 8(32%) patients. resulting in successful tracheal intubation during routine induction of anaesthesia.[10.]

In a high fidelity simulation mannequin study, Narang AT. Et al observed that in one of the most difficult airway case with tongue edema, encountered frequently in trauma patients, the video laryngoscope provided an enhanced view of the cords(50% versus 12%) using less time, increased intubation success(83% versus 23%) compared to direct larygoscopy and decreased time to intubation.[**15.**]

Evaluation of video laryngoscopy showed the advantage of obtaining both a direct laryngoscopic view and a camera view. The study highlighted the unique benefit of the camera image as a tool for education and documentation. Studies have shown that usage of video assisted laryngoscopic techniques have reduced the incidence of use of additional assistance like bougie and stylet.[**1.**]

McElwain .J. et al performed a study comparing the C-MAC, Glidescope and Airtraq video laryngoscopes with Macintosh direct laryngoscope in a manikin with a simulated difficult airway by application of neck collar, and found that C-MAC had better CL grades compared to Macintosh laryngoscope (CL grade 1 in 81% versus 10%).[**16.**]

However, all these claimed benefits have not yet been proved in sufficient number of human studies, so as to apply the results to the population at large.

Also there is not much literature on the utility of the C-MAC in Indian population, both for elective surgeries as well as emergency situations, where endotracheal intubation is desired.

BASIC SCIENCES

APPLIED ANATOMY OF UPPER AIRWAY:

The upper airway consists of nose and nasal cavity, mouth and oral cavity, the pharynx, the larynx and trachea.

1. **Mouth and oral cavity:**

- The mouth extends from the lips to the oro-pharyngeal isthmus at the level of the palatoglossal folds and is divided by the teeth into an outer vestibule and oral cavity proper.
- The oral cavity is lined by the squamous epithelium containing mucous secreting glands.
- **Boundaries:** It is bounded anterolaterally by the teeth and gums, superiorly by the hard and soft palates. The palatoglossal fold (anterior pillar of the tonsil) runs between the soft palate and the tongue which marks the oropharyngeal isthmus. It joins the tongue at the junction of its anterior two thirds and posterior one third.
- **The Tongue:** The tongue sits on the floor of the mouth, almost filling it. It contains intrinsic and several extrinsic muscles connecting it to the associated structures like,
    - ✓ Genioglossus : Connects to mandible
    - ✓ Hyoglossus : Connects to hyoid bone
    - ✓ Styloglossus : Connects to styloid process at base of the skull
    - ✓ Palatoglossus : Connects to the soft palate

The undersurface of the tongue is attached to the floor of the mouth by a fold of mucous membrane called the frenulum. Posterior third of the tongue has a different embryological origin and is contained within the oropharynx.

SOFT PALATE

Soft palate consists of an aponeurotic sheath into which several muscles are inserted laterally. It is attached anteriorly to the back of the hard palate and its free posterior edge bears the midline uvula which separates nasopharnyx from the oropharynx. While the inferior aspect of the soft palate is covered with a squamous epithelium, its superior aspect bears a ciliated columnar epithelium.

Muscles acting on the soft palate:

- Tensor palate and levator palati attach laterally and they tense and elevate the palate respectively.
- Palatoglossus passes in the palatopharyngeal fold to the tongue and narrows the oropharyngeal opening.
- Palatopharyngeus lies in the palatopharyngeal fold (posterior pillar) and joins with pharyngeal constrictor muscle. It narrows the oropharyngeal opening.
- Musculus uvula is an intrinsic muscle which draws up the uvula.

Somatic innervations of the oral cavity:

❖ **The vestibule:**

Sensory : Trigeminal (V_2 & V_3) via alveolar and labial Branches

- Motor : Facial (VII)

- **Hard palate:**
  - Sensory : Trigeminal (V_2) via palatine and nasopalatine Branches
  - Taste : Facial (VII) via branches of V_2.

- **Soft palate:**
  - Sensory : Trigeminal (V_2) via palatine branches to anterior region and Glossopharyngeal to the posterior region.
  - Motor : Trigeminal (V_3) to tensor levipalati and via pharyngeal plexus (IX, X, XI) to all other muscles.
  - Taste : Facial (VII) via greater petrosal nerve.

- **Tongue:**
  - Sensory : Trigeminal (V_3) via lingual nerve to anterior 2/3. Glossopharyngeal (IX) to posterior 1/3.
  - Motor : Pharyngeal plexus (IX, X, XI) to Palatoglossus and hypoglossal nerve supplies all other muscles.
  - Taste : Facial (VII) via chorda tympani to anterior 2/3 and Glossopharyngeal (IX) to posterior 1/3.

Blood Supply and Lymphatic Drainage

- Arterial Supply: lingual, facial & maxillary branches of external carotid artery. Drainage of blood is to the corresponding veins. Soft palate drains into the pharyngeal venous plexus.
- Lymphatic drainage: Deep cervical lymph chain drains the anterior tongue and floor of the mouth drain initially into sub mental and subsequently to the submandubular nodes.

THE PHARYNX

The phanynx is a fibromuscular tube which connects the nasal and oral cavities with the larynx and oesophagus. It is composed of a thin facial layer that forms thick buccopharyngeal fascia posteriorly, continues as adventitia of the oesophagus inferiorly and gets attached to the skull base superiorly.

There are three constrictor muscles within the pharynx.

a. The superior constrictor which inserts into the base of the skull.
b. The middle constrictor which inserts into the mandible & hyoid bone
c. The inferior constrictor which inserts into the cricoid cartilage.

The inferior constrictor contributes to a muscular band and the cricopharyngeus, forms the upper oesophageal sphincter. All the muscle segments are inserted posteriorly into a tendinous median raphe.

Divisions of the pharynx

The pharynx is divided into the nasopharynx, the oropharynx and the hypopharynx.

a. **Nasopharynx:** It is situated directly behind the nasal cavity. Its inferior boundary lies at the level of the soft palate. The roof is formed by the sphenoid and occipital bones of the skull base. The posterior wall is separated from the spinal column by a tough prevertebral fascia which covers the longus capitus muscle, the deep prevertebral musculature and the arch of the first cervical vertebra. Five passages communicate with nasopharynx. The two nasal choanae, the orifices of the two Eustachian tubes, and the oropharynx. Mucous membranes of the roof and posterior wall contain lymphoid tissue termed as the adenoid tonsil.

b. **Oropharynx:** It lies directly posterior to the oral cavity and extends from the soft palate superiorly to the tip of the epiglottis inferiorly. The posterior wall consists of the prevertebral fascia and the bodies of the second and third cervical vertebrae. The lateral walls contain the paired tonsillar fossae which are formed by the palatoglossal and palatopharyngeal folds and contain the palatine tonsils.

   Medial to the tonsillar fauces lies the base of the tongue. The tongue base is anterior to the laryngeal inlet and attaches to the epiglottis by the paired lateral glossoepiglottic folds and by the single median glossoepiglottic fold. Glossoepiglottic folds bind two spaces, the epiglottic and the valleculae. The

posterior dorsal tongue surface is irregularly contoured because of the lingual tonsils.

c. **Hypopharynx:** It extends inferiorly from the upper edge of the epiglottis to the inferior edge of the cricoid cartilage and communicates with the oropharynx, the laryngeal inlet and the esophagus. On the side of the larynx are funnel shaped pyrilossoepigform recesses. These recesses aree bound superiorly by the lateral glossoepiglottic folds and lie between the aryepiglottic folds and the internal lining of the thyroid cartilage. The posterior border of the hypopharynx comprises the buccopharyngeal, prevertebral fascia and the deep prevertebral musculature. The hypopharynx is located at the level of the 4^{th} to 6^{th} cervical vertebrae.

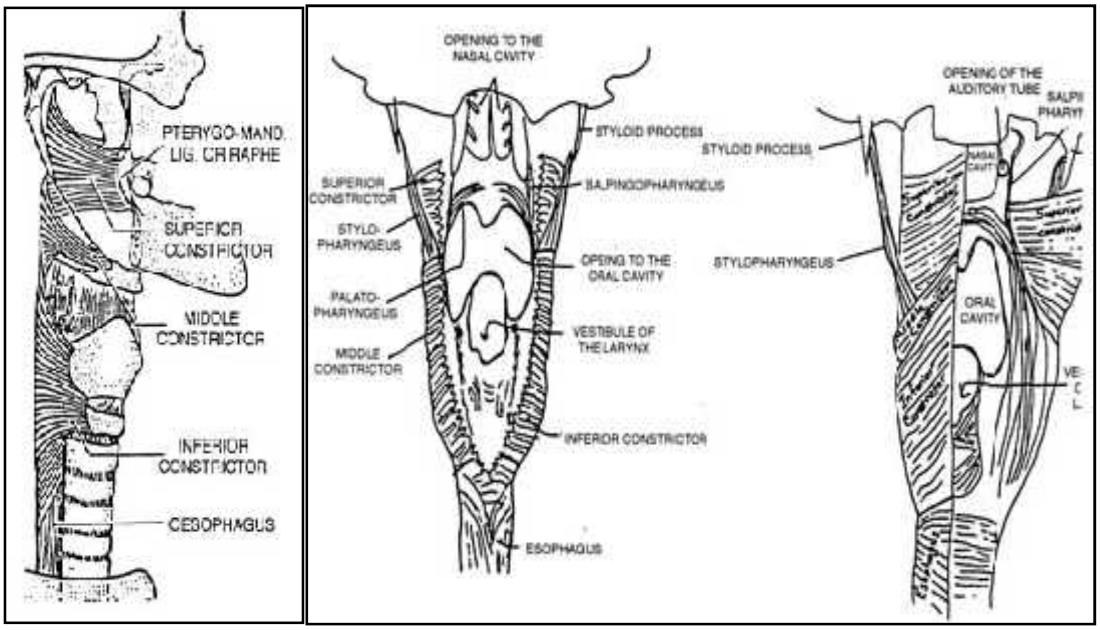


Fig 1: The Pharynx (a) Muscles of Pharynx (b) Posterior View (c) Anterolateral view

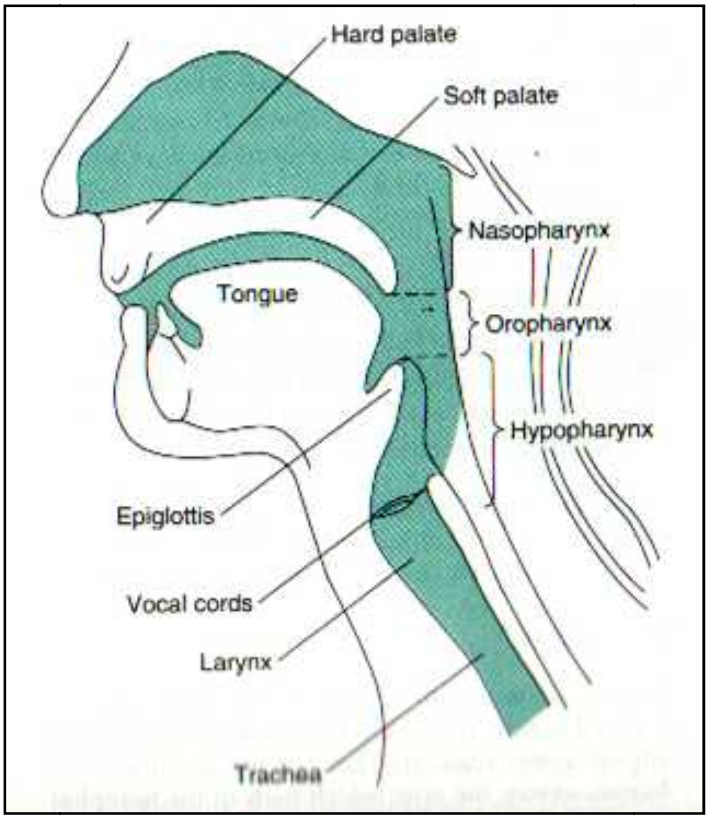


Fig 2: Divisions of Pharynx

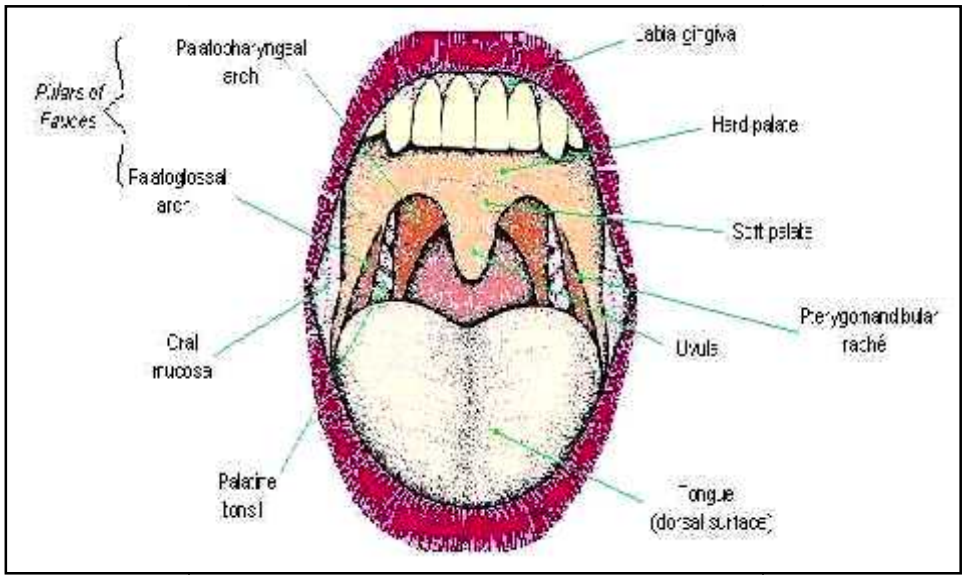


Fig 3: The oral cavity

THE LARYNX

It lies at the level of the 4^{th} to 6^{th} cervical vertebrae. It is "slung" from the underside of the hyoid bone and can be easily palpated through the skin of the anterior neck. It is covered superficially by the skin, deep fascia and the thin strap muscles of the neck.

Functions of the larynx: The larynx is continuous with the trachea and has specialized constrictor dilator mechanism in the airway. The constrictor mechanism results in an effective and rapid closure that prevents aspiration into the lower airway. The vocal cords help in the act of phonation.

Laryngeal skeleton: There are three unpaired (thyroid, cricoid and epiglottis) and three paired (arytenoids, corniculate and cuneiform) cartilages which form the skeleton of the larynx.

a. **Thyroid cartilage:** It is the largest cartilage of the larynx. It is composed of two superior horns that aid in its suspension from the hyoid bone. The inferior horns articulate with the cricoid cartilage below to form the cricothyroid joint. It is often described as 'sheild shaped' and consists of two laminae that are joined in the midline anteriorly but posterior borders are far apart. The cartilaginous protrusion in front of the neck is known as the Adam's apple.

b. **Cricoid cartilage:** It is shaped like a signet ring. It lies immediately below the thyroid cartilage and is the only complete cartilaginous ring in the larynx. The anterior portion is short, 5-7 mm in height and is called the arch, and the posterior portion is taller, 2-3 cm in height and is called the lamina. The lamina project upwards behind the thyroid cartilage and articulates superiorly with the arytenoids cartilages. The inferior cornu of the thyroid cartilage

articulates with the side of cricoids cartilage at the junction of the arch and lamina.

c. **Epiglottis cartilage**: It is a leaf shaped cartilage placed in the anterior wall of the upper part of the larynx. The upper end is broad and free. It projects upward behind the hyoid bone and the tongue and overhangs the laryngeal inlet. The lower end is attached to the laryngeal inlet. The lower end is attached to the upper part of the angle between the two laminae of the thyroid cartilage and to the back of the hyoid bone on its upper end.

d. **Arytenoid cartilage:** The two arytenoids are pyramidal in shape and articulate into the upper lateral border of the cricoids. The vocal folds are attached to the anterior surface of the arytenoids. The posterior and lateral cricoarytenoid muscles are inserted onto the lateral sides of the arytenoids.

e. **Corniculate cartilage:** These are the two small cartilages which articulate with the apex of the arytenoids cartilages and lie in the posterior part of the aryepiglottic folds.

f. **Cuneiform cartilages:** These are two small cartilages placed in the aryepiglottic folds just vertical to the corniculate cartilages.

VOCAL CORDS

These are composed of muscles, ligaments, sub mucosal soft tissue and the covering mucous membrane. They extend from the arytenoids posteriorly to the thyroid cartilage anteriorly. The laryngeal cavity begins at its entrance. The vestibule of the larynx lies below the vocal cords, which in turn leads to the rima vestibuli. Two mucosal folds that bind the rima vestibule are called the ventricular folds. The lateral spaces between the ventricular and vocal folds are called the ventricles. The narrow space between the vocal folds is called the rima glottides (glottis). The space that leads from the rima glottides to the trachea is the infraglottic cavity or the subglottis.

Nerve supply of the larynx: The nerve supply to the larynx travels through the right and left, superior and recurrent laryngeal nerves, all of which are branches of the vagus nerve. The external branch of the superior laryngeal nerve is motor to the cricothyroid muscle and the internal branch of the superior laryngeal nerve is sensory up to the level of the vocal cords. The recurrent laryngeal nerve supplies the remainder of the intrinsic muscles and also sensory below the subglottis.[17,18]

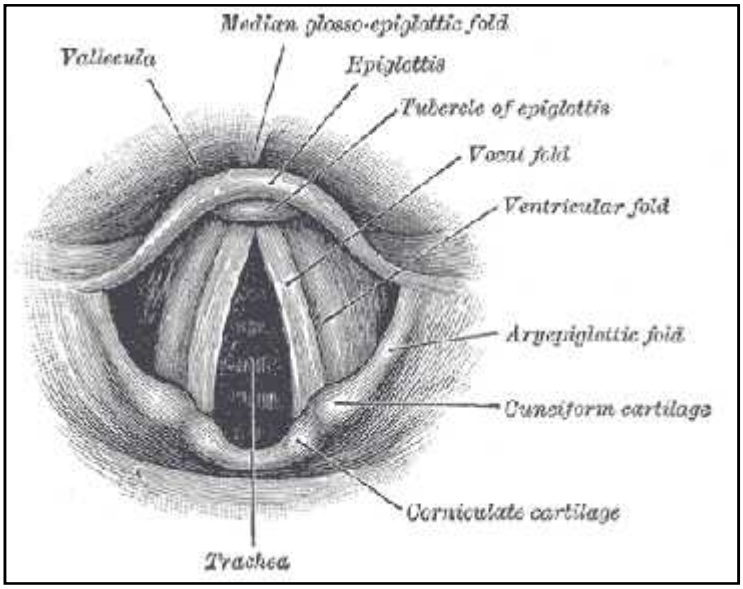


Fig 4: Vocal cords at laryngoscopy

TRACHEA

The trachea begins at the level of C5 vertebra, where it is attached to the lower side of the cricoid cartilage. It is about 11-14 cm long in adults and ends at the carina. The position of the carina alters with posture and respiration but is usually regarded to begin at about T4-5 level. At the carina, it divides into right and left main bronchi. Tracheal wall is supported by many 'C' shaped cartilages which are deficient posteriorly. This part of the tracheal wall is lined by the trachealis muscle.

The anterior aspect of the trachea is covered with skin, pretracheal fascia, the thyroid isthmus, and the thin strap muscles of the neck until it passes behind the sternum. Posteriorly it is related to the esophagus. The mucosa of the trachea is lined by pseudostratified ciliated columnar epithelium. The sensory supply is from the vagus.

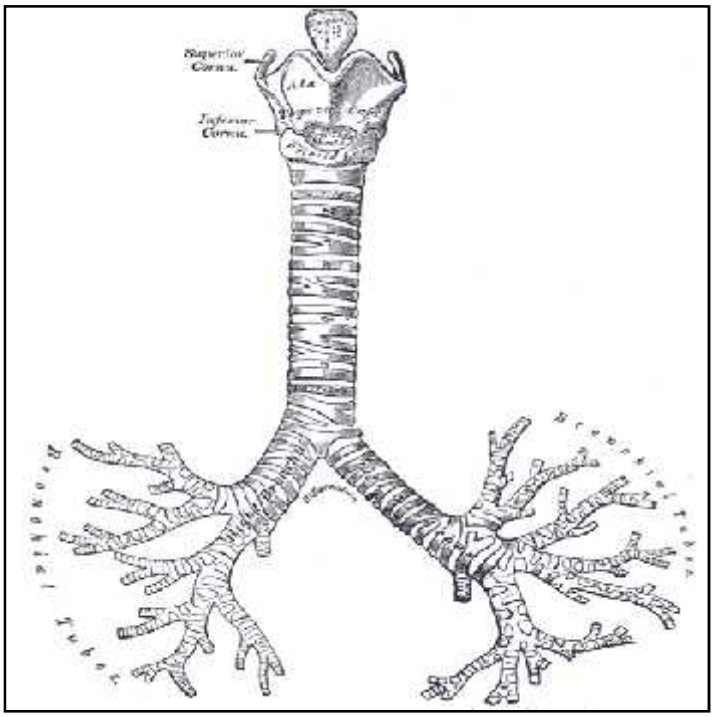


Fig 5: Trachea

ENDOTRACHEAL INTUBATION

History

- Intubation of animal trachea was first done by Vesalius in 1543
- Human endotracheal intubation was first done by curry in 1792
- Magill modernized the endotracheal intubation in anaesthesia in 1920
- Rowbotham was the first to perform the blind nasal intubation in 1920
- Waters and Guedel in 1928 introduced endotracheal tubes

Indications

- Surgery on the head and neck
- Protection of the respiratory tract
- During anaesthesia using IPPV and muscle relaxation
- To facilitate suction of the respiratory tract (Pulmonary toilet)
- Thoracic surgery
- Cardiopulmonary arrest

Preparation

Availability and functioning of the following equipment should be checked.

- Laryngoscope
- Tracheal tubes
- Stylet
- Magill forceps
- Securing tape
- Catheter mount
- Lubricant gel
- Throat pack
- Anaesthetic breathing system and face mask
- Reliable suction

TECHNIQUE OF ORAL INTUBATION

Head Positioning

The correct position for the head is the “sniffing position”, with the neck (cervical joint) slightly flexed and the head (atlanto-occipital joint) extended. One places a pillow or folded sheets (5cms in height) below the occiput to maintain the position

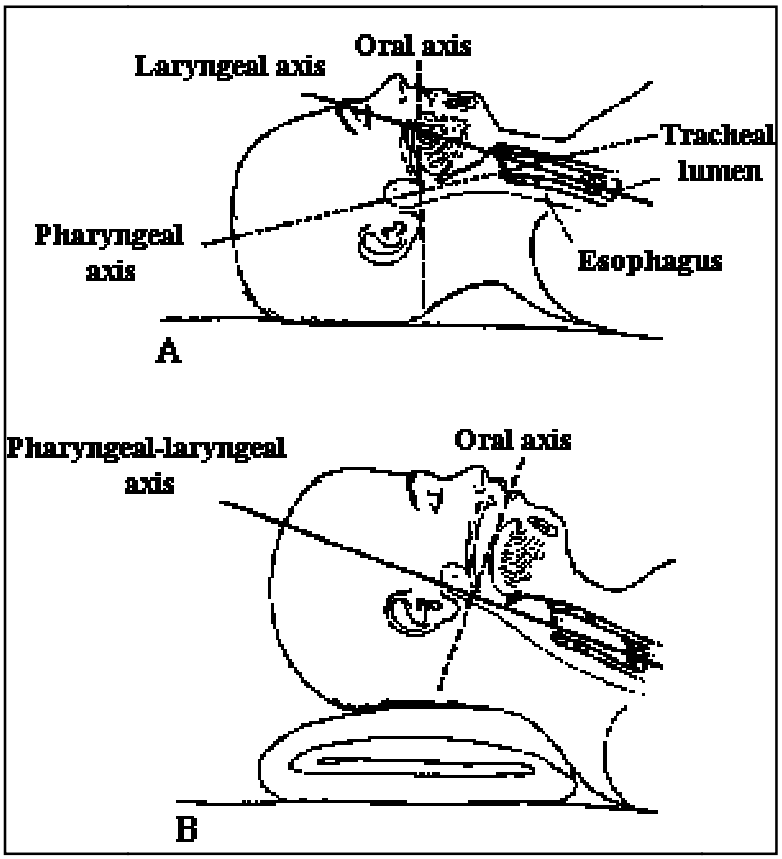


Fig 6: The sniffing position with the three axis

Laryngoscopy

The laryngoscope is held in the left hand and introduced into the right hand side of the mouth. The tongue is swept to the left and the tip of the blade is advanced until a fold of cartilage is visualized at 12 O'clock position. This is the epiglottis and it sits over the glottis.

The tip of the blade is advanced to the base of the epiglottis, known as the vallecula, and the entire laryngoscope is lifted upwards and outwards. This flips the epiglottis upward and exposes the glottis below. An opening is seen with two white vocal cords forming a triangle on each side.

Intubation

The endotracheal tube is inserted into the right side of the mouth and inserted between the open vocal cords under direct vision. The correct position of the tube is confirmed by auscultation or capnography. The tube is secured at this level and the cuff is inflated.

LARYNGEAL VIEW CLASSIFICATION[20.]

Difficult intubation has been classified into four grades according to the view obtainable at laryngoscopy. Cormack and Lehane Grade I – IV are as follows.

Grade I - If most of the glottis is visible, then there is no difficulty in Intubation

Grade II - If only the posterior extremity of the glottis is visible, then there may be a slight difficulty. Light pressure on the larynx will nearly always bring at least the arytenoids into view, if not the cords.

Grade III - If no part of the glottis can be seen but only the epiglottis,then there may be fairly severe difficulty in intubation

Grade IV - If not even the epiglottis can be exposed then intubation is impossible except by special methods. This situation is well recognized where there is obvious pathology but is exceedingly rare if the anatomy is normal

RIGID LARYNGOSCOPES

Various laryngoscopes have been described since MacEvan, a distinguished surgeon of the Glasgow Royal infantry, who first used his fingers to guide an endotracheal tube into the trachea in 1878[21.] Hundreds of blades have since been described, with a whole new generation of video assisted laryngoscopes

Design

A laryngoscope consists of a handle joined to a blade. This junction is usually referred to as the fitting. The blade consists of five parts.

1. The spatula is the main shaft of the blade. The bottom contacts the tongue and the top faces the roof of the mouth.

2. The web or step projects upwards from the blade towards the roof of the mouth.
3. The flange projects laterally from the web. The direction may be over the blade so that a cross sectional area is open partially, or completely enclosed to form tube. Alternatively, the flange bends away from the blade and is referred to as reversed flange.
4. The beak is the tip of the blade , placed in the vallecula or beyond the epiglottis to elevate it directly.
5. Approximating the beak is a light source. There may be additional features, such as oxygen delivery and suction.

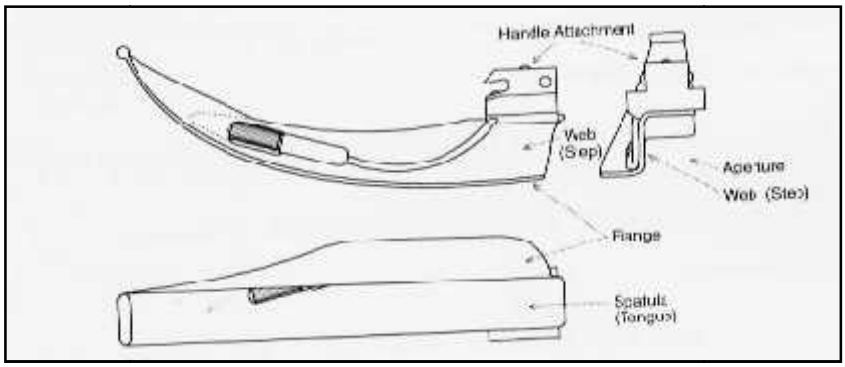


Fig 7: Macintosh laryngoscope blade: (top) lateral view (bottom) plane facing roof of mouth

Macintosh Laryngoscope Blade:[22.]

In 1943, Macintosh designed a curved blade in order not to entrap the epiglottis. The Macintosh blade is advanced until the distal tip is placed in the vallecula and then upward traction is applied to the tongue base facilitating exposure of the larynx.

VIDEO LARYNGOSCOPES.

Both direct and videolaryngoscopes share the common feature of a handle attached to a blade with a light source, but in video scopes there is a camera at the tip of the blade allowing indirect visualization of the glottis on a screen.

Classification:[23.]

1. Presence of an integrated channel (to guide the placement of the endotracheal tube)
2. The form of a videostylet (with the endotracheal tube placed around the device)
3. A rigid laryngoscope (without a channel, the endotracheal tube requiring some kind of independent stylet to guide placement)

   Rigid blade laryngoscopes are sub-divided into those with a “standard” blade and those with an angled blade.

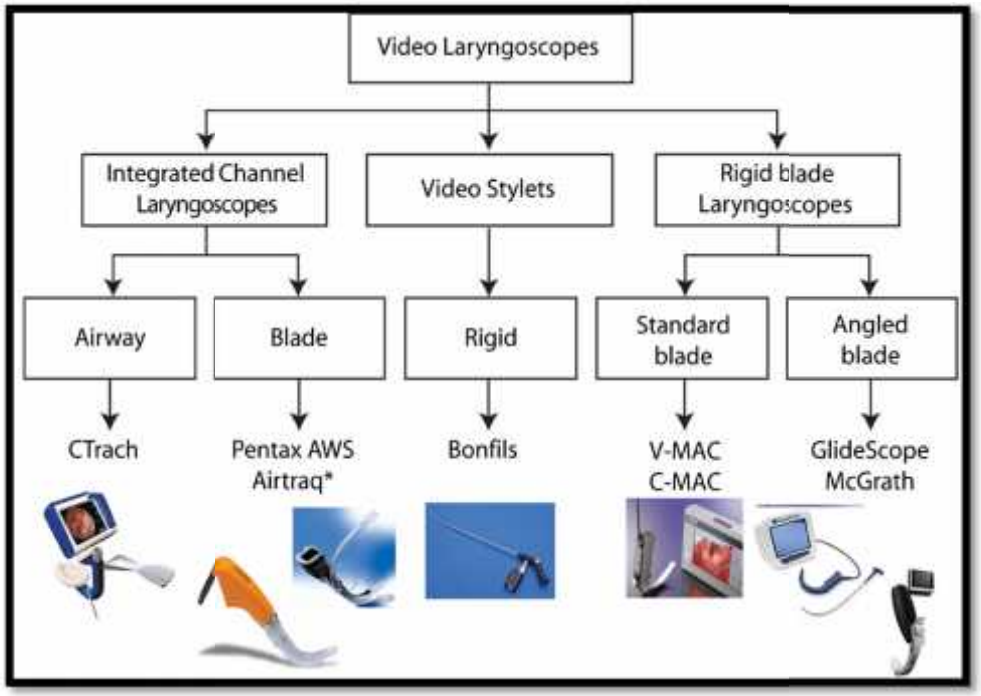


Figure 8: Classification of Videolaryngoscopes

RIGID VIDEOLARYNGOSCOPES WITH STANDARD MACINTOSH BLADES.

As the name indicates, they have the same design as that of the standard Macintosh blade. The diffierence is that the bulb near the tip of the standard scope is replaced by a camera. The insertion technique is the standard direct laryngoscopic one. After insertion, the operator sees an enlarged image of the upper airway on the screen. Since these devices have a curvature resembling that of Macintosh blade, the glottis can be viewed either directly or indirectly on the screen.[24.]

C-MAC Video Laryngoscope System

The C-MAC (Karl Storz, Tuttlingen, Germany) video laryngoscope system is a modification of the Storz DCI system. The C-MAC VL can provide a useful alternative during routine induction of general anesthesia and in securing a difficult airway. The C-MAC is based on a modified Macintosh blade that has the same curvature as the standard, but it is different from the original Macintosh blade in its thinner profile (maximum of 14 mm) and its beveled shoulder, which reduces the risk of oral and dental injury and facilitates insertion in patients with limited mouth opening. Optionally, the blade may be equipped with a guide channel for introducing a suction catheter to help maintain a clear visual field during laryngoscopy. The C-MAC system is compatible with various blades. The electronic module (E-module) fits into the blade handle and allows a rapid exchange of Macintosh stainless steel blade sizes 2, 3, and 4, Miller sizes 0 and 1, and the D-Blade. The combined optical system of the C-MAC consists of a complementary metal-oxide semiconductor (CMOS) chip set (320 × 240 pixels), an optical lens with an aperture angle of 80 degrees, and a high-power, light-emitting diode (LED) at the distal third of the blade with effective antifogging properties. The blade handle with the E-module and the

external, 7-inch LCD color monitor have push buttons that allow the operator to capture images from the screen and record video sequences, which are storable on standard SD memory cards, which have a 2-GB capacity. In the rare case that visualization of the glottic opening is still difficult, the D-Blade may be attached to the system within seconds. The higher curvature of the D-Blade allows a better look around the corner, and the low blade profile may permit use even in patients with limited mouth opening (e.g., 15 mm); however, direct laryngoscopy is not possible in most cases.

Other parts of the C-MAC system include the C-MAC pocket monitor (PM), which is a 2.4-inch LCD monitor combined with a lithium-ion battery–equipped E-module that fits in all available blades of the C-MAC system (e.g., Miller 0 and 1, Macintosh 2-4, D-Blade). The rechargeable battery supplies the monitor and the LED light source of the blades with 1 hour of energy without recharging, so that the VL is fully portable and can be used wireless. Power is turned on by a magnetic switch when lifting the monitor. Because this system is designed for mobile use, there are no other switches or connections for picture or video recording and exportation. To save battery capacity, the monitor turns off after 10 minutes automatically.

Instrument Use

For portable use, the monitor and blade handles can be packed separately in a rugged carrying bag, which permits use of all monitor buttons through the bag, even under difficult ambient conditions (e.g., prehospital settings). The C-MAC uses the identical blades, and the laryngoscopic technique is the same as with the conventional C-MAC system. However, successful handling of the device with the small monitor needs to be tested in clinical trials.

McGrath MAC Video Laryngoscope

The McGrath MAC (Aircraft Medical, Edinburgh, United Kingdom) is a slim-profile, mobile VL that consists of a battery-containing handle, a steel blade core (CameraStick), and a 2.5-inch LCD monitor fixed to the handle. The proprietary lithium-ion battery pack provides approximately 250 minutes of power. The McGrath MAC is fully immersible for high-level disinfection. As in the McGrath Series 5 VL, there is no connection port to transfer the image to an external monitor.

GlideScope Direct

The GlideScope Direct (Verathon Medical, Bothell, WA) is a stainless steel Macintosh blade that adds to the existing GlideScope system. The purpose of this blade is to expand the system with the option to teach conventional laryngoscopy because the GlideScope Direct allows direct and indirect (video laryngoscopic) glottic visualization.

Truview Picture Capture Device

The Truview picture capture device (PCD) VL (Truphatek International Limited, Netanya, Israel) has an integrated optical lens (optical view tube), a unique 42-degree blade tip angulation, and a view through a 15-mm eyepiece. The LED light source is stored in the handle, and the light is transmitted to the blade tip by fiberoptic strands. It is available in five blades sizes, and all of them allow direct laryngoscopy. The blades are equipped with an integrated oxygen jet cleaning and insufflation system, which can connect to an external oxygen flow meter and provide oxygen at a rate of 4 to 6 L/min. The video properties of the optical Truview blade can be achieved by magnetic connection of the eyepiece to the camera of the Truview PCD screen.

RIGID VIDEOLARYNGOSCOPES WITH HIGHLY CURVED BLADES

Alignment of the oropharyngolaryngeal axis is not necessary using highly curved blades. With a look around the corner, optimal visualization of the glottis can be achieved without further manipulation (e.g., flexion or extension of the cervical spine). This may be important in patients with cervical immobilization, severe micrognathia, a fixed temporomandibular joint, or limited regional access.

High curvature of the blade typically makes it impossible to perform direct laryngoscopy; tracheal intubation requires indirect visualization. To follow the high curvature of the blade with an ETT, a tube guide or malleable stylet is necessary.

GlideScope

The GlideScope is the prototype of obligate indirect video laryngoscopes that display an image of the laryngeal inlet on an accompanying monitor. Made of medical-grade plastic, the laryngoscope is available in different sizes for fitting small children to morbidly obese patients. A high-power LED and miniature CMOS video camera are embedded posteriorly midway along the blade, resulting in a vertical profile up to 16 mm. Angulation of 60 degrees at midblade permits laryngeal inlet visualization with little tissue manipulation. An antifogging mechanism effectively maintains the view. The video image is transmitted to a 7-inch LCD monitor through a video cable; an integrated USB port allows recording of captured images and videos.

McGrath Series 5

One of the first fully portable and wireless devices with higher blade angulation and an integrated monitor is the McGrath Series 5 VL (Aircraft Medical Edinburgh, UK). It combines a steel blade with a length that may be adjusted according to the patient's

body size and a single-size, disposable blade sheath. The low-profile blade has a disarticulating handle that can accommodate patients with limited mouth opening and severely limited neck mobility.

VIDEO LARYNGOSCOPES WITH TUBE-GUIDING CHANNELS

Some video laryngoscopes with high blade curvatures have integrated tube-guiding channels to improve tube passage without the use of a tube stylet. The VL and tube are directed together to the glottic entrance. Because of the surrounding channel, the tube cuff is reasonably protected from damage.

King Vision

The King Vision (King Systems, Noblesville, IN) is a fully portable and wireless VL with high blade angulation. It has a reusable-battery–operated monitor and a disposable blade that also includes a CMOS video camera. The disposable blade is available with or without a tube-guiding channel, and one blade size is provided for adult use (tube sizes 6.0 to 8.0 mm). The King Vision's video output allows bystanders to view the images on an external medical monitor.

Pentax Airway Scope AWS-S100

The Pentax Airway Scope (AWS-S100, Pentax Medical, distributed by AMBU, Inc., Glen Burnie, MD) is a fully portable, battery-operated, and wireless VL that is available in one size only. The AWS-S100 has a portable, transparent blade (PBlade) equipped with a port through which a suction catheter can be passed. It uses an LED light and flexible wire for a charge-coupled device (CCD) camera, rather than the CMOS camera chip used in other VLs.

Airtraq

The Airtraq (Prodol Meditec, Guecho, Spain) is a single-use, indirect laryngoscope that incorporates two channels. One transfers the image to a proximal viewfinder through a series of prisms and lenses, and the other acts as a conduit for the ETT. A clip-on camera can transfer the image from the viewfinder to an external monitor. The Airtraq is available in different sizes for pediatric and adult patients. Nasal and double-lumen versions are available.[25.]

MATERIALS AND METHODS

The present study titled **"COMPARISON OF THE GLOTTIC VIEW OBTAINED BY THE C-MAC VIDEOLARYNGOSCOPE AND DIRECT LARYNGOSCOPE IN PATIENTS WITH A SIMULATED DIFFICULT AIRWAY-A ONE YEAR HOSPITAL BASED CASE SERIES STUDY"** was conducted

in patients aged 18-60 years, of either gender, undergoing elective surgery in supine position, under general anaesthesia and endotracheal intubation, at KLE'S Dr Prabhakar Kore Hospital and Medical Research Centre, Nehru Nagar, Belgaum, during the period from January 2012 – December 2012**.**

TYPE OF STUDY:

Case series study

a) **Inclusion Criteria**:

- 1. ASA physical status 1 and 2
- 2. Age between 18 to 60 years.

b) **Exclusion Criteria** :

1. Patient refusal
2. Patient with known/anticipated difficult airway
3. ASA grade 3 and 4.
4. Patients with potential full stomach.
5. Pregnant and lactating females.

Sample size:

Sample size was calculated using formula

$$N = \frac{4 \times p \times q}{d^2}$$

Where,

N- Sample size

p- Pickup rate by the new procedure being evaluated

q- 100-p

d- Relative error

P of test is taken as 86%

(Based on results of preliminary studies evaluating the C-MAC videolaryngoscope)

Relative error taken as 8.6% (10% of p)

A total sample size of 60 patients was obtained, on the basis of references and pilot study.

Sampling procedure:

Patients fulfilling the inclusion and exclusion criteria, were randomly chosen into the study group.

Methodology:

After obtaining ethical committee clearance and written informed consent, 60 patients (ASA I-II) of either gender, posted for elective surgeries in the supine

position, under general anaesthesia in whom tracheal intubation was indicated, were enrolled in the study.

Pre anaesthetic evaluation of the patient and routine investigations were done. An IV line was secured. Standard monitoring devices were attached before induction of anaesthesia, including non-invasive arterial blood pressure, heart rate, and oxygen saturation.

After 5min of pre oxygenation with a facemask (for adequate oxygen reserve), patient was premedicated with injection GLYCOPYRROLATE-0.005mg/kg,MIDAZOLAM-0.05mg/kg, PENTAZOCINE-0.5mg/kg, General Anaesthesia was Induced with inj THIOPENTONE-5 mg/kg and SUCCINYL CHOLINE-2mg/kg. Then a rigid cervical immobilisation collar was applied.

METHOD OF LARYNGOSCOPY

Direct laryngoscopy (Macintosh scope) was performed with the neck collar in situ, (without applying external laryngeal pressure (BURP Maneuver). The best obtained CORMACK-LEHANE (C/L) view, modified by Yentis and Lee was identified.

Immediately, laryngoscopy was performed using the C-MAC Videolaryngoscope.

A second anaesthesiologist, (blinded to the laryngeal view obtained under direct laryngoscopy), graded the glottic view, (CORMACK-LEHANE view) on the video monitor, using the C-MAC Video laryngoscope, without external laryngeal pressure. The position of the device was adjusted to have the glottis in the centre of the screen. The two laryngoscopies were performed immediately one after the other,

each taking a maximum time of 30-35 seconds. Intubation was carried out with the CMAC Videolaryngoscope, in presence of the collar The anaesthesiologist graded the subjective experience of intubation as easy (E) or difficult (D). Any situation leading to external laryngeal manipulation, more than one attempt, use of bougie etc were all categorised as 'D'. In the situation of difficulty namely inability to intubate in one attempt or inability to maintain oxygen saturation >90% with mask the neck collar was removed immediately, and patient was intubated by the conventional standard technique.

Correct tube position, and subsequently, successful ventilation, were assessed with capnography and bilateral chest auscultation.

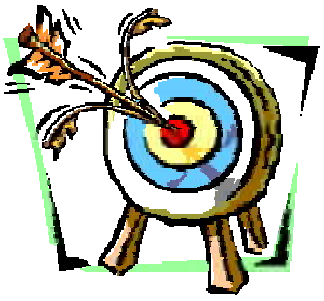
Oxygen saturation (SpO_2), mean arterial blood pressure, and heart rate were recorded at baseline and after laryngoscopy.

Anaesthesia was continued as per individual case requirement, with maintenance with non depolarising muscle relaxants, according to standard protocol.

Analysis plan:

The observations (good glottic view) were found out from the collected data, for both, direct laryngoscopy and video laryngoscopy and analyzed by Kappa Analysis.

Introduction



Objectives

Review of Literature

Basic Sciences

Methodology

Results

Discussion

Conclusion

Summary

Bibliography

Annexure-I

Annexure-II

Annexure-III

Annexure-IV

RESULTS

The present case series was conducted to compare the C MAC Videolaryngoscope with the standard Macintosh laryngoscope in providing glottic view for endotracheal intubation in patients with a simulated difficult airway.

60 patients aged between 18-60yrs, of either sex, belonging to ASA class I and II, scheduled to undergo elective surgeries under general anaesthesia, in whom endotracheal intubation was indicated, were included in this study.

Table 1: DEMOGRAPHIC DATA - AGE

AGE GROUP	NUMBER	PERCENTAGE
≤20	6	(10.0)
21-30	25	(41.7)
31-40	17	(28.4)
41-50	8	(13.3)
51-60	4	(6.6)
TOTAL	60	(100.0)

Table 2: DEMOGRAPHIC DATA - SEX

SEX OF PATIENT	NUMBER	PERCENTAGE
MALE	28	(46.7)
FEMALE	32	(53.3)
TOTAL	60	(100.0)

Table 3: GLOTTIC VIEW GRADING UPON DIRECT LARYNGOSCOPY

GLOTTIC VIEW	I	II	III	IV	TOTAL
No. Of patients (%)	---	14 (23.3)	39 (65)	7 (11.7)	60 (100.0)

It was observed that Grade I and II were 23.3% (14/60) and grade III and IV (RESTRICTED) in 76.7% (46/60)

Table 4: GLOTTIC VIEW GRADING UPON C-MAC VIDEOLARYNGOSCOPY

GLOTTIC VIEW	I	II	III	IV
No of patients	17 (28.4)	29 (48.3)	14 (23.3)	---

Table 5: IMPROVEMENT IN GLOTTIC VIEW (CL GRADE) WITH C-MAC

GRADES OF IMPROVEMENT	NUMBER OF CASES
SAME	20 (33.3%)
1 GRADE	26 (43.3%)
2 GRADES	13 (21.6%)
3 GRADES	1 (1.6%)

Table 6: EASE OF INTUBATION WITH CMAC

EASE OF INTUBATION	EASY (E)	DIFFICULT (D)	TOTAL
No of patients (%)	44 (73.3)	16 (26.7)	60 (100.0)

Table 7: EASE OF INTUBATION COMPARED WITH THE GLOTTIC VIEW BY C-MAC VIDEOLARYNGOSCOPY

C-MAC CL GRADE	D	E	TOTAL
I	0	17	17
II	7	22	29
III	9	5	14
IV	--	--	--

Chi square = 16.408

P < 0.001. Significant

Table 8: AGREEMENT BETWEEN TWO VIEWS – DIRECT AND C-MAC VIEW BY KAPPA STATISTICS

DIRECT GLOTTIC VIEW	C-MAC GLOTTIC VIEW				
	I	II	III	IV	TOTAL
I	0	0	0	0	0
II	7	7	0	0	14
III	9	18	12	0	39
IV	1	4	2	0	7
TOTAL	17	29	14	0	60

RELATIVE AGREEMENT	EXPECTED AGREEMENT-RANDOM AGREEMENT by kappa analysis	KAPPA QUOTIENT
47%	17.19%	0.1719

Good glottic view with **CMAC** is **77%** (17+29=46/60=77%) and in **Direct laryngoscopy** good glottic view is **23%** (0+14=14/60=23%).

The difference 54% (77-23) observed in these two proportions is found statistically significant when Z test for the difference between two proportions are applied.

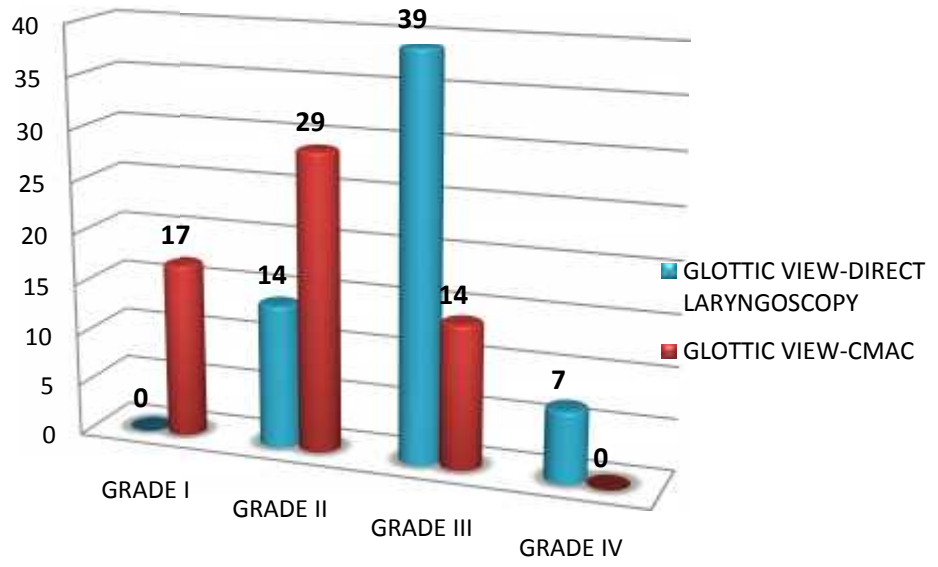
(Z=5.4 at P=0.001 Highly significant)

Kappa quotient values range from 1.0 (COMPLETE AGREEMENT) to

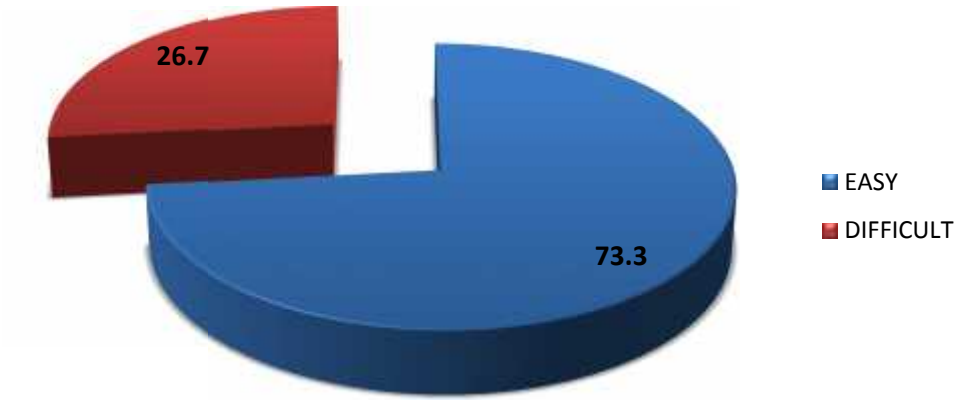
0.0(NO AGREEMENT).

Thus, as per kappa agreement analysis, it shows low agreement between the two devices used for laryngoscopy,

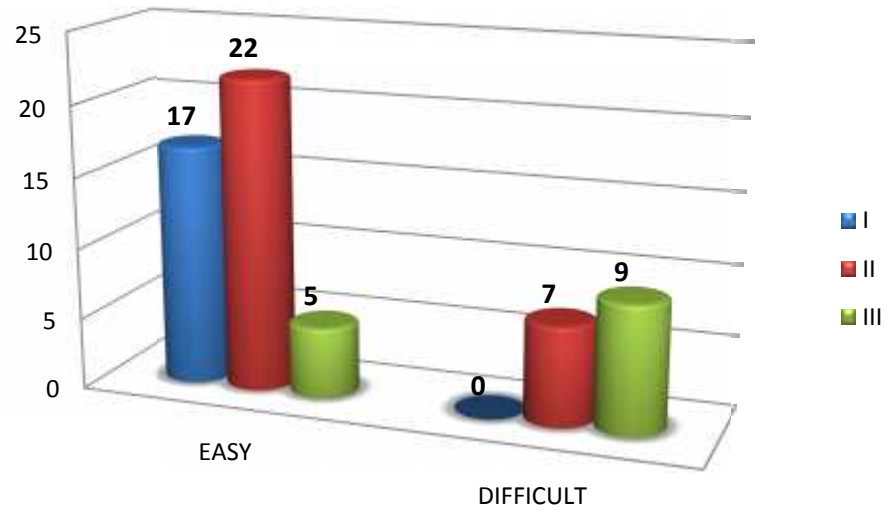
Graphs 1 :Comparison of Glottic View Obtained by Direct Laryngoscopy to that by C-MAC Videolaryngoscopy



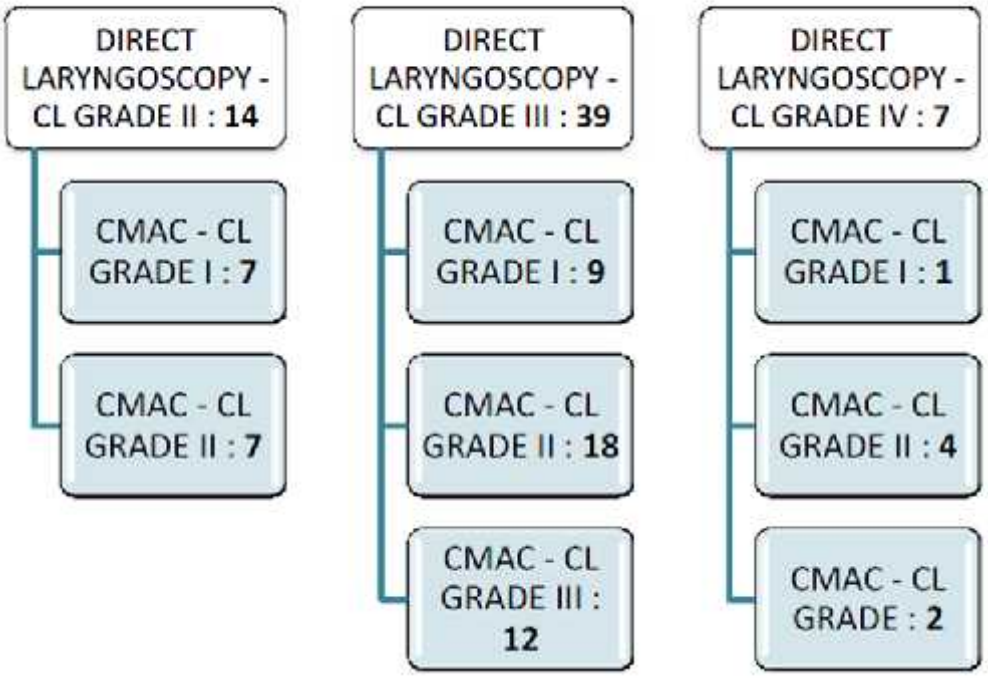
Graph 2 :Ease of Intubation with C-MAC



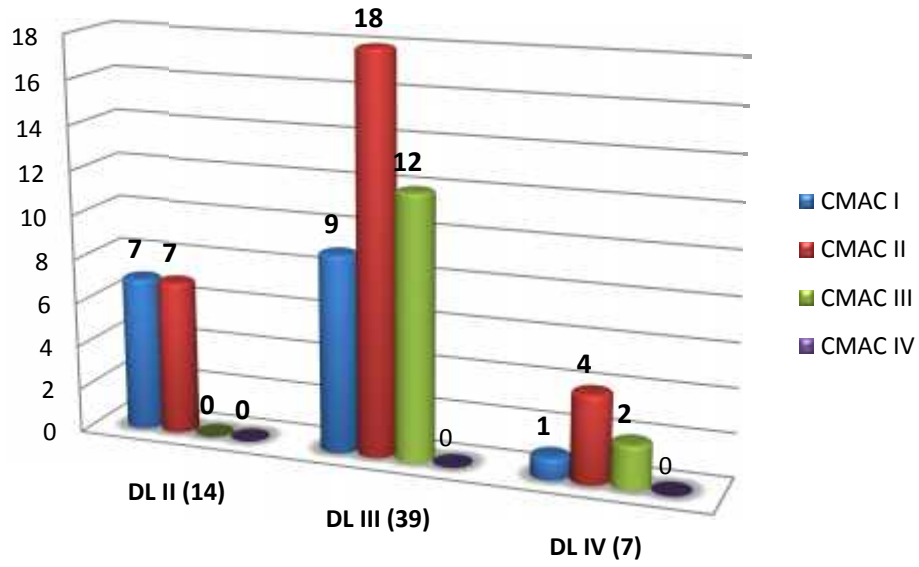
Graph 3 :Ease of intubation compared to glottic view by C-MAC



Graph 4. Improvement in glottic view with CMAC



Graph 5: Glottic View By C-MAC Compared To Glottic View By Direct Laryngoscopy



DISCUSSION

Difficult visualisation of the larynx (DVL) has been defined by the ASA task force as occurring when it is not possible to visualize any part of the vocal cords by conventional laryngoscopy[26.], as Cormack Lehane grade III and IV. Endotracheal intubation is a very commonly performed procedure, in the operating room and in other settings too, usually completed with ease. The incidence of DVL has been reported to be between 1.5 to 13%, that of difficult intubation to be 1 to 4% and failed intubation between 0.1 to 0.3%.[27.] A closed claim analysis has shown that the most common complication in such cases was hypoxia caused by inadequate ventilation and oxygenation. In 85% of these cases, the outcome was death or brain damage.[28]

A preplanned preinduction strategy includes the consideration of various interventions designed to facilitate intubation should a difficult airway occur. Noninvasive interventions intended to manage a difficult airway include, awake intubation, video-assisted laryngoscopy, intubating stylets or tube-changers, SGA for ventilation (*e.g.*, LMA, laryngeal tube), SGA for intubation (*e.g.*, ILMA), rigid laryngoscopic blades of varying design and size, fiberoptic-guided intubation, and lighted stylets or light wands. Meta-analyses of RCTs comparing video-assisted laryngoscopy with direct laryngoscopy in patients with predicted or simulated difficult airways report improved laryngeal views, a higher frequency of successful intubations, and a higher frequency of first attempt intubations with video-assisted laryngoscopy (Category A1-B evidence)[26.]

We conducted a study to evaluate the effectiveness of the C-MAC videolaryngoscope in comparison to the conventional Macintosh laryngoscope in the setting of a difficult airway. Since the videolaryngoscope is a newer device, it was

decided to use it in a simulated difficult scenario initially. A difficult airway was simulated in the patient by applying the rigid cervical collar prior to performing laryngoscopy. In order to avoid patient bias both the laryngoscopes were used sequentially in the same patient, after induction of general anaesthesia.

In our study, in the presence of a simulated difficult airway, restricted glottic view (CL Grade III & IV) was observed in 76.7% of patients with the conventional Macintosh laryngoscope, compared to 23.3% with CMAC, which was comparable to 68% CL grades III & IV with the cervical collar in situ in the study done by Komatsu.R et al.[29.]

76.6% of grade III & IV with direct laryngoscopy could be attributed to the fact that successful visualisation of larynx with direct laryngoscopy requires the optimum position of larynx along the line of sight. The presence of neck collar will reduce the mouth opening and restrict cervical spine flexion & extension also. With the use of CMAC, the camera lies closer to the tip of the blade, providing an indirect view of the larynx, and circumvents the problem of achieving a direct line of sight as shown in only 23.3% cases having CL grade III & IV.

In our study it was observed that glottic view improved with the use of CMAC Videolaryngoscope compared to the Macintosh laryngoscope. View improved by 1 CL grade in 43.3%, by 2 CL grades in 21.6% and by 3 CL grades in 1.6%. This is comparable to the study done by Piepho.T et al to evaluate the use of CMAC videolaryngoscope in patients who had a poor glottic view on Macintosh direct laryngoscopy, it was found that glottic view improved in 94% of the patients. In 31% cases by 1 CL grade, 62% cases improved by 2 CL grades and in 2% cases improvement was by 3 CL grades.[14.]

Hofstetter.C et al conducted a study comparing conventional laryngoscopy with Macintosh videolaryngoscopy, and observed a significant improvement in the laryngeal view[30.]

Initial studies for CMAC and other such videolaryngoscopes were conducted on manikins, with and without a simulated difficult airway. In one such study done by Saito.T et al comparing the airway scope and Coopdeck videolaryngoscope portable VLP-100, the airway scope was associated with better glottic views and higher rate of successful tracheal intubations.[11.]

Though there is improvement in the laryngeal views, videolaryngoscopes with acutely curved blades (Glidescope) still carry the risk of failure of intubation, because of the difficulty with alignment of the endotracheal tube with the oropharyngeal axis. In this regard, CMAC has a definitive advantage over the other videolaryngoscopes, as the CMAC blades resemble a standard Macintosh blade. Thus the intubation would be similar to that with direct laryngoscope.

In a randomised clinical trial comparing direct Macintosh laryngoscope to the CMAC videolaryngoscope, in groups matched for predictors of difficult airway, Aziz.M.F et al observed that CL grade III & IV were in 6.7% for CMAC group and 19% in direct Macintosh group.[32.] The predictors of difficult airway included were reduced cervical movements, Mallampatti class III or IV, reduced mouth opening and a history of difficult direct laryngoscopy. However, presence of difficult airway predictors preoperatively does not actually mean a difficulty in intubation. Secondly, groups were matched for few of the predictors of difficulty. There can be many more causes and predictors for difficult airway that could have been present in either of groups. In our study, to avoid this bias and the basic anatomical differences of airway

from person to person, the glottic views were assessed sequentially in the same patient with both the devices.

In another study by Noppens.R et al, comparing the Macintosh laryngoscopy with the CMAC in the emergency department, in patients with atleast one predictor of difficult airway, the visualisation of the glottis using Cormack Lehane grading with Macintosh laryngoscopy was frequently graded as difficult (20%, CL III & IV) compared to CMAC (7%, CL III & IV).[33.]

Another comparison between the usefulness of the CMAC and Conventional Macintosh laryngoscopy in the emergency department done by Sakles.J et al, found that for patients with restricted cervical mobility, the CMAC was successful for intubation in 82 of 83 cases(98.8%) where as direct laryngoscope was ultimately successful in 81.1% of the patients.[34]

These data appear to validate the idea that cervical immobility hinders the ability to create a direct line of sight to laryngeal inlet with a conventional direct laryngoscopy.[35.] Because the C-MAC obtains a view of the glottis indirectly with the help of a micro videocamera, the view would be better. Thus providing a benefit in cervical spine immobilised patients with blunt trauma.

Byhahn.C et al evaluated the CMAC Videolaryngoscope in simulated difficult airway cases, and found that ,upon application of the collar, poor glottic view was seen in 70% cases with direct Macintosh laryngoscopy and 14% with the C-MAC.[13.] Observations of our study were comparable to these, being 76.6% poor view with Macintosh laryngoscope and 23.3% with C-MAC.

In our study, the intubation was attempted with the cervical collar in situ, with the C-MAC Videolaryngoscope. The intubation experience was subjectively assessed as easy (E) or difficult (D). The intubation was found to be easy (E) in 73.3% cases.

Of the ones graded as difficult, majority of the patients belonged to a higher Cormack Lehane garding. (CL III, by C-MAC in 9 cases of the 16 categorised as difficult) Thus reinforcing the fact that a good glottic view is paramount in successful intubation.

The difficulty encountered in intubation despite a good glottic view could possibly be due to the unfavourable anatomical axis that forced the tip of the tube downwards to the esophageal inlet and the poor manoeuvrability of the tube due to limited oropharyngeal space, caused by limited mouth opening with the cervical collar in place.

A study by Kaplan.MB et al, analysing the improvement in laryngoscopic view by videolaryngoscopy with a Macintosh blade in 865 unselected patients, reported a failure rate of only 0.3%.[36.]

In our study, the presence of the cervical collar made mouth opening difficult, significantly limiting the operator's ability to move the tube in a sagital plane, so as to direct the tip towards the glottic opening. This fact was likely to have had a major impact on the relatively high rate of difficult intubations in our study.

Successful intubation in such situation can be achieved by use of adjuncts like gum elastic bougie, intubating stylets, BURP manoeuvre, which has shown to improve the Cormack Lehane grades and the POGO scores.

No procedure related complication, such as obvious dental, lip or airway injury was observed in any patient. In all the cases, intubation was successfully performed with the cervical collar in situ. However, specific causes for difficulty in intubation in each of the cases was not studied.

Cervical immobilisation is a routine procedure in trauma patients, particularly the cervical spine injuries, quite a few of whom require endotracheal intubation in the emergency department prior to completion of the diagnostic procedures.[37.] Reduced mouth opening and restricted cervical spine movement by the collar also simulates a difficult airway situation that could be encountered in the operation theatre. With the technique of videolaryngoscopy making its way into the difficult airway algorithm (ASA 2013), it is essential to have sufficient training in using one, both for normal and difficult airways. The C-MAC videolaryngoscope, with its original Macintosh blade design with additional advantages, would probably have a smaller learning curve compared to the other video devices with altogether different designing.

LIMITATIONS OF THE STUDY

The Cormack Lehane grading system was proposed with reference to direct laryngoscopy with a Macintosh blade.

With the use of vieolaryngoscope, both the angle and the direction of vision are completely different even with the same type of blade. While the best glottic view obtained under direct laryngoscopy also quantifies the best glottic exposure in terms of anatomy and intubating conditions, it remains a mere view with a Macintosh videolaryngoscope. Therefore Cormack Lehane grading system is ill suited to predict endotracheal intubation difficulties with view obtained by videolaryngoscope.

SCOPE FOR FURTHER STUDIES

- Evaluation of the C-MAC videolaryngoscope in situations of difficult airway, in the operation theatre as well as the ICU setting.
- Comparison of the conventional Macintosh laryngoscopy to the other videolaryngoscopes as well as between the video devices.

CONCLUSION

From the present study we concluded that:

1. C-MAC videolaryngoscope, a new video device with original Maintosh blade design improved the glottic view in comparison to the conventional Macintosh direct laryngoscopy, for accomplishing endotracheal intubation in a simulated difficult airway setting.

2. However, in some cases, endotracheal intubation was difficult with the C-MAC with collar in situ despite a good glottic view.

SUMMARY

Difficult airway may be encountered in both anticipated and unanticipated circumstances. Difficult laryngoscopy and failed intubation result in severe morbidity related to anaesthesia. This has forced the anaesthesiologists to persue their interest in developing newer gadgets to facilitate successful and safe endotracheal intubation. One such gadget is the C-MAC videolaryngoscope, one of the many video assisted devices available.

The present study was conducted to compare the usefulness of C-MAC videolaryngoscope with conventional direct Macintosh laryngoscope to provide glottic view, for endotracheal intubation in a simulated difficult airway. 60 patients belonging to ASA I and II, of either sex, between 18-60 years, undergoing elective surgery and requiring endotracheal intubation were included. The incidence of difficult laryngoscopy with Macintosh was in 76.7% cases compared 23.3% with C-MAC videolaryngoscope in presence of a simulated difficult airway with a cervical collar. With the use of CMAC Videolaryngoscope compared to the Macintosh laryngoscope, glottic view improved by 3 CL grades in 1 patient(1.6%), by 2 CL grades in 13 patients(21.6%) and by 1 CL grade in 26(43.3%) of the patients. Thus, C-MAC videolaryngoscope significantly improved restricted glottic view when compared with Macintosh laryngoscope. Intubation with C-MAC with collar in situ were found to be easy (E) in 44 cases (73.3%). In some cases, intubation was difficult despite a good glottic view.

In conclusion, C-MAC videolaryngoscope significantly improved the glottic views in difficult laryngoscopy when compared to conventional Macintosh blade, for accomplishing endotracheal intubation.

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ANNEXURE - I

CONSENT FOR PARTICIPATION IN RESEARCH STUDY

Mr/Mrs/Miss. _____ we are requesting you to enroll yourself in study conducted by J.N. Medical College, Belgaum under KLE University, Belgaum.

Respected Sir/Madam we request you to enroll yourself to participate in our study as you are eligible for participating in the study. During the study you will be asked some questions regarding your present complaint and you are supposed to answer to the best of your knowledge.

Your participation in research is voluntary. Your decision whether or not to participate in the study will not affect your relationship with J.N. Medical College. If you decide to participate you are free to withdraw at any time.

The purpose of research is **"COMPARISON OF THE GLOTTIC VIEW OBTAINED BY THE C-MAC VIDEOLARYNGOSCOPE AND DIRECT LARYNGOSCOPY IN PATIENTS WITH A SIMULATED DIFFICULT AIRWAY "**

Procedure Involved:

If you agree to enroll yourself in my study, I will ask your present, past and family history. Then you will be clinically examined in detail and routine investigations like Hb, TC, DC, Platelet count, RBS, Blood urea, Serum creatinine, will be done. During anaesthesia, a cervical immobilization collar will be applied and then intubation will be attempted.

Risks:

The risks associated are potential difficulty at laryngoscopy and intubation.

Benefits:

The benefits of taking part in this research are that, video assisted laryngoscopes reduce the forces to maxillary incisors, give better visualization, easier use and faster intubation time.

Voluntary Participation/Withdrawal:

Taking part in the study is voluntary. You may choose not to enroll yourself in this study. Your decision will not change present or future health care services offered to you at K.L.E.S hospital.

Alternatives:

Even if you decline the participation in the study, you will get the routine line of management.

Privacy and Confidentiality:

The only people to know that you are a research subject are members of the research team. No information about you or information provided by you during the research will be disclosed to other without your written permission except:

1. In emergency to protect your rights and welfare.
2. If required by law.

Authorization to Publish Results:

When the results of the research are published or discussed, in a conference, no information will be displayed that would disclose your identity. Any information that is obtained in connection with this study and that can be identified with you will remain confidential.

Financial Incentives for participation:

No financial incentives are being offered to enrolled patients. It is purely being done with the idea of research and all the cost of the study will be borne by the investigator.

Compensation:

In the event of injury related to the study, treatment will be made available through KLES Hospital & MRC, Belgaum. There is no compensation or payment for such medical treatment by law.

Questions:

In case you have any questions related to the study, in future or in case of study related injury or illness, you can contact Ph No. 0831-2473777 Extn 1292 Dept of Anaesthesiology, KLES Hospital and MRC, Belgaum.

Consent for participation in research trial

I, _____ voluntarily agree for the participation as a subject of study. By signing this consent form I am not giving up any of my legal rights, I may withdraw from the study anytime. I am signing the consent form after having read or been read for me in vernacular language, including the risks and the benefits and having all my questions answered.

Subject Name : _____

Signature or the Left Thumb Print of Subject : _____

Date :

Witness Name : _____ Signature: _____ Date :

Investigators Name: _____ Signature: _____ Date :

Place : _____

ANNEXURE - II

PROFORMA

Title: Comparison of glottic view obtained by the C-MAC Video laryngoscope and direct laryngoscope in patients with a simulated difficult airway-A 1 year hospital based case series study.

Patients Name	:	I.P No.	:
Age	:	Weight	:
Height	:	Gender	:
Date of operation	:	Occupation	:
Address	:	Anaesthesiologist:	

Preanaesthetic evaluation

Chief complaints

Past History

- HTN / DM/ IHD / Arrhythmia / LVH / Valvular heart disease
- H/o uncontrolled hypertension/diabetes mellitus
- H/o previous surgery/(s) where airway difficulty was encountered.

Family History

General physical examination

Weight (Kg)	:	Temperature (^{0}F)	:	Pallor	:
Cyanosis	:	Pedal oedema	:	Clubbing	:
PR	:	BP	:	RR	:

Systemic examination:

RS	:	CNS	:
CVS	:	GIT	:

Airway Assessment - MALLAMPATI GRADE-

Spine-

Investigations

Hb%	:	Urine routine	:
Blood urea	:	Serum creatinine:	
FBS	:	CXR	:

Diagnosis

Proposed surgery

Preoperative physical status ASA Grade I II III IV V

- **Inclusion Criteria**:

- 1. ASA physical status 1 and 2.
- 2. Age between 18 to 60 years.

- **Exclusion Criteria** :

- 1.Patient refusal
- 2.Patient with known/anticipated difficult airway
- 3. ASA grade 3 and 4.
- 4. Patients with potential full stomach.
- 5. Pregnant and lactating females.

a) **Methodology:**

After ethical committee clearance and written informed consent, patients (ASA I-II) of either gender, undergoing elective surgeries in the supine position, under general anaesthesia in whom endotracheal intubation was indicated, were enrolled in the study.

Pre anaesthetic evaluation and routine investigations of the patient was done.
An IV line was secured.
Standard monitoring devices were attached before induction of anaesthesia, including non-invasive arterial blood pressure, heart rate, and oxygen saturation.

After 5min of pre oxygenation with a facemask. Anaesthesia was given with Premedication GLYCOPYRROLATE 0.005mg/kg, MIDAZOLAM 0.05mg/kg, PENTAZOCINE 0.5mg/kg, Induction with inj THIOPENTONE 5 mg/kg and SUCCINYL CHOLINE 2mg/kg**.** A rigid cervical immobilisation collar was applied.

METHOD OF LARYNGOSCOPY

Direct laryngoscopy (Macintosh scope) was performed with the neck collar in situ, (without applying external laryngeal pressure

(BURP Maneuver). The best obtained CORMACK-LEHANE (C/L) view, modified by Yentis And Lee was identified.

Immediately, laryngoscopy was performed using the C-MAC Videolaryngoscope.

A second anaesthesiologist, (blinded to the laryngeal view obtained under direct laryngoscopy), graded the glottic view, (CORMACK-LEHANE view) on the video monitor, using the C-MAC Video laryngoscope, without external laryngeal pressure. The position of the device was adjusted to have the glottis in the centre of the screen. The two laryngoscopies were performed immediately one after the other, each taking a maximum time of 30-35 seconds.

. Intubation was carried out with the CMAC Videolaryngoscope, in presence of the collar The anaesthesiologist graded the subjective experience of intubation as easy (E) or difficult (D). Any situation leading to external laryngeal manipulation, more than one attempt, use of bougie etc were all categorised as 'D'. In the situation of difficulty namely inability to intubate in one attempt or inability to maintain oxygen saturation >90% with mask the neck collar was removed immediately, and patient was intubated by the conventional standard technique.

Correct tube position, and subsequently,successful ventilation, were assessed with capnography and bilateral chest auscultation.

Oxygen saturation (SpO_2), mean arterial blood pressure, and heart rate were recorded at baseline, after oxygen administration, and after laryngoscopy.

Anaesthesia was continued as per individual case requirement, maintained with non depolarising muscle relaxants, according to standard protocol.

Observations:

C/L GRADING	DIRECT SCOPY	VIDEO SCOPY

INTUBATION WITH C-MAC	EASY (E)	DIFFICULT (D)
TICK APPLICABLE		

	MAP	SPO2	HR
BASELINE			
AFTER O2 ADM			
AFTER SCOPY			

- SIGNATURE OF THE ANAESTHESIOLOGIST - _____
- SIGNATURE OF THE WITTNESS - _____
- SIGNATURE OF THE PRINCIPAL INVESTIGATOR - _____

ANNEXURE - IV

MASTER CHART

S/N	DATE	AGE	SEX	IP No.	MP Class	GLOTTIC VIEW		EASE OF INTUBATION
						DIRECT	CMAC	
1	06.01.12	43	M	481132	II	III	II	E
2	08.01.12	60	M	475832	III	IV	II	D
3	08.01.12	41	M	481656	I	III	II	E
4	11.01.12	20	F	481441	I	III	III	D
5	22.01.12	60	F	480434	II	III	III	D
6	03.02.12	20	F	481202	I	II	II	E
7	03.02.12	24	M	482614	I	III	III	D
8	07.02.12	26	F	481794	I	III	II	D
9	13.02.12	20	F	482484	I	III	III	E
10	13.02.12	52	F	482545	II	III	III	E
11	17.02.12	39	F	483106	I	IV	II	E
12	17.02.12	28	M	483538	I	IV	III	D
13	19.02.12	38	M	483116	II	III	III	D
14	06.03.12	34	M	482691	I	IV	II	E
15	08.03.12	55	F	483458	II	III	II	E
16	12.03.12	25	M	483522	I	IV	0	E
17	18.03.12	46	M	484128	II	IV	II	E
18	18.03.12	25	F	484168	I	IV	III	D
19	24.03.12	22	M	485962	II	III	II	E
20	28.03.12	45	F	486012	II	III	II	D
21	30.03.12	36	M	486771	I	II	I	E
22	04.04.12	23	F	487506	II	III	III	E
23	06.04.12	24	M	488991	II	III	II	E
24	06.04.12	20	F	490895	II	III	II	D
25	10.04.12	45	M	491553	II	II	II	E
26	17.04.12	30	F	491858	I	III	III	D
27	22.04.12	48	F	493403	II	III	II	E
28	28.04.12	20	F	494711	II	III	III	E
29	06.05.12	49	F	495301	II	III	III	E
30	13.05.12	28	M	495036	I	III	II	E
31	17.05.12	20	F	495036	II	II	II	E
32	06.06.12	29	F	499658	II	III	II	E
33	13.06.12	28	F	499858	II	III	II	E
34	20.06.12	21	F	506110	II	III	III	D
35	22.06.12	27	M	505961	II	III	I	E

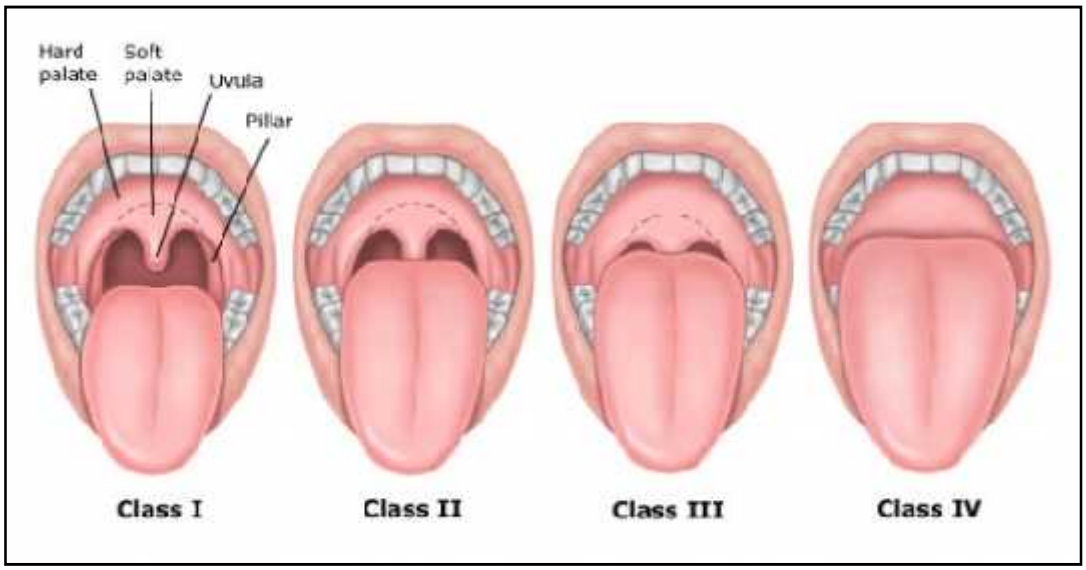
36	30.06.12	40	M	506341	II	III	I	E
37	04.07.12	30	M	508242	I	II	II	E
38	06.07.12	33	M	513122	II	III	I	E
39	12.07.12	29	F	516642	I	III	II	D
40	18.07.12	31	F	523114	II	II	I	E
41	22.07.12	26	M	526651	II	III	I	E
42	28.07.12	42	F	532214	I	III	II	D
43	03.08.12	25	F	535128	II	II	II	E
44	06.08.12	28	M	535844	I	III	I	E
45	14.08.12	33	F	541121	II	III	II	D
46	26.08.12	40	M	548644	II	II	II	E
47	02.09.12	33	M	551123	III	III	I	E
48	09.09.12	28	F	554186	II	III	II	E
49	15.09.12	31	M	558673	III	III	I	E
50	22.09.12	26	F	561212	II	II	I	E
51	30.09.12	31	M	564324	II	II	I	E
52	07.10.12	40	F	567122	II	III	II	E
53	14.10.12	31	F	569757	II	II	I	E
54	14.10.12	22	M	569769	I	III	I	E
55	17.10.12	30	F	571121	II	II	I	E
56	22.10.12	36	M	576124	II	III	II	E
57	26.10.12	34	M	577126	II	III	III	D
58	30.10.12	21	M	578128	I	II	II	E
59	01.12.12	34	F	581232	II	III	I	E
60	04.12.12	26	F	581345	II	II	I	E

ANNEXURE - IV

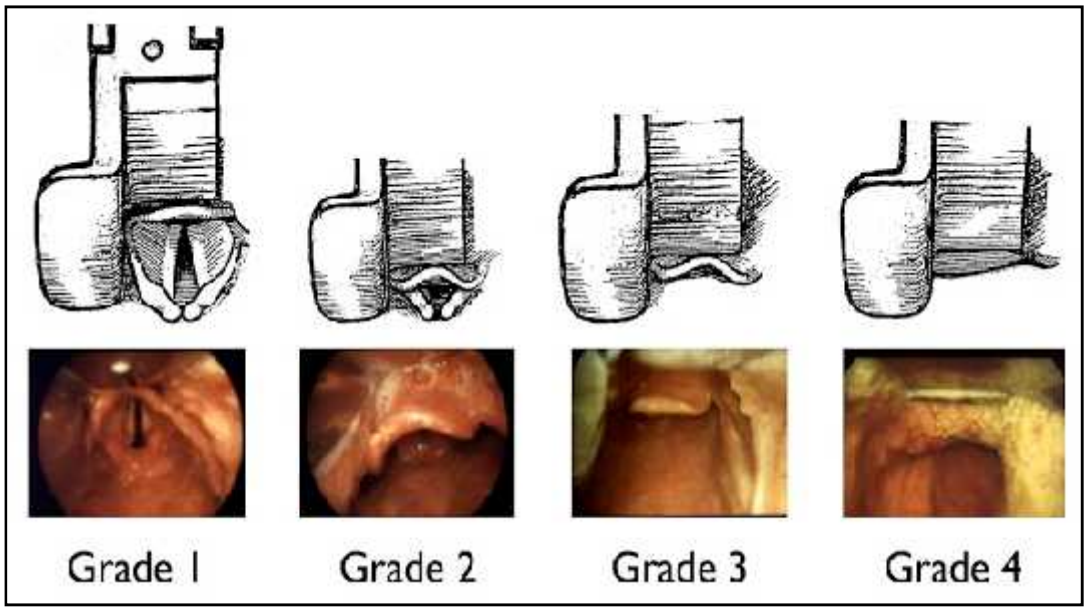
KEY TO MASTER CHART

D	–Difficult
E	– Easy
F	– Female
Glottic View (CL)	– Cormack Lehane Grading
M	– Male
MP Class	– Modified Mallampati Class

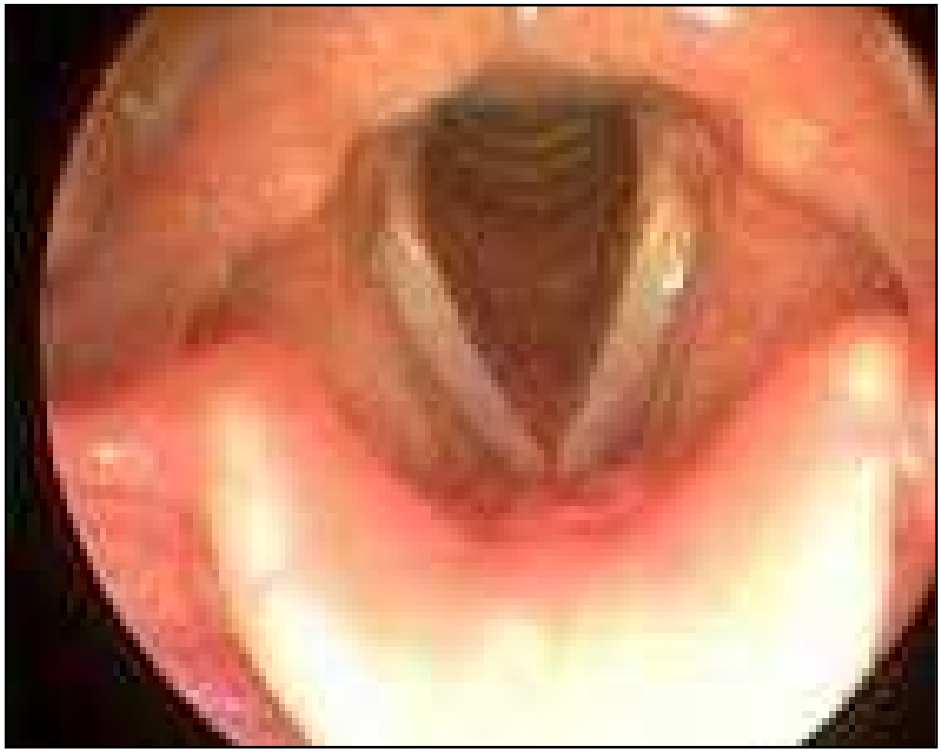
ANNEXURE - III -PHOTOGRAPHS



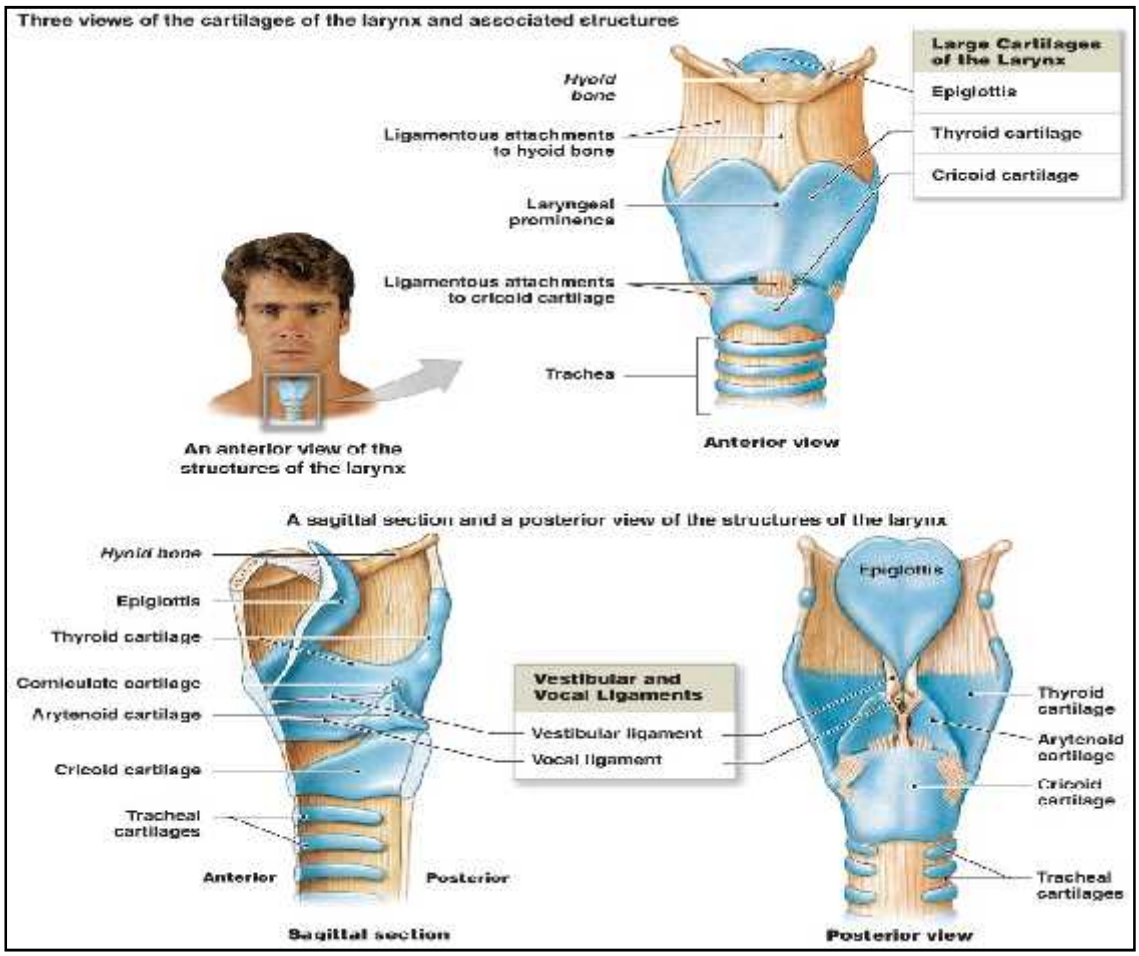
Photograph 1: Modified Mallampati Grading of the oropharynx

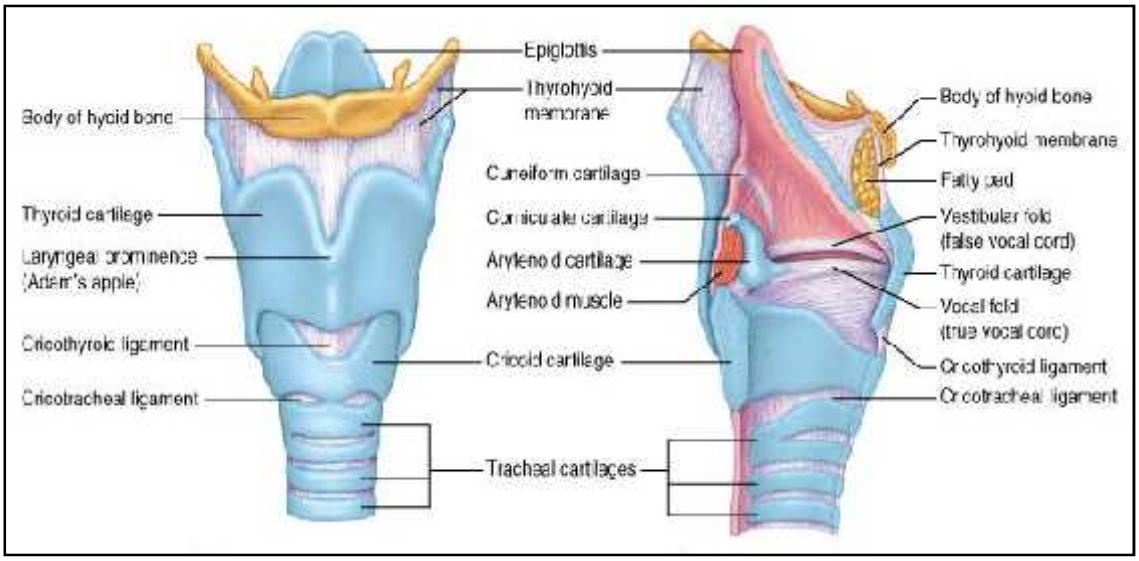


Photograph 2: Cormack and Lehane Grading of the glottis

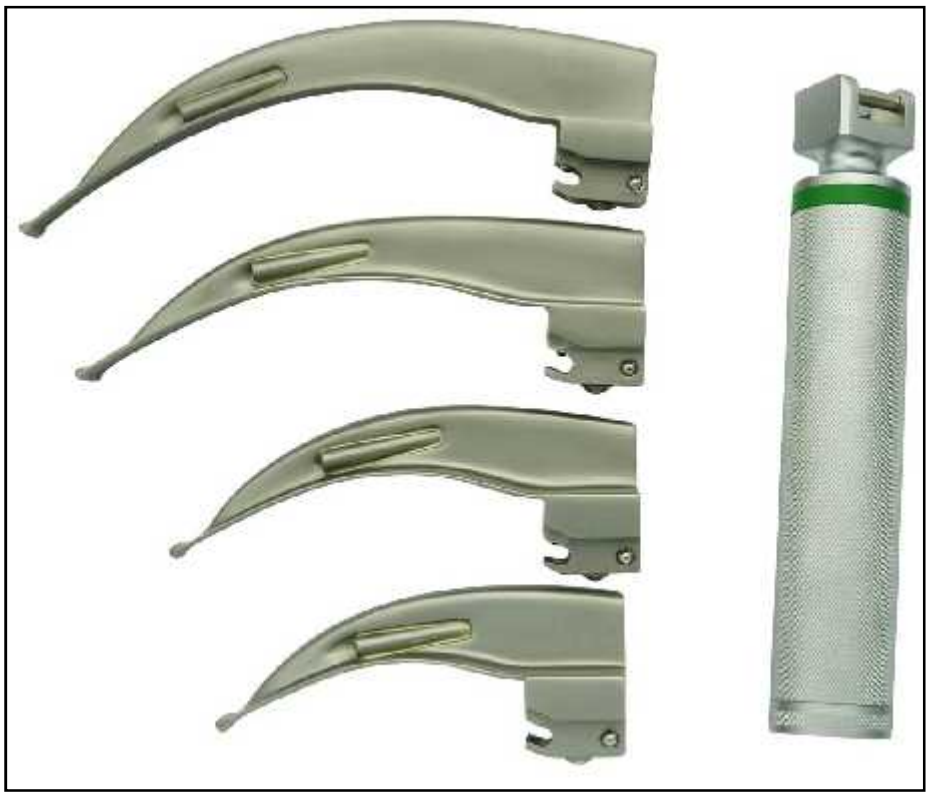


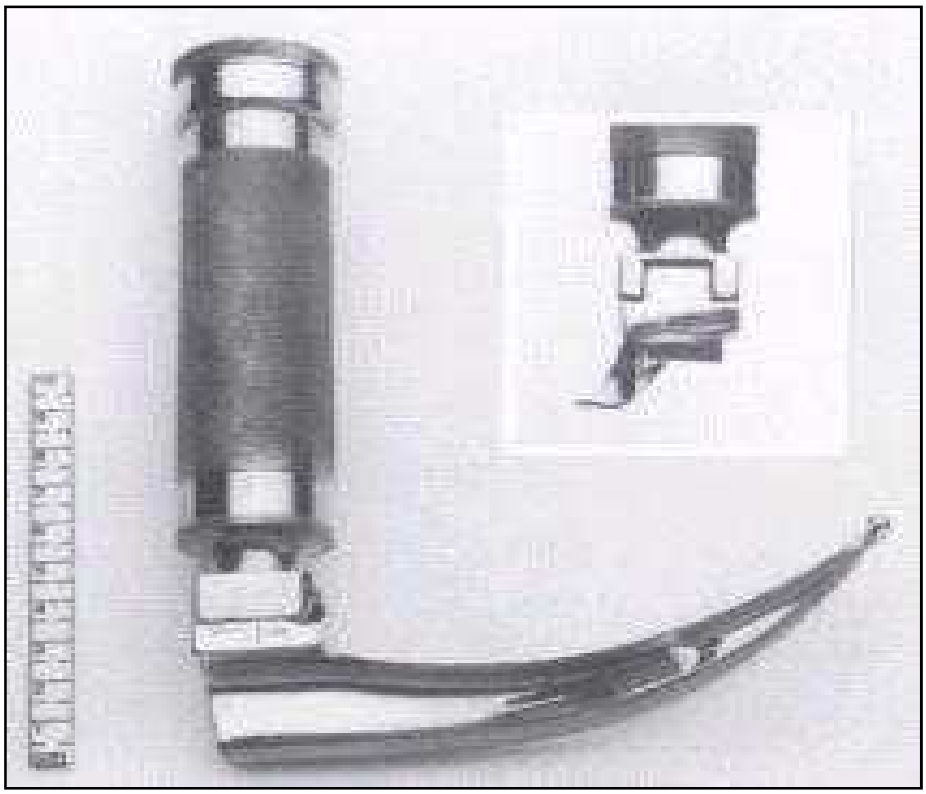
Photograph 3: Vocal Cords at Laryngoscopy



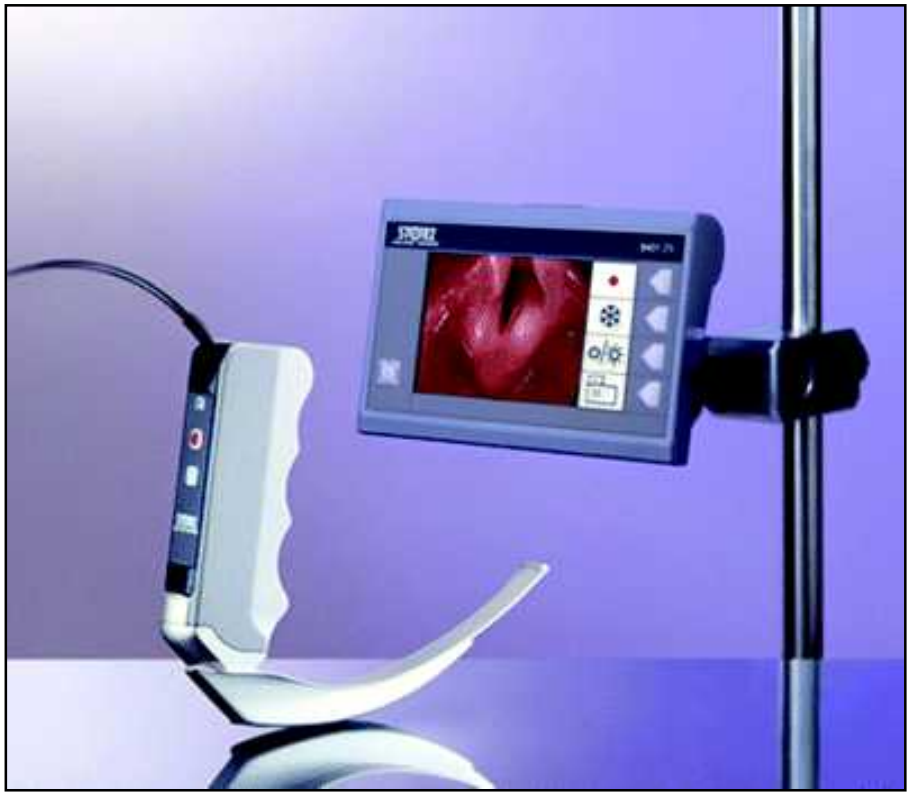


Photograph 4& 5: Larynx





Photograph 6 & 7: Macintosh laryngoscope



Photograph 8: C-MAC Videolaryngoscope

Photograph 9: Various Videolaryngoscopes

S/N	DATE	AGE	SEX	IP No.	MP Class	GLOTTIC VIEW		EASE OF INTUBATION
						DIRECT	CMAC	
1	06.01.12	43	M	481132	II	III	II	E
2	08.01.12	60	M	475832	III	IV	II	D
3	08.01.12	41	M	481656	I	III	II	E
4	11.01.12	20	F	481441	I	III	III	D
5	22.01.12	60	F	480434	II	III	III	D
6	03.02.12	20	F	481202	I	II	II	E
7	03.02.12	24	M	482614	I	III	III	D
8	07.02.12	26	F	481794	I	III	II	D
9	13.02.12	20	F	482484	I	III	III	E
10	13.02.12	52	F	482545	II	III	III	E
11	17.02.12	39	F	483106	I	IV	II	E
12	17.02.12	28	M	483538	I	IV	III	D
13	19.02.12	38	M	483116	II	III	III	D
14	06.03.12	34	M	482691	I	IV	II	E
15	08.03.12	55	F	483458	II	III	II	E
16	12.03.12	25	M	483522	I	IV	0	E
17	18.03.12	46	M	484128	II	IV	II	E
18	18.03.12	25	F	484168	I	IV	III	D
19	24.03.12	22	M	485962	II	III	II	E
20	28.03.12	45	F	486012	II	III	II	D
21	30.03.12	36	M	486771	I	II	I	E
22	04.04.12	23	F	487506	II	III	III	E
23	06.04.12	24	M	488991	II	III	II	E
24	06.04.12	20	F	490895	II	III	II	D
25	10.04.12	45	M	491553	II	II	II	E
26	17.04.12	30	F	491858	I	III	III	D
27	22.04.12	48	F	493403	II	III	II	E
28	28.04.12	20	F	494711	II	III	III	E
29	06.05.12	49	F	495301	II	III	III	E
30	13.05.12	28	M	495036	I	III	II	E
31	17.05.12	20	F	495036	II	II	II	E
32	06.06.12	29	F	499658	II	III	II	E
33	13.06.12	28	F	499858	II	III	II	E
34	20.06.12	21	F	506110	II	III	III	D
35	22.06.12	27	M	505961	II	III	I	E
36	30.06.12	40	M	506341	II	III	I	E
37	04.07.12	30	M	508242	I	II	II	E
38	06.07.12	33	M	513122	II	III	I	E
39	12.07.12	29	F	516642	I	III	II	D
40	18.07.12	31	F	523114	II	II	I	E
41	22.07.12	26	M	526651	II	III	I	E
42	28.07.12	42	F	532214	I	III	II	D

S/N	DATE	AGE	SEX	IP No.	MP Class	GLOTTIC VIEW		EASE OF INTUBATION
						DIRECT	CMAC	
43	03.08.12	25	F	535128	II	II	II	E
44	06.08.12	28	M	535844	I	III	I	E
45	14.08.12	33	F	541121	II	III	II	D
46	26.08.12	40	M	548644	II	II	II	E
47	02.09.12	33	M	551123	III	III	I	E
48	09.09.12	28	F	554186	II	III	II	E
49	15.09.12	31	M	558673	III	III	I	E
50	22.09.12	26	F	561212	II	II	I	E
51	30.09.12	31	M	564324	II	II	I	E
52	07.10.12	40	F	567122	II	III	II	E
53	14.10.12	31	F	569757	II	II	I	E
54	14.10.12	22	M	569769	I	III	I	E
55	17.10.12	30	F	571121	II	II	I	E
56	22.10.12	36	M	576124	II	III	II	E
57	26.10.12	34	M	577126	II	III	III	D
58	30.10.12	21	M	578128	I	II	II	E
59	01.12.12	34	F	581232	II	III	I	E
60	04.12.12	26	F	581345	II	II	I	E