“COMPARISON OF EASE OF TRACHEAL INTUBATION USING INTUBATING VIDEO-STYLET WITH C-MAC VIDEO LARYNGOSCOPE: A ONE YEAR RANDOMISED CLINICAL TRIAL”

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ENDORSEMENT

This is to certify that the dissertation entitled **"COMPARISON OF EASE OF TRACHEAL INTUBATION USING INTUBATING VIDEO-STYLET WITH C-MAC VIDEO LARYNGOSCOPE": A ONE YEAR RANDOMISED CLINICAL TRIAL"** is a bonafide research work done by **(REG NO. BA0119004).**

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ACCEPTANCE LETTER

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ABBREVIATIONS

ASA	-	American Society of Anesthesiology
ADS	-	Airway Difficulty score
CL	-	Cormack Lehane
CMOS	-	Complementary metaloxide semiconductor
cms	-	Centimeters
ECG	-	Electrocardiogram
ETT	-	Endotracheal tube
I.V	-	Intravenous
EtCO2	-	End tidal carbon dioxide concentration
ICU	-	Intensive care unit
IDS	-	Intubation Difficulty score
LED	-	Liquid electronic display
LCD	-	Liquid crystal display
min	-	Minute
POGO	-	Percentage of glottic opening
SD	-	Standard deviation
VL	-	Videolaryngoscope

ABSTRACT

TITLE:"**COMPARISON OF EASE OF TRACHEAL INTUBATION USING INTUBATING VIDEO-STYLET WITH C-MAC VIDEO LARYNGOSCOPE: A ONE YEAR RANDOMISED CLINICAL TRIAL**"

Background:

Endotracheal intubation is gold standard to secure an airway and it can be achieved with the aid of conventional Macintosh laryngoscope, videolaryngoscope and fibre-optic devices. The Video-stylet, with a distinct advantage of reduced hemodynamic stressor response, not requiring oro-laryngeal alignment and real-time indirect visualization of the glottis is a novice device for intubation. Evaluation of its efficacy would further enhance its incorporation in regular anaesthesia practice.

Objective:

Our objective is comparing the ease with which tracheal intubation can be performed using intubating video stylet with C-MAC videolaryngoscope using the Intubation Difficulty Score, and to measure the time taken to successfully intubate trachea, stress response and incidence of complications.

Methods:

Sixty patients aged between 18 years to 60 years with ASA physical status I and II, all of whom have satisfied the inclusion criteria were recruited for this prospective study and they were randomized equally (30 patients each) into Group A (C-MAC group) and Group B (Video-stylet group). Group A patient were intubated using C-MAC videolaryngoscope whereas patients in Group B were intubated with Video-stylet after induction of general anaesthesia. Primary and secondary outcomes were evaluated during the endotracheal intubation.

Results:

Gender distribution, age distribution [Mean - Group A (C-MAC) - 38.03 years, Group B (VS) 39.43 years], BMI [Group A (C-MAC) - 22.8, Group B (VS) - 23.48 kg/m^2] were comparable in both groups. ADS [Group A (C-MAC) -7.93, Group B (VS) - 7.47] was comparable as well. IDS between two groups suggested statistically superior results with the VS group than C-mac group (0.77 vs 1.73, $p<0.0001$). The mean time for intubation in Group A (C-MAC) was 25.07(±1.66) seconds and in Group B (VS) was 22.07(±1.87) seconds. The hemodynamic stress response (HR, SBP, DBP, MAP) to intubation with Group B (VS) was comparatively lower when compared to Group A (C-MAC).

Conclusion:

Video-stylet can be considered as a practical option for endotracheal intubation with its clear cut advantages in terms of simplicity of intubation and the duration required for intubation. Hence it has the propensity to be a valuable substitute to conventional laryngoscopy in normal adult airway.

Key words: video-stylet, C-MAC videolaryngoscope

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INTRODUCTION

Airway management is of paramount importance to anaesthesiologists in clinical practice. Securing airway of a patient can range from very easy to most difficult in the broad spectrum of airway management. Endotracheal intubation is the gold standard for airway management. Failure to secure an airway leading to morbidity remains most dreadful complication in clinical anaesthesiology practice[1].

Through the years newer modalities as well as interventions have come into existence to make tracheal intubations easier to perform in perioperative settings. The newer technologies being more superior to conventional laryngoscopy resulting in lesser trauma, reduced hemodynamic response, and better visualization of airway anatomy.

It is noticed that the best chance to safely intubate a patient is the first attempt by an anaesthesiologist. Failure to do so will result in complications which might lead to significant morbidity[2]. Also, one third of cases for tracheal intubations during routine general anaesthesia practice come with unanticipated difficult airway. So such scenarios have contemplated the modern anaesthesiologists to develop novel devices to facilitate endotracheal intubation. Such devices include fiber-optic bronchoscope (flexible), optical stylet (rigid), lightwand, and several other types of videolaryngoscopes.

In the latest guidelines for clinical practice, the ASA advocates use of videolaryngoscopy which should and can be contemplated both as a preliminary approach to endotracheal placement of tube (awake or subsequent to initiation of general anaesthesia) and in scenarios where mask ventilation was achieved but resulted in failed endotracheal intubation[3-6].

To circumvent the difficult airway situation that can characteristically ensue following direct laryngoscopy, various airway devices were designed over the years.

A device which is similar to conventional Macintosh laryngoscope but with a added feature of improved oro-pharyngeal and laryngeal view being transmitted to an LED screen through a camera fitted to the laryngoscope blade is the C-Mac video-laryngoscope. It offers continuous live image(video) of the oropharynx and larynx as we pass the videolaryngoscope into the mouth. But it has few limitations of its use, being the inability to co-ordinate hand and eye movements at ease, fogging of the camera distorting the image, the endotracheal tube sliding posteriorly to esophagus and difficult to manoeuvre it into the trachea which might increase the time taken for intubation thereby increasing the hemodynamic response to laryngoscopy.[7]

Video stylet is a recently introduced intubation device which has a rigid optical fibre laden stylet which is malleable to resemble the contour of the oropharynx. The endotracheal tube is to be railroaded on the stylet. The tip has the light source which gets transmitted to the LED screen attached to the stylet. Video stylet being lighter than other airway gadgets, offering clear vision of the airway, being malleable, chargeable and easy to carry has revolutionised the airway management. It offers lesser hemodynamic response, reduced incidence of sore throat, dental trauma, soft tissue trauma, decreased cervical spine movement than the conventional laryngoscopy.[8]

Literature search did not yield any studies evaluating video stylet in comparison with C-mac videolaryngoscope for endo-tracheal intubation. Hence, we have made an attempt to compare the ease of intubation using video stylet, with the standard C-Mac videolaryngoscope, the hemodynamic response and also the incidence of complications with the two devices.

Our null hypothesis is that the two methods would be equally effective for endotracheal intubation

OBJECTIVES

PRIMARY OBJECTIVE :

To compare the ease of tracheal intubation using intubating video stylet with C-MAC videolaryngoscope using Intubation Difficulty Score.

SECONDARY OBJECTIVE :

To measure time taken to successfully intubate the trachea, stress response and incidence of complications.

REVIEW OF LITERATURE

Endotracheal intubation is contemplated as the ideal method for securing an airway for surgeries under general anaesthesia. Endotracheal intubation with general anaesthesia is indicated in behaviorally challenged patients, infants, children and young adults undergoing surgeries, neurosurgical procedures, ENT, oral and maxillofacial surgeries, significant coagulopathy, acute hemodynamic instability and patient's refusal for regional anaesthesia to name a few.

Laryngoscopes were instituted into clinical practice to create a direct line of sight between the anaesthesiologists and the larynx. Tracheal intubation is conventionally performed with the aid of a Macintosh laryngoscope. Direct laryngoscopes are the Macintosh, Miller, McCoy types, the ENT laryngoscopes. The indirect laryngoscopes include the videolaryngoscopes and optical stylets which provide real-time image of the larynx and laryngeal structures.

In ***1858***, ***John Snow*** administered chloroform to animals with the help of tracheostomy tubes. A similar technique in humans was utilized by ***Fredrick Trendelenberg*** in ***1871***. Intubating the trachea for the primary intention of providing anaesthesia was first introduced by ***Sir William MacEwan*** in ***1878***.[14]

Alfred Kirsten in ***1895*** and ***Gustav Kellian*** in ***1912*** established the direct laryngoscopy technique for endotracheal intubation. The practice of cuffed endotracheal tube was endorsed by ***Arthur Guedel*** and ***Ralph M Waters*** in ***1928***. This technique paved the way for utilization of closed circuit anaesthesia.[14]

Endotracheal intubation involves aligning the oral, pharyngeal and laryngeal axes in order to visualize the vocal cords distinctly and pass the rigid endotracheal tube through it. To attempt intubation and pass the endotracheal tube with ease, the visualization of vocal cords and larynx is of paramount importance. Poor visualization of glottis in among ***1%*** to ***9%*** of the attempts has been encountered with standard laryngoscopy. The introduction of ***Cormack and Lehane*** grading system in the year ***1984*** clarified the significance of vocal cord visualization in difficult airway scenarios.[15]

Quantification of difficult airway over the years involved evaluating intubating techniques and conditions to find a scale useful to objectively compare normal as well as complex endotracheal intubations[16]. This lead to development of ***Intubation Difficult Scale*** (IDS) score in the year ***1997*** which is used till date[17]. ***Airway Difficulty Score*** was introduced by The European Society of Anaesthesiologists in the year ***2000*** to predict difficulty in airway management.[18]

Dr John Pacey in the year ***2001***, invented the first videolaryngoscope making use of metal oxide semiconductors, video-chips and a video-camera present at the tip of the laryngoscope blade to visualize the glottis. Every videolaryngoscope available now is unique in their design. Standard Macintosh blade, angulated blade and blade with a channel for passage of the tube are the three main categories to which the videolaryngoscopes belong and have their own advantages and disadvantages based on their design.[19]

The C-MAC Videolaryngoscope developed by ***Karl Storz*** in the year ***2010*** revolutionized the use of videolaryngoscopes and has been efficiently used in clinical practice till date. It has a slim-blade profile with the original Macintosh design with a closed blade and no edges. The view furnished by the videolaryngoscope includes the tip of the blade and its passage into the vallecula, the glottis, the vocal cords and surrounding airway anatomy. A color image or a video-stream through the optical camera is displayed on high – resolution LCD monitor.

The Flexible Fibre-optic laryngoscope was first used in ***1972*** and in ***1979, Katz*** and ***Berci*** introduced the term "***optical stylet***" to illustrate an endoscope which is rigid and straight, used as an endotracheal tube stylet for tracheal intubation[20]. Fixed curving of distal end as a modification to the straight rigid endoscope was introduced by ***Bonfils***. Due to commercial failures, technological development and various disadvantages with its use in clinical practice, the popularity of earlier designed optical stylets ceased to become existent and newer, redefined video-stylets have made their appearance in recent times.

A randomized parallel-group study in 2018 by De-Xing Liu et al[39] discussed the ease of intubation in non-difficult airways, while comparing vide laryngoscopy and direct laryngoscopy. This study had 360 patients undergoing tracheal intubation for elective abdominal surgeries either with video-laryngoscope or direct laryngoscope. The study showed that the rate of glottic exposure was similar for both intubation devices irrespective of the level of experience of the anaesthesiologists using the devices.

The glottic exposure with Cormack Lehane grading I-II was higher with videolaryngoscope when compared to direct laryngoscope inferring that a visual intervention device is beneficial for good glottic exposure. One-time intubation success rate was greater with videolaryngoscope meaning re-intubation can be eluded with the use of videolaryngoscope in the first effort itself. The study also detected that even though there was adequate glottic exposure, passing the endotracheal tubes would be challenging and hence was a limitation with the use of videolaryngoscope.

In 2009, a prospective comparison study on “Expected difficult tracheal intubation” between direct and video laryngoscopy in 200 participants by A. Jungbauer et al[40] investigated and published results stating that the use of video-laryngoscope made intubation far easier and quicker with an excellent view of the laryngeal structures. They also concluded that the video-laryngoscope is an invaluable tool for difficult intubation scenarios with higher success rate of intubation in them and also requiring fewer maneuvers to optimize the airway for intubation.

A single blinded randomized controlled trial conducted by Michael F. Aziz et al[41] which studied the comparison of the effectiveness between the C-MAC video laryngoscope and a direct laryngoscope when faced with a difficult airway, conducted in 2010 with 300 patients with predictors which were valid for difficult tracheal intubation undergoing general anaesthesia. The study found that C-MAC performed better than direct laryngoscopy in terms of success of intubation during predicted difficult airway scenario. The use of C-MAC necessitated fewer maneuvers to assist intubation and also offered an enhanced view of the larynx. The time duration of laryngoscopy was lengthier with C-MAC and trauma during intubation was found to be equivalent in the use of both devices. The study claimed to have validity of a higher degree as the functioning of both the devices were replicated in routine clinical anaesthesia practice. Even though the C-MAC provided a magnified laryngeal view with anterior extension, the possibility of a failed tracheal intubation was comparable with the use of both the devices.

An original contribution in the year 2016 by Roya Yumul et al[42] who compared three videolaryngoscopy devices with direct laryngoscopy while intubating obese patients enrolled patients aged between 18-80 years and BMI >30 kg/m^2 planned for bariatric surgery under general anaesthesia. The finding from this study declared that videolaryngoscopy in obese individuals presented a superior laryngeal view than direct laryngoscopy and the time to intubation was reduced with the use of Video-Mac group when compared to Glidescope, Direct laryngoscopy group and McGrath groups. The Video-Mac group allowed efficient soft tissue retraction, enhanced glottis view with easier progression of endotracheal tube into the trachea. Satisfaction score was overall much higher with Video-Mac group when likened to the rest and the Video-Mac group requiring lesser adjuncts and a reduced number of intubation attempts.

“Limitations of Videolaryngoscopy” published in the year 2016 by A. Norris and T. Heidegger[43] stated that the performance of videolaryngoscopes may be situation specific. The model of videolaryngoscope is directly related to the trauma caused by the device during intubation and also time for intubation is an area causing concern with the use of videolaryngoscopes. It is imperative to keep in mind the possible advantages and limitations that may come from achieving maximum benefit with the use of specific videolaryngoscope for a specific difficult intubation scenario.

Syed Hussain Amir et al[24] in their original article in 2017, compared and evaluated the Video Stylet and the flexible fibre-optic bronchoscope used for the intubation of adult patients. They observed 60 patients undergoing general anaesthesia electively between the age group of 20-60 years, weighing between 40-70 kgs under ASA 1 and ASA 2 with Mallampati grading I and II. These patents were distributed into Fibreoptic group (FO-30) and Videostylet group (VS-30). The documented time taken for intubation was considered as primary outcome while successful intubations, hemodynamic response and post-operative complications were considered as secondary outcomes. They also noticed that the jaw thrust maneuver with two handed technique improved glottis view, reducing the intubation time and increased the success rate but the jaw thrust stirred a sympathetic response. Video-stylet is reusable, rechargeable, easy to handle and clean, robust and an inexpensive device compared to fibre-optic bronchoscope.

In a randomized crossover mannequin study by Jieun Youn, Sang kuk Han[25] in the year 2019 on "Comparison of fibre-optic bronchoscope and Videostylet during endotracheal intubation: A simulation study" with twenty eight novice doctors comparing the use of rigid video-stylet with single use fibre-optic bronchoscope on outcomes like time taken for intubation, overall success rate, time to visualise the glottis and time taken for passage of the tube into the glottis of an airway mannequin trainer found that indirect laryngoscopes like video-stylets and fibre-optic bronchoscopes as secondary rescue devices for successful intubation during conventional laryngoscopy failure. The image quality with both devices may be inferior due to secretions in oral cavity and pharynx. Success of intubation using the bronchoscope is related to education and training and intubation with the video-stylet is easier for beginners.

A manikin based randomized study by Jimmy Ong et al[26] in 2016 compared the Macintosh laryngoscope and the Trachway video intubating stylet in simulated difficult intubations with ten anaesthesiologists intubating a manikin with normal airway, cervical spine immobilization, cervical spine immobilization with tongue edema and tongue edema being the four difficult airway scenarios offered during the study.

The outcomes measured were the time taken for intubation, successful intubations and tracheal intubation difficulties in varying simulated difficult airway scenarios. It was perceived that experienced anaesthesiologists had an easier learning curve even in difficult airway scenarios. Video intubating stylet enabled better picturing of glottis opening and laryngeal structures in tongue edema and combined tongue edema with cervical immobilization scenarios which simulated patients with morbid obesity in clinical practice. Macintosh laryngoscope was found to have difficulties in maneuvering the blade in the above said scenarios.

A prospective randomized study by Amr Samir Wahdan et al[27] compared the intubating Video stylet with fibre-optic bronchoscopy in patients who were being operated on for open abdominal surgery in the lateral position in 2019. The study recruited fifty patients between the ages of 18 and 60 years ASA status 1 or 2, either gender, having Mallampatti Class I or II, planned for open abdominal surgery under general anaesthesia with endotracheal intubation in lateral position. Outcomes noted were time for intubation and success of intubation. It was noted that Videostylet presented favourable and faster intubating conditions with easier manipulation of the device during airway intubation of unusual, unconventional lateral decubitus position scenarios but was linked with an increase in hemodynamic response and the incidence of sore throat after intubation.

A case report in 2011 by Pei-Jiuan Tsay et al[28] studied the Trachway intubating stylet in a patient of ankylosing spondylitis who underwent total hip replacement under general anaesthesia and documented successful use of rigid

Trachway intubating stylet which is malleable in difficult airway with reduced inter-incisor distance and cervical spine deformities. Intubating stylet proves to be an efficient choice other than awake fibre-optic intubation or where LMAs cannot be introduced into the oral cavity.

Duk-Dong Ko et al[29] in their clinical research article published in the year 2012, which compared the hemodynamic changes post endotracheal intubation by the Optiscope, as well as the conventional laryngoscope. This study included fifty eight patients aged between 20-65 years and ASA class 1 or 2 experiencing general anaesthesia and had their time for intubation, hemodynamic variables like systolic blood pressure, mean blood pressure, heart rate, diastolic blood pressure, sore throat, and percentage of glottis opening documented. Optiscope being a semi rigid fiberscope showed similar hemodynamic variability or did not show reduced hemodynamic response when compared with conventional laryngoscopy. The study could not show large differences in sore throat and first attempt intubation success rate with the use of Optiscope.

A comparative study conducted by Markus Weiss et al[30] in 1999 on the management of a difficult airway, all the while comparing the Bullard laryngoscope with the video-optical intubation stylet. Here a mannequin head with a grade III laryngoscopic view was used for intubation comparison with video-optical intubation stylet and Bullard laryngoscope. Ten intubation attempts were given for anaesthesiologists and intubation time and failed intubation was recorded with the operator assessing the degree of intubation difficulty with each device using a Likert scale. The study observed that video optical intubation stylet has lower degree of difficulty in intubation and higher intubation success rates but there was no difference in mean intubation time with the two devices used. Failed intubations were noted with Bullard laryngoscope. The study concluded that Video-optical intubating stylet can be used as an urgent endoscopic intubation assistance device instantly in difficult intubation scenarios.

In the year 2016, H. Seo et al[31] published an article studying the comparison between a rigid video-stylet and conventional lightwand intubation in patients with cervical spine immobilization, wherein one hundred sixty eight patients of ASA 1 or 2 posted for cervical-spine surgery while under general anaesthesia. The success rate of intubation and post operative complication incidence with two techniques were similar, though the Optiscope required more time and few scooping movements than lightwand. Lightwand curtailed cervical movements before tracheal intubation in unstable cervical injury cases but manual in-line stabilization before intubation creates difficult intubation with lightwand. There was no substantial decrease in post-operative complications with the two techniques. Jaw thrust helps in improving the laryngeal image was one recommendation made.

A prospective randomized crossover trial on a fluoroscopic comparison between Shikani Optical Stylet and a Macintosh laryngoscope with regards to cervical spine motion was published in 2007 by Timothy P. Turkstra et al[32]. They discovered that Shikani Optical Stylet intubations with manual in-line stabilizations had reduced C-spine movements by 55% but required longer time for intubation when compared to Macintosh laryngoscope. The optical stylet offered Cormack Lehane grade I view of vocal cords and proves valuable tool for intubation is suspected cases of pharyngeal or laryngeal trauma.

P. Biro et al[33] prospectively investigated the intubation experience with the Sensascope, which is a steerable semirigid video stylet in 2006 and they concluded that Sensascope optical stylet can improve intubation time to less than 20 seconds and provide high primary success rate of intubation after appropriate training. Any increase in Cormack Lehane grading proportionately augmented the time for intubation but was statistically insignificant. Any higher Cormack Lehane grading with direct laryngoscopy was effortlessely intubated with ease using the Sensascope which reiterated the finding that Sensascope served as valuable tool in unanticipated difficult airway scenarios. Use of sensascope needed no additional head extension or strained laryngoscope traction which can cause dental trauma or adverse cardiovascular responses.

To compare the Macintosh laryngoscope with the rigid video stylet for double lumen tube tracheal intubation, a randomized controlled clinical trial was conducted by Yang et al[34]. This study revealed rigid video-stylet provided a higher success rate for the first intubation and higher speed of tracheal intubation with lesser trauma and a better vocal cord view when compared to intubation using Macintosh laryngoscope but inferior when compared with videolaryngoscope. Cormack Lehane grading was improved to I or II from ¾ due to ability of video stylet to move closer towards the glottic structures and improving the image.

A research article on the performance and learning curve for the C-MAC Macintosh video laryngoscope and the novel C-MAC video stylet in a simulated difficult airway authored by James Pius, Noppens RR[35] in 2020 involving twenty one anaesthesia residents provided with six randomized intubation attempts and subsequent intubation with simulated difficult airway on Bill 1 airway mannikin model. They documented that the video-stylet offered quicker and effortless intubation when compared to videolaryngoscope and also restated the fact that the video-stylet's learning curve was comparable with videolaryngoscope. The POGO scores fared better with the video-stylet than videolaryngoscope group and intubation with video-stylet demonstrated enhanced intubating condition at different stages.

A prospective randomized control trial was conducted to study the Clarus Video System (Trachway) and the direct laryngoscope in endotracheal intubation with cricoid pressure in simulated rapid sequence induction intubation by Yen-Chu Lin et al[36] from 2016-2018 demonstrated Clarus video system – video stylet as a useful device in terms of intubation of trachea with the use of cricoid pressure. The Clarus Video system proved to be a superior choice than direct laryngoscope in patients with restricted mouth opening and delicate incisors and an amateur trainee with few practices can master the use of the Video stylet. The study however had a limitation with no statistical difference between the intergroup time taken for intubation with videostlet or lightwand or with the use of direct laryngoscope.

A prospective clinical research report published in 2020 compared the direct laryngoscope with video-lighted stylet (Intular Scope^{TM}) for endotracheal intubation in a normal airway. This study was authored by Ji Yeon Lee et al[37] and included seventy patients aged between 20-65 years belonging to ASA 1 or 2 undergoing surgeries under general anaesthesia with orotracheal intubation in whom hemodynamic response, time taken for intubation and POGO scores for comparison, randomised into two groups. The study highlighted that hemodynamic responses during intubation with videostylet are parallel with the direct laryngoscope group with lengthier time for intubation and higher first-attempt failure rate noted with the video-stylet group. Probable reason could be trouble in identifying upper airway midline and inserting the videostylet through it. The study claimed less severe hoarseness of voice and sore throat with videostylet based intubation. However the results of the study are limited by the comparison of intervention in normal airway.

A study by Hsu. S et al[38] studied left endobronchial intubation with a double lumen tube using the Trachway video stylet or direct laryngoscopy was conducted in 2013 on sixty patients aged 18 years and over belonging to ASA status 1-3 requiring endobronchial intubation for thoracic surgery were randomised into two groups, direct laryngoscopy group and Trachway video-stylet group. The endobronchial intubation with double-lumen tube was achieved quicker with Trachway video-stylet when compared to direct laryngoscopy with reduced hoarseness of voice with the video-stylet use. Trachway video-stylet evaded any necessity for BURP maneuvers for intubation. Nevertheless, the results of this study could not be employed to difficult intubation scenarios as this study involved patients with normal BMI and normal airways. The study results can only be utilised for left endobronchial intubation rather than for right double lumen tube or any other double-lumen tubes.

BASIC SCIENCES

FUNCTIONAL ANATOMY OF UPPER AIRWAY

- The upper airway serves as a conduit for passage of air from the atmosphere into the lungs. Its plays a vital role in physiologic as well as dynamic functioning of human body in terms of gas transport, delivery and exchange of filtered and humidified air to the lungs.
- The upper airway comprises of structures involving nose upto the glottis. The upper airway executes key functions such as:
  1. Olfaction
  2. Phonation
  3. Deglutition
  4. Filtration and humidification of inspired gases
- The upper airway comprises of the following:
  1. Nose and nasal cavity
  2. Oral cavity
  3. Pharynx
  4. Larynx
  5. Trachea

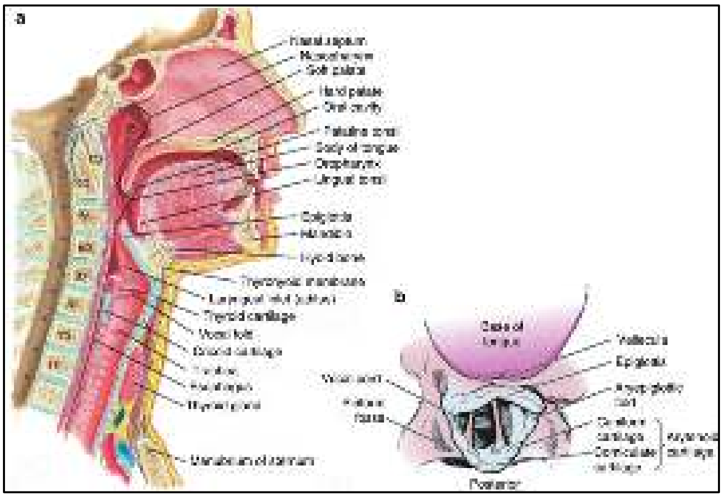


Figure 1 – Anatomy of Upper Airway

- **<u>NOSE & NASAL CAVITY</u>**
  - Functionally the airway starts from the nares and the mouth.
  - An adult human being has two nostrils which are approximately 10 to 14 cm long and extends all the way upto nasopharynx.
  - Whole of nasal cavity is divided in the midline by cartilaginous quadrilateral septum together in conjunction with two outermost medial fragments of lateral cartilages.
  - The nasal septum constitutes:
    1. Septal cartilage
    2. Perpendicular plate of ethmoid
    3. Vomer
  - Individually both the nasal fossae are convoluted in shape and presents nearly 60 cm^2 surface area on either side for humidifying and warming of inspired air.

- Nasal fossa is enclosed laterally by superior, middle and inferior turbinates which divide the fossa into superior, middle and inferior meatuses respectively.
- Ostia are the apertures through which paired paranasal sinuses drain through it into the lateral part of the nose.
- The upper one-third of nasal cavity consists of the olfactory area and the lower third of nasal cavity comprises of respiratory function of nose.
- Ethmoidal branches of ophthalmic artery, greater palatine and sphenopalatine divisions of maxillary artery, lateral nasal and superior labial branches of facial artery forms the arterial supply of the nasal cavity.
- Kiesselbachs plexus is formed by the union of the above arteries at the antero-inferior portion of nasal septum called the Little's area.
- The nasal mucosa receives its nonolfactory sensory supply by the anterior ethmoidal and maxillary nerves being the primary divisions of trigeminal nerve.

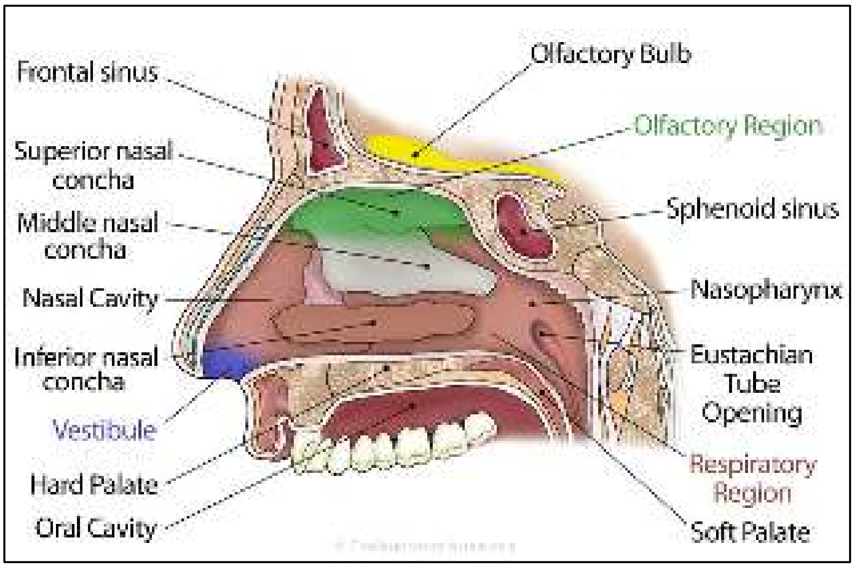


Figure 2 – Anatomy of Nasal Cavity

ORAL CAVITY

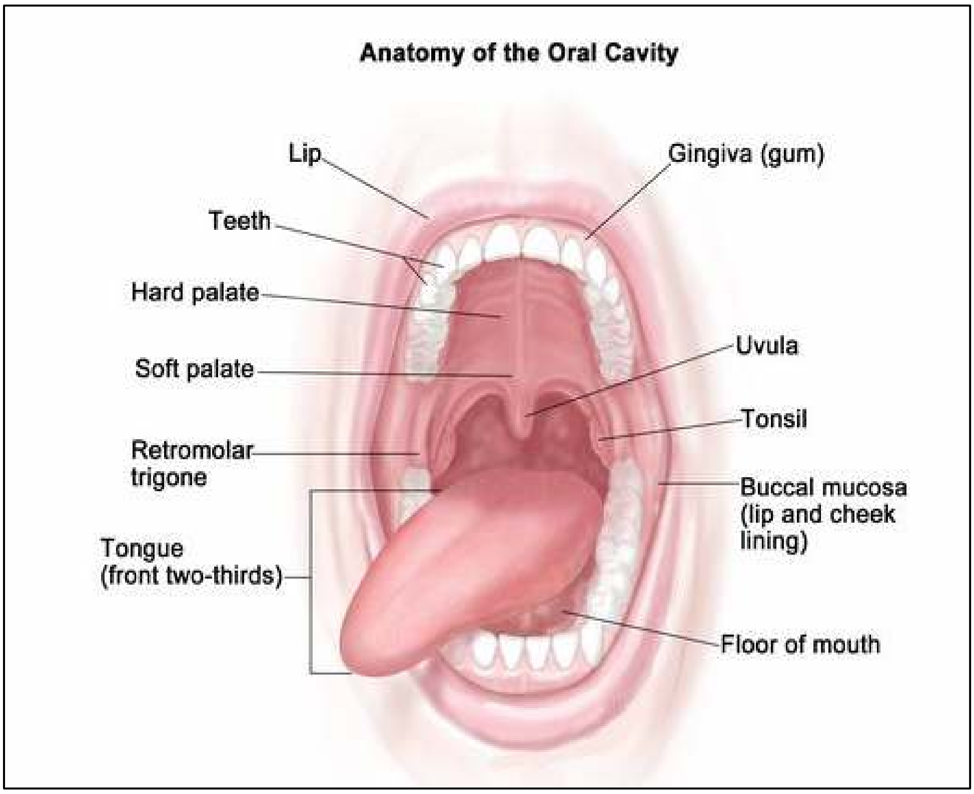


Figure 3 – Anatomy of Oral Cavity

- **MOUTH**:
  - Mouth forms the gateway to the oral cavity and it expands from the lips till the oropharyngeal isthmus.
  - The oropharyngeal isthmus sits at the level of palatoglossal folds.
  - The teeth separate the oral cavity into oral cavity proper and the vestibule.
- **VESTIBULE**:
  - It is the space which lies between the lips and teeth externally and teeth and its alveolar processes internally. It usually receives secretions of the parotid glands.

- **ORAL CAVITY PROPER**:
    - The oral cavity forms the opening of the digestive tract and it is bound by:
        1. Anteriorly: Lips
        2. Posteriorly: Oropharynx
            - Pharyngeal connection is achieved through oropharyngeal isthmus bounded superiorly by soft palate, tongue forming the base with palatoglossal arches forming the lateral ends.
        3. Laterally: Buccal mucosa and cheeks
        4. Superiorly: Hard and soft palate
        5. Inferiorly:
            - Anteriorly: Sublingual region
            - Posteriorly: Tongue
    - The tongue, teeth, gums, hard and soft palate are held within the confines of oral cavity.
    - The squamous epithelium comprising of secreting glands which are mucous in nature, lines the oral cavity.
- **TONGUE**:
    - It is a soft muscular organ forming the floor of oral cavity.
    - The tongue is anchored to the floor of oral cavity with the help of frenulum.
    - The V-shaped sulcus terminalis divides the tongue into:
        - Anterior two-third: Oral part
        - Posterior one-third: Pharyngeal part

- A fibrous septum in the midline partitions the tongue into two equal right and left halves. Each half comprises of four extrinsic and four intrinsic musculatures.
- The four extrinsic muscles alter the position of the tongue. These include:

MUSCLES	ACTION
Genioglossus	Protrusion and depression
Styloglossus	Retraction and elevation
Palatoglossus	Elevation of posterior tongue
Hyoglossus	Depression and retraction

- The four intrinsic muscles alter the shape of the tongue. These include:

MUSCLES	ACTION
Superior longitudinal	Shortens and thickens the tongue
Inferior longitudinal	Shortens and turns apex under
Transverse	Narrows and elongates the tongue
Vertical	Flattens and broadens the tongue

- The tongue has innervations for its motor, sensory and gustatory functions.

FUNCTION	NERVES	AREA
Motor	1. Hypoglossal 2. Pharyngeal plexus via Vagus nerve	All intrinsic and extrinsic muscles **EXCEPT** Palatoglossus Palatoglossus
Sensory	1. Lingual nerve 2. Glossopharyngeal nerve 3. Internal laryngeal branches of vagus	Anterior $2/3^{rd}$ of tongue Posterior $1/3^{rd}$ of tongue Root of tongue
Taste	1. Chorda tympani 2. Glossopharyngeal nerve	Anterior $2/3^{rd}$ of tongue Posterior $1/3^{rd}$ of tongue

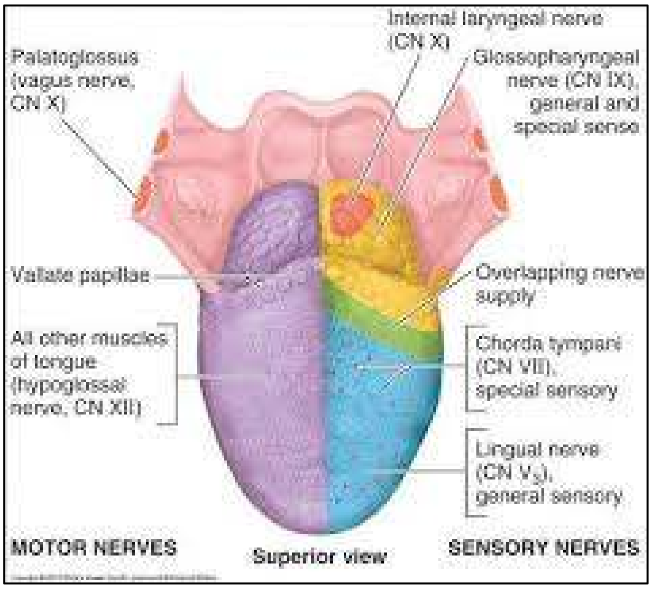


Figure 4 – Nerve Supply of Tongue

- **ARTERIAL SUPPLY**:
  - The Lingual artery, a branch of external carotid artery supplies the tongue and floor of the mouth.
  - Tonsillar artery, branch of facial artery and Ascending pharyngeal artery, branch of external carotid artery, form the secondary arterial supply to the tongue.
- **VENOUS SUPPLY**:
  - The dorsal lingual vein and deep lingual vein which finally pours into pterygoid plexus, tonsillar plexus and pharyngeal plexus.
- **Lymphatic drainage**:

AREA	LYMPH NODES
Tip of tongue	Submental
Anterior 2/3rd of tongue	Submandibular and deep cervical
Posterior 1/3rd of tongue	Deep cervical

- **HARD PALATE:**

  - It is bony plate horizontal in shape forming the roof of oral cavity.
  - It separates the nasal and oral cavities.
  - Anterior 2/3rd is formed by palatine process of maxilla and horizontal palate of palatine bone constitutes the posterior 1/3rd of hard palate fusing down the midline.
  - The palatine and nasopalatine branches of trigeminal nerve provide the sensory supply to the hard palate whereas facial nerve via branches of trigeminal form the gustatory supply.
  - Hard palate aids in essential phonation and mastication of food particles.

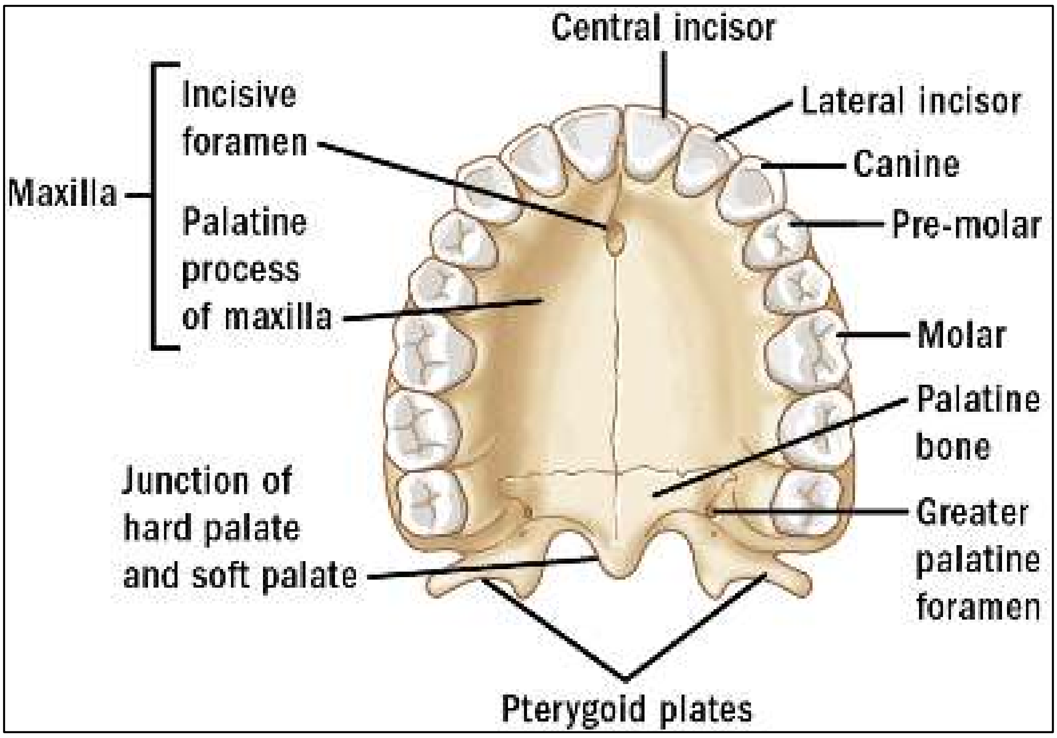


Figure 5 – Anatomy of Hard Palate

SOFT PALATE:

- It is a flexible structure that forms the latter continuation of hard palate.
- The palatine aponeurosis is the anterior continuation of soft palate towards the hard palate while the posterior end of soft palate terminates as uvula that hangs in the oral cavity.
- There are five muscles of soft palate which perform the overall functioning of swallowing, phonation and breathing. They are as follows:

MUSCLES	ACTION	NERVE SUPPLY
Tensor veli palatini	Tenses palate	Medial Pterygoid nerve
Levator veli palatini	Elevates palate	Pharyngeal plexus of Vagus nerve
Palatoglossus	Draws soft palate towards tongue to initiate swallowing	Pharyngeal plexus of Vagus nerve
Palatopharngeus	Pulls pharynx anteriorly and superiorly during swallowing	Pharyngeal plexus of Vagus nerve
Musculus uvula	Draws up the uvula	Pharyngeal plexus of Vagus nerve

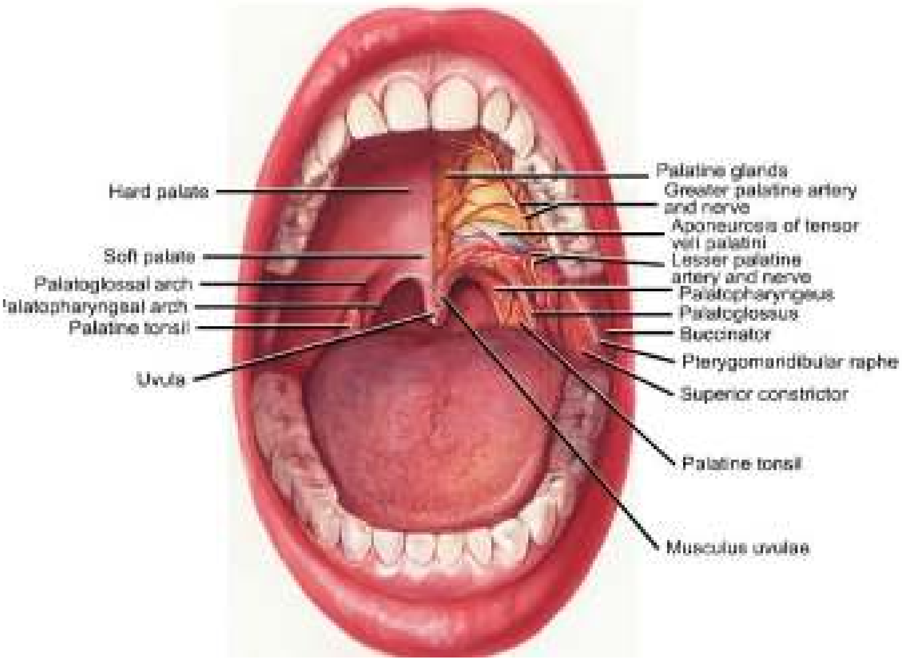


Figure 6 – Anatomy of Soft Palate

- **PHARYNX:**
  - It operates as a common passage for food and respiratory gases and acts as a fibromuscular conduit between oral and nasal cavities connecting it to oesophagus and larynx respectively.
  - Pharynx is made up of thin facial layer which models into compactly thickened buccopharyngeal fascia.
  - It extends to about 12-15 cm in length spreading across:
    - Superiorly: Skull base
    - Inferiorly: Adventitia of oesophagus
    - Anteriorly: Cricoid cartilage
    - Posteriorly: Fourth and sixth cervical vetebra
  - The widest part of pharynx is at the level of hyoid bone(5cm) and the narrowest part being the esophagus(1.5cm).

- The pharyngeal wall comprises of **circular layer of muscles externally and inner longitudinal muscle layer.** Each layer is made up of three paired muscles.

OUTER CIRCULAR MUSCLES	INNER LONGITUDINAL MUSCLES
Superior constrictor	Stylopharyngeus
Middle constrictor	Salphingopharyngeus
Inferior constrictor	Palatopharyngeus

- The constrictors help in propulsion of food from the oropharynx to oesophagus in a coordinated manner and are innervated by pharyngeal plexus.
- The inner longitudinal muscles function to shorten larynx and elevates pharynx during the process of deglutition and are innervated by glossopharyngeal nerve.
- Pharynx is subdivided into:
  - Nasopharynx
  - Oropharynx
  - Hypopharynx
- **NASOPHARYNX:** The nasal cavity opens into the nasopharynx posteriorly. It is interconnected to the nasal conchae, the openings of Eustachian tube on either side and the oropharynx below. It usually extends from base of skull till the superior surface of soft palate. The roof is formed by occipital and sphenoid bones of skull. The adenoid

tonsil is lymphoid tissue contained in the mucous membranes of roof and posterior wall of nasopharynx. Its chief function is to aid in respiration.

- **OROPHARYNX:** It is situated rostrally behind the oral cavity proper. The soft palate forms its superior extent while the epiglottis tip forms its inferior extent. Prevertebral fascia, second cervical vertebral body and third cervical vertebral body form the posterior wall of oropharynx. The palatoglossal and palatopharyngeal folds shape the tonsillar fossae which houses the palatine tonsil on either lateral wall of oropharynx. The base of tongue lies medial to the tonsillar fauces and anterior to inlet of larynx and supported by paired glossoepiglottic folds laterally and solitary median glossoepiglottic fold. It aids in deglutition.

.

- **HYPOPHARYNX:** Also referred to as the laryngopharynx, forms the caudal segment of the pharynx dividing it into larynx anteriorly and the oesophagus posteriorly. The upper edge of epiglottis forms the superior border while the cricoid cartilage at C6 forms the inferior border. The pyriform sinuses, being pear-shaped, are located on either side the laryngopharynx and play pivotal role in production of speech. The thyroid cartilage is situated laterally with respect to laryngopharynx and medially lies the areyepiglottic folds.

- **NERVE SUPPLY OF PHARYNX**:

MOTOR	SENSORY	TASTE
1.Glossopharyngeal nerve 2.Cranial division of accessory nerve	1. Pharyngeal branches of glossopharyngeal nerve 2. Palatine branches of maxillary nerve	1. Lesser petrosal nerve

- **ARTERIAL SUPPLY:** The maxillary artery, lingual artery and facial artery, ascending pharyngeal artery and superior thyroid artery supply the pharynx.
- **VENOUS DRAINAGE:** The venous drainage to pharynx is through the corresponding veins travelling along the main arterial supply to the pharynx finally emptying into pterygoid and pharyngeal plexus.
- **LYMPHATIC DRAINAGE:** The retropharyngeal lymph nodes and upper deep cervical lymph nodes form the lymphatic supply of whole of pharynx.

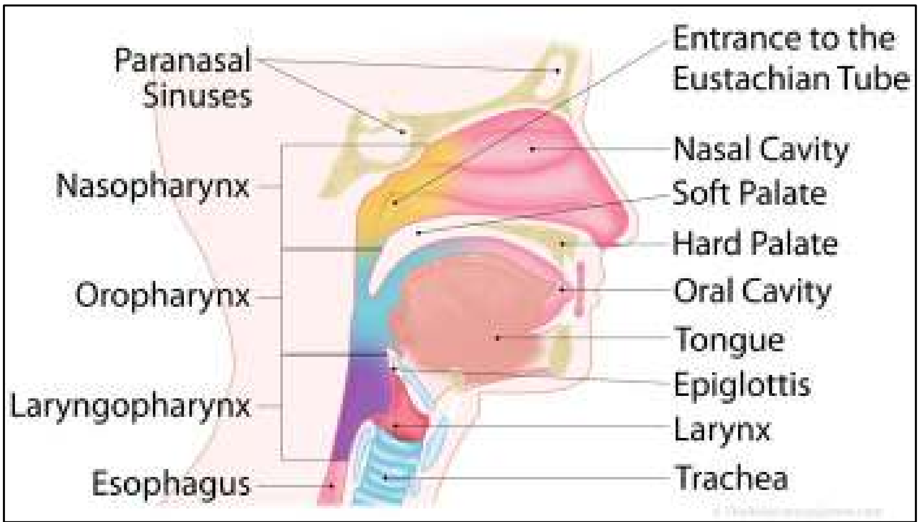


Figure 7 – Anatomy of Pharynx

- **LARYNX:**
  - It is a membrano-cartilaginous ligamental framework suspended from underneath the hyoid bone.
  - The larynx is overlaid superficially by thin strap muscles, deep fascia and skin.
  - It extends from 4^{th} to 6^{th} vertebra situated more cephalad in children and adult females compared to adult males.
  - Inlet to the larynx is bounded by:
    - Anteriorly: Upper edge of epiglottis
    - Posteriorly: Mucous membrane between either arytenoid cartilages
    - Laterally: Areyepiglottic folds
  - Laryngeal framework is stabilized by paired and unpaired cartilages, ligaments and mucous membranes.

PAIRED CARTILAGES	UNPAIRED CARTILAGES
AREYTENOID	THYROID
CORNICULATE	CRICOID
CUNEIFORM	EPIGLOTTIS

  - **THYROID CARTILAGE**: It is the largest and longest laryngeal cartilage with shieldlike shape acquired due to midline fusion of two quadrilateral lamina. The angle at which this fusion occurs is 120^0 in females while it is more acute of around 90^0 . The thyroid notch at the top of thyroid cartilage formed by union of two laminae in the midline has vocal ligaments and vestibular ligaments binding to it on the inner side of the fusion line.

- **CRICOID CARTILAGE**: It is signet ring in shape and is a solitary cartilaginous ring who's formation is complete in nature. The arch, anterior portion, is around 5-7 mm in height while the lamina, posterior portion, is 2-3 cm in height and taller. The lamina supports two facets in total, one articulates with the inferior cornua of thyroid cartilage on lower side while areytenoid cartilage articulates with the facet superiorly.
- **EPIGLOTTIS CARTILAGE:** Its fibroelastic character gives leaflike shape to the epiglottis. The thyroepiglottic ligaments attaches the superior border of epiglottis to the thyroid cartilage while hyoepiglottic ligament ties epiglottis to back of hyoid bone. The vallecula is pouchlike space located between median glossoepiglottic fold and lateral pharyngoepiglottic folds. It projects over the laryngeal inlet.
- **AREYTENOID CARTILAGE:** The two areytenoid cartilages are pyramidal in shape, located on superolateral part of cricoid lamina and forms the posterior part of larynx.
- **LARYNGEAL CAVITY:** The laryngeal cavity spreads from the laryngeal inlet to the lower border of cricoid cartilage. There exists two folds of vocal cords called the superior vestibular fold(false vocal cords) and the inferior vocal folds(true vocal cords), amidst which lies the sinus of larynx which appears as a slit-like recess. The anterior commissure of the larynx is where the two vocal cords meet. The posterior commissure of larynx lies in the midline posteriorly structured by the posterior intercartilaginous part extending between

two areytenoid cartilages and its mucosa. The area spreading across from the laryngeal inlet towards the vestibular folds is called the vestibule or supraglottic larynx. The opening between the inferior vocal cords is called the rima glottidis or the glottis from where the infraglottic larynx exists. During quiet respiration, the vocal processes are 8mm apart approximately. The saccule of the larynx originates from the anterior part of sinus as a pocket between the false vocal cords and the innermost surface of the thyroid cartilage. The quadrangular membrane which is the upper part of the fibrous sheet that lies underneath the mucosa of larynx divided by the sinus of larynx, structures the aryepiglottic fold forming the fibrous skeleton of the laryngeal inlet. The caudal part of the quadrangular membrane thickens to model itself into vestibular ligament, lying underneath the false vocal cords. The cricovocal membrane is developed by the lower sheet of fibrous tissue below the sinus of the larynx. It stretches between mid-point of prominence of thyroid cartilage anteriorly and vocal process of areytenoid cartilage posteriorly. The unrestricted superior border of cricovocal membrane comprises the vocal ligament, true vocal cord framework. The cricovocal membrane hardens to create the cricothyroid ligament in the midline.

- **MUSCLES OF LARYNX:** Extrinsic muscles primarily aids in movement of larynx while intrinsic muscles perform the necessary function of voice production.

- Extrinsic muscles of larynx include the Suprahyoid and infrahyoid muscles (strap muscles).
- **SUPRAHYOID MUSCLES:** Binds the larynx to the hyoid bone helping in elevation of larynx.
    1. Stylohyoid
    2. Geniohyoid
    3. Mylohyoid
    4. Stylopharyngeus
- **INFRAHYOID MUSCLES:** Lowering of larynx, modulating the inner association of cartilages and folding onto one another
    1. Sternothyroid
    2. Sternohyoid
    3. Thyrohyoid
    4. Omohyoid

EXTRINSIC MUSCLES	**ACTION**
Inferior pharyngeal constrictor	Swallowing
Sternohyoid	Indirectly depresses the larynx
Sternothyroid	Lowers the larynx
Thyrohyoid	Lowers the larynx
Thyroepiglottic	Inversion of mucosal areyepiglottic fold
Stylopharyngeus	Folds the thyroid cartilage

INTRINSIC MUSCLES	ACTION
Cricothyroid	Elongates vocal cords ensuing higher pitch
Posterior Cricoarytenoid	Abduction of vocal cords
Lateral or anterior cricoarytenoid	Adduction of vocal cords
Thyroarytenoid	Relaxes and approximates the vocal cords
Aryepiglottic	Adduction of areyepiglottic folds
Transverse Arytenoid	Adduction of vocal cords
Oblique Areytenoid	Closure of glottis
Vocalis	Relaxation of vocal cords

- **BLOOD SUPPLY:** The supraglottic region, epiglottis and superior vocal cords are supplied by superior laryngeal artery while the inferior laryngeal artery delivers arterial supply to subglottic region and inferior vocal cords. The corresponding laryngeal veins accompany laryngeal arteries and drain into superior and inferior thyroid veins draining into internal jugular and subclavian veins eventually.
- **LYMPHATIC DRAINAGE:** The lymph vessels draining the supraglottic region drains into upper deep cervical group of lymph nodes while the infraglottic region will empty into the lower deep cervical group of lymph nodes.
- **NERVE SUPPLY:** The superior laryngeal nerve and recurrent laryngeal nerves are derived from the vagus nerve. The recurrent laryngeal nerve has Right and Left branches which are anatomically

distinct. The Right recurrent laryngeal nerve winds underneath the subclavian artery before moving cephalad while the left recurrent laryngeal nerve loops around arch of aorta before resuming its cephalad course.

NERVE	**SUPPLIES**
Superior laryngeal nerve – **External branch**	Motor supply to Cricothyroid muscle
Superior laryngeal nerve – **Internal branch**	Sensory supply to mucous membrane upto level of vocal cords, posterior aspect of the base of the tongue, the surfaces of the epiglottis, the aryepiglottic fold.
Recurrent laryngeal nerve	1. Motor supply to all intrinsic muscles of larynx **EXCEPT Cricothyroid muscle** 2. Sensory supply to mucous membrane caudal to level of vocal cords

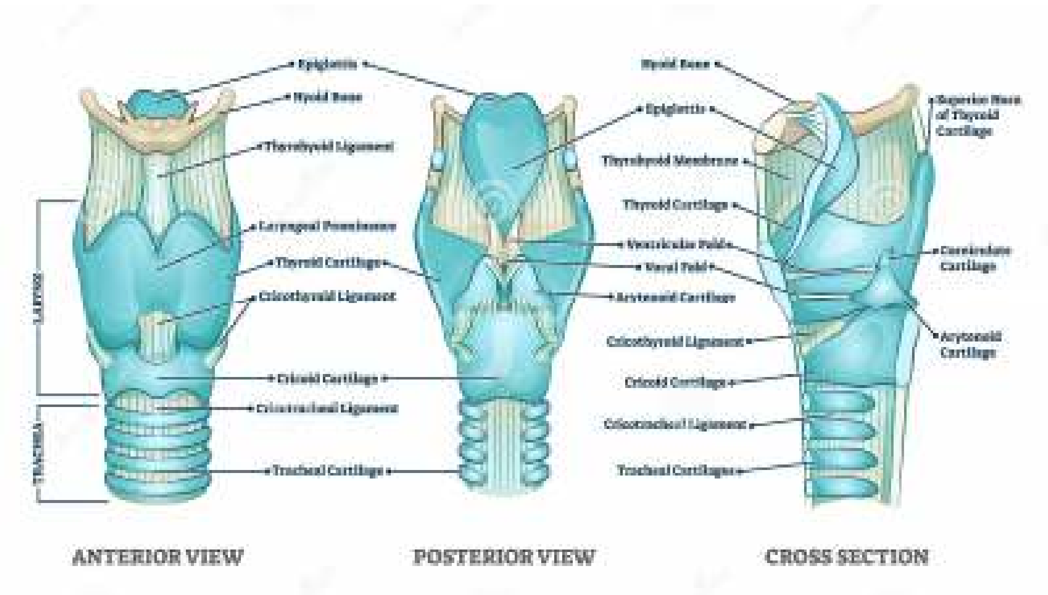


Figure 8 – Anatomy of Larynx

- **TRACHEA:** The semi-cartilaginous adult trachea continues from the inferior side of cricoid cartilage at the level of 6^{th} cervical vertebrae and terminates at the carina around 4^{th} or 5^{th} thoracic vertebrae. It is approximately about 12 mm in diameter and around 11-14 cm long. Numerous 'C' shaped cartilages reinforces the tracheal wall which is scarce posteriorly. At the commencement of sixth tracheal ring, the trachea enters the thorax. The trachea splits into right and left main bronchus from the carina. The recurrent laryngeal nerve, branch of vagus supplies sensory sensation to the trachea.
    - **RELATIONS**:
        - Anteriorly: Skin, pretracheal fascia, thyroid isthmus, and strap muscles.
        - Posteriorly: Esophagus, recurrent laryngeal nerves.
    - **BLOOD SUPPLY**: The inferior thyroid artery forms the arterial blood supply while the inferior thyroid veins drains the venous blood from trachea.
    - **LYMPATICS**: Pretracheal, paratracheal nodes and deep cervical nodes.[9-13]
- **LARYNGOSCOPY:**
    - Direct laryngoscopy is an essential procedure to visualise the larynx which facilitates the endotracheal intubation of trachea before general anaesthesia or during resuscitation procedures.

- Essential components required for endotracheal intubation incudes laryngoscope with appropriately sized blade, fitting endo-tracheal tube and anaesthetized patient.

- The patient is placed in supine position and optimal intubating position called the “SNIFFING POSITION” familiarized by Sir Evan Magill head is then extended at atlanto-axial joint and flexed at atlanto-occipital joint. This enables positioning of oro-pharyngeal axis and oro-laryngeal axis in a straight line.

- The laryngoscope is then held in left hand and then advanced into right side of oral cavity. Employing the curvature of laryngoscope, the tongue is swooped to the left which enables the visualization of vallecula. The base of the epiglottis is visible which is then lifted upwards and outwards with the aid of tip of laryngoscope blade. Uplifting of epiglottis facilitates the visualization of vocal cords and rima glottidis.

- The endotracheal tube is then introduced into the glottis and fixed at 21 cm for males and 19cm for females, at the angle of the mouth.

- Confirmation of endotracheal tube is checked by bilateral auscultation of breath sounds, bilateral equal chest raise and capnography.

Figure 9 – Positioning During Laryngoscopy

PREDICTORS OF DIFFICULT INTUBATION

Over the years, unanticipated difficult airway incidence is variable and is dependent on various patient characteristics. Several screening tests including physical examination performed bedside were established for predication of difficult airway. The diagnostic precision of such bedside screening tests varied from trial to trial due to several differences in difficult airway incidence, patient characteristics and diagnostic test thresholds.

MODIFIED MALLAMPATTI GRADING:

Modified Mallampati was coined by Samsoon and Young, following 4 grades may be noted.Modified Mallampati test is usually utilized bedside screening test for airway assessment. It assesses the expanse of space inside the oral cavity to contain the laryngoscope when inserted into the oro-pharynx.

The patient is asked to be seated with head in neutral position. The investigator should place their eye at the level of patients mouth. The patient is then asked to open the mouth widely with protrusion of the tongue. The posterior pharynx, faucial pillars, soft palate and hard palate are the observations to be made. [15-16]

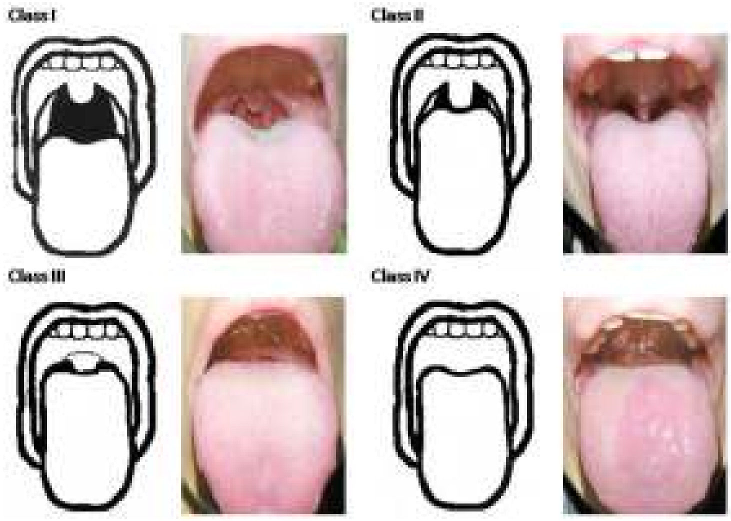


Figure 10 – Modified mallampatti grading

"Class I: Faucial pillars, uvula, soft and hard palate visible

Class II: Uvula, soft and hard palate visible

Class III: Base of uvula and hard palate visible

Class IV: Hard palate visible"

Assessment of intubation difficulty

The efficacy of direct laryngoscopy is measured in terms of best view of the vocal cords. The degree of difficulty encountered during direct laryngoscopy and intubation is most commonly assessed using Cormack Lehane grading. The other indicators include POGO (Percentage of Glottic Opening) and Intubation Difficulty scale (IDS) score, a quantitative scale of difficult intubation with seven variables assessing the complexity of tracheal intubation, developed by Adnet et al.[33]

7.1 Cormack and Lehane classification

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 – Visualization of entire vocal cords

Grade II-Visualization of posterior part of the laryngeal aperture

Grade III-Visualization of epiglottis

Grade IV-No glottis structure seen

Cook(1999) has further subdivided Cormack and Lehane s Grade II and Grade III as IIa,IIb,IIIa and IIIb

IIa-Visualization of posterior part of vocal cord

IIb-Visualization of arytenoids only

IIIa-epiglottis liftable

IIIb-epiglottis adherent or only tip visible

As per Cook, Grade I and Grade IIa patient can be directly intubated, IIb and IIIa would require intubating aids like bougie, stylet, lightwand, while IIIb and IV cannot be intubated using conventional laryngoscope but would require alterative specializes technique and equipments.[18]

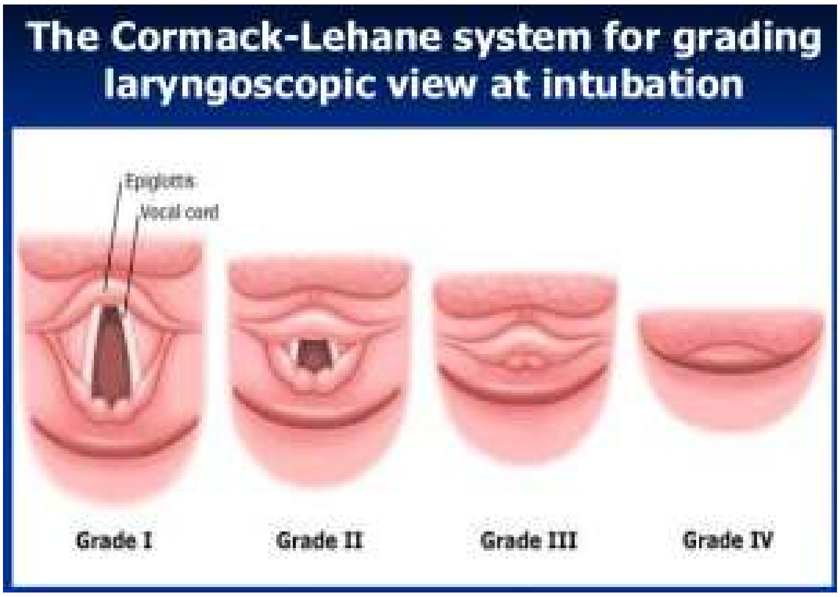


Figure 11 – Cormack Lehane Grading

LARYNGOSCOPE

- Laryngoscopes are devices used to visualise the larynx and its surrounding supporting structures. It is commonly used for endotracheal intubation for surgical procedures.[21]

- Additional usages of laryngoscopes include placement or guiding of naso or oro-gastric tube, placement of transesophageal echocardiographic probe, for removal of foreign body and for examination of upper airway anatomy.

- With the technological advancement and diversified challenges faced during difficult intubation scenarios, various designs of laryngoscopes are in use now and ranges from formerly used rigid laryngoscopes with light source, videolaryngoscopes, video-stylets to fibreoptic devices.

DESIGN OF SIMPLE RIGID LARYNGOSCOPE:

- A simple rigid laryngoscope usually is available as an individual piece or as a separable blade and handle device.
- The detachable simple rigid laryngoscope consists of the 'fitting' which is the intersection where the blade and handle meet to complete the circuit to light up the power source in the form of a light bulb. To aid the fixing of base of blade to the handle, there exists a hinge pin on the handle where the blade can rest in operating position.
- A single piece rigid laryngoscope is designed with a switch mounted on the handle to turn on the lamp.
- A laryngoscope blade comprises of numerous distinguished parts namely:

1. The base of a laryngoscope blade is the one which gets fixed to the handle and is called the 'heel'. The heel has a slot which is required for interlocking the blade with the handle.
2. The spatula(tongue) forms the core of shaft of laryngoscope blade. It assists in compressing and manipulation of the tongue, soft tissues in oral cavity and the lower jaw. Blades are usually designed as curved or straight blades depending on their application for intubation. The curved blade renders easier intubation of trachea whereas straight blades offer improved laryngeal visualization.

3. The flange protrudes out laterally from the spatula and is supported to it with the help of web. The flange assists in guiding instruments as well as deflecting the tissues from the midline. The cross-sectional design of blade is determined by the flange. A ‘step’ is another name given to the flange. Sometimes the flange curves itself away from the laryngoscope blade and called reverse flange.

4. The beak is the distal end of the blade which comes in contact with vallecula and epiglottis. It assists by elevating the epiglottis directly or indirectly to visualise the glottis. It is thick and blunted to reduce trauma.

5. The laryngoscope blade comes with a light source(bulb) which illuminates when the blade hooks to the handle. The lamp sits in a socket on the blade. The socket is situated usually at the distal end of blade or near the tip.

6. Delivery of oxygen and suction apparatus attached to the blade are the supplementary features available on the laryngoscope blade.

HANDLE:

- The handle is the part of rigid laryngoscope assembly which supplies power for the lamp(bulb) through the disposable or rechargeable batteries placed inside them.

- Rigid laryngoscopes have handles which provides a metallic contact when blade is connected to the handle, in order to complete the electrical circuit wherea fibreoptic laryngoscopes have halogenated lamp bulb which are illuminated through a distant light source.

- The handle when connected to blade form the working position wherein the activator switch gets depressed to complete the electrical circuit.
- The handle grip is roughened for enhanced grip.
- There are various handle sizes available for practice.
- The angulation created where handle meets the blade is right angle commonly but acute or obtuse angulation does exist.

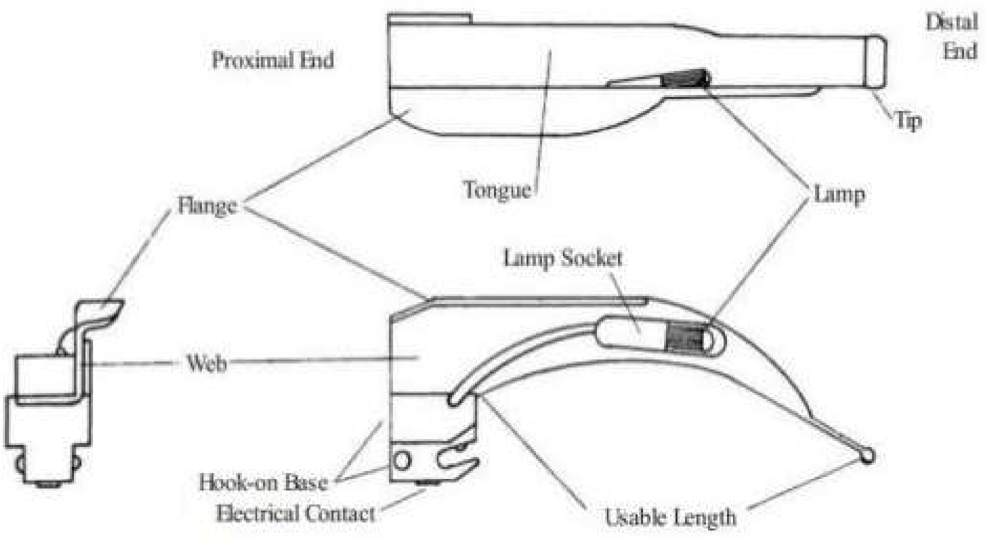


Figure 12 – Macintosh Laryngoscope

MACINTOSH LARYNGOSCOPE

It is the most popular simple rigid laryngoscope in clinical use now. The macintosh blade's tongue is gentle extending to the tip. A reverse Z is formed by blade's web, flange and the tongue in their cross section. Macintosh blade causes more cerical movement than miller blade, videostylet.[22]

Numerous modifications to the conventional Macintosh blade exist like Left handed Macintosh blade, English Macintosh, Polio blade, improved vision Macintosh blade, Tull (Suction) Macintosh blade.

- **RESPONSES TO LARYNGOSCOPY:**

Laryngoscopy includes lifting the epiglottis to visualise the glottis in order to pass the endotracheal tube to trachea to ventilate the patients. There are certain implications of laryngoscopy on cardiovascular and respiratory changes which are profound in their nature. These reflex responses are usually of short duration with little consequence to healthier patients but maybe catastrophic to patients with underlying comorbid conditions.

  - **CARDIOVASCULAR SYSTEM**:

The most commonly found reflex response to laryngoscopy in adults is tachycardia and systemic hypertension which is mediated through cardioaccelerator and sympathetic chain ganglia which leads to extensive release of norephinephrine from adrenergic nerve terminals, ephinephrine from adrenal medulla and beta adrenergic nerve stimulation leads to release of renin from stimulation of renin – angiotensin system. In younger individuals, direct laryngoscopy can cause vagal stimulation and bring about profound bradycardia.

- **CENTRAL NERVOUS SYSTEM**:

Laryngoscopy can trigger elevation of ICP in susceptible individuals as it increases cerebral blood flow and also is capable of increasing the cerebral metabolic rate of oxygen consumption.

- **RESPIRATORY SYSTEM**:

Direct laryngoscopy can cause traumatic as well as non-traumatic injuries to upper airway structures. Mucosal injury to lips, tongue, oro-pharynx, chipping of loose tooth, penetrating trauma to trachea, larynx, glottic structures leading to vocal cord palsies and dislocation of arytenoid cartilages. Extreme cervical flexion and extension can bring out spinal column fractures in high- risk patients. Sore throat is the most common complication related to direct laryngoscopy occurring in about 14 – 57% of patients undergoing general anaesthesia with endotracheal intubation. Laryngospasm is the most dreaded complication with direct laryngoscopy in patients who are inadequately sedated.

- **VIDEO LARYNGOSCOPE:**
  - Videolaryngoscope comprises of a laryngoscope which are designed to work in conjunction with a video-system offering distinguished advantages over simple laryngoscopes.

- It employs the use of video camera for visualization of upper airway and to guide endotracheal intubation.
- It is a form of indirect laryngoscopy through the camera eliminating the direct vision of airway with naked eyes.

- **INDICATIONS FOR VIDEO LARYNGOSCOPY:**
  - Elective nasal or oral intubation
  - Anticipated difficult airway
  - Unanticipated failed laryngoscopy
  - Diagnostic documentation of vocal cord functioning and recurrent laryngeal nerve functioning after thyroid or neck surgeries.
  - Obese individuals
  - Hypopharynx foreign body removal

- **CONTRAINDICATIONS FOR VIDEO LARYNGOSCOPY:**
  - No absolute contraindications
  - Blood or vomitus in the airway
  - Operator inexperience is a relative contraindication

- **ADVANTAGES OF VIDEO LARYNGOSCOPY:**
  - Superior efficacy when compared to direct laryngoscopy in difficult intubations.
  - Enhanced viewing of the airway without the need to align 3 airway axes.
  - High - resolution magnified live image of the airway.

- Reduced lifting force and hence decreased stressor response.
- Ability to cast the live image on monitor to be visualised by others for enhanced clinical decisions making in unanticipated difficult airway.
- Learning tool.

- **DISADVANTAGES OF VIDEO LARYNGOSCOPY:**

  - Varying learning curve.
  - Longer intubating time compared to direct laryngoscopy.
  - Obscured image of airway in presence of secretions and blood.
  - Expensive.

CLASSIFICATION OF VIDEO LARYNGOSCOPE: [23]

1. Macintosh modification
2. Angulated blade
3. Tube/guide channel

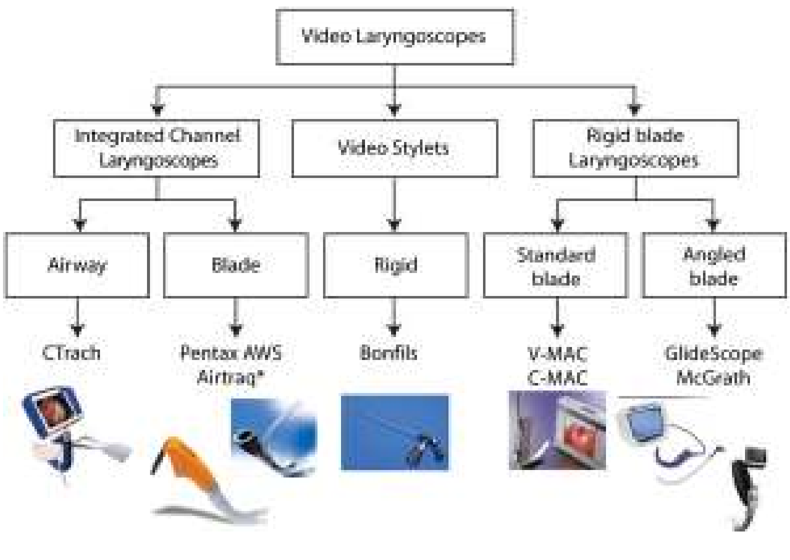


Figure 13 – Classification of Videolaryngscopes

RIGID VIDEOLARYNGOSCOPE WITH STANDARD MACINTOSH BLADE

- It consists of macintosh blade bound to a handle.
- The optical fibres remain embedded to a metal guide inside the blade covering the two-thirds of a blade.

GLIDESCOPE DIRECT: It is an architype of indirect videolaryngoscope displaying the visual anatomy of larynx and surrounding structures on to a monitor. Glidescope direct is built of plastic(medical grade) and are available in various sizes. The blade of glidescope direct is angulated 60 degrees at mid-blade allowing adequate laryngeal view manipulating surrounding tissues to a lesser degree. A small CMOS video camera accompanied by LED of higher power source is implanted behind the blade in the middle giving a vertical height of 16mm. The complete live image of the airway is broadcasted on a 7inch LED monitor.

CMAC VIDEOLARYNGOSCOPE: C- MAC is based on a modified Macintosh blade that has the same curvature as the standard, but is different from the original Macintosh blade. Its thinner profile and bevelled shoulder, both reduces the risk of oral and dental injuries. Its combined optical system of the CMAC consists of a complementary metal oxide semiconductor, high power LED at the distal third of the blade with effective antifogging properties. The external 7inch LCD colour monitor have a push button, storable standard SD memory with 2 GB capacity.

TRUVIEW PICTURE CAPTURE DEVICE: It is an exclusive 42 degree angulated Macinotsh blade tip and embedded optical lens, providing the view of airway across a 15mm eyepiece. It admits a LED light source contained in handle transmitting the light to the blade tip by optical fibres. It permits direct laryngoscopy and five blade sizes of Turview Picture Capture Device are available. There exists a magnetic connection through which eyepiece and PCD screen are linked broadcasting the image on the screen. The blades are furnished with oxygen insufflation as well as oxygen jet cleaning.

VIDEO LARYNGOSCOPE WITH TUBE GUIDING CHANNLES

KING VISION: It is a battery operated highly angulated video laryngoscope with a non-reusable blade. The batteries are reusable and the KING VISION is connected to a CMOS video camera and the image is transmitted to a monitor mounted on the scope itself. The videolaryngoscope provides a tube guiding channel which is optional. It offers only a solitary adult size blade.

PENTEX AIRWAY SCOPE: It comprises of a transparent blade of only one size in use and the entire assembly is operated through a battery. Pentex Airway Scope is wireless videolaryngoscope available with a single size blade and is very much handy and portable. The blade houses a suction port to let a suction catheter pass through it. It is different from other videolaryngoscopes in terms of use of device camera with flexible wire for charge and an LED light source than using a conventional CMOS camera chip used in various other videolaryngoscopes.

AIRTRAQ: The AIRTRAQ is a non-recyclable indirect laryngoscope with two channels provided on the blade to facilitate for passage of an endotracheal tube with one while the other channel accommodates a view finder which is proximally placed transmitting the image to an external monitor. It is available in multiple sizes for paediatric and adult use. Nasal version and double lumen versions are the alternatives available with AIRTRAQ.

RIGID VIDEOLARYNGOSCOPES WITH ANGLED BLADE

McGRATH MAC: It is user friendly rigid videolaryngoscope offering dual direct and indirect laryngoscopy features and has similar blade design to that of Macintosh blade. It consists of vertical display monitor with battery of 250 minutes backup. It has wide range of blades available for both pediatric and adult patients. The COMOS camera and LED of high intensity is part of the assembly with a steel reinforced camera stick. The blade is for single use and made of optical polymer robust in nature. The handle has lithium batteries insitu. A slimmer blade is also available.

C-MAC VIDEOLARYNGOSCOPE

The first Macintosh kind of videolaryngoscope system introduced for clinical practice in anaesthesiology is the C-MAC videolaryngoscope. The same device provides both direct as well as videolaryngocopic visualization of the oro-pharyngo-laryngeal structures. It is primarily manufactured by Karl Storz in the year 1999.

It comprises of:

1. Laryngoscope.
2. Electronic module.
3. 7 inch monitor.

The laryngoscope is plugged into the electronic module through which the optical image is displayed onto the monitor.

BATTERY: It features battery with lithium-ion technology providing 2 hours of continuous power source which is rechargeable. The monitor incorporates two buttons ie one to take still pictures while the other button continuously records video, all of which can be stored on detachable digital card.

LARYNGOSCOPE BLADES: The C-MAC blades are available in three sizes 2,3,4 for use in adult patients. The blades have larger proximal flange to aid smoother passage of endotracheal tube but would need a larger mouth opening to accommodate the blade.

CAMERA: The tip of C-MAC blade holds 320X240 pixel strength semi-conductor video-chip made of metal oxide and a fog-resistant lens offering 80 degree viewing angle located at the tip.

- **TECHNIQUE OF USE:**
    - Keep the videolaryngoscope unit ready for use.
    - Switch on the videolaryngoscope with blade(size 3 or 4) attached to the video base unit to confirm the working status of the entire unit and heating up will prevent the fogging of the lens.
    - Endotracheal tube is kept ready after checking the cuff.
    - Once the patient is induced, the videolaryngoscope blade is advanced into the oro-pharynx in the midline and the live image is visualised on the monitor while the blade is progressed into the vallecula.

- Lateral movement of the tongue is not necessary with the use of videolaryngscope.
- The epiglottis once visualised is lifted and vocal cords and glottic opening is pictured.
- The endotracheal tube is inserted through the glottic opening till the black line crosses the vocal cords.

Figure 14 – C- Mac Videolaryngoscope

OPTICAL STYLET

Optical stylets are rigid or semi-rigid tubular devices which encloses optical fibres inside the rigid tube. The endotracheal tube is rail-roaded over the stylet and a monitor is attached to the proximal end which displays the image. The CMOS video chip is another alternative to fibreoptic bundle located in the distal end of the sylet.

The BONFILS Fibrerscope, the LEVITAN FPS, the CLARUS VIDEOSYSTEM, ANICA videostylet are few examples of optical stylet in clinical use.

The optical stylets can either be used alone or in conjunction with the direct Macintosh laryngoscope for endotracheal intubation.

The optical stylets are usually manufactured with outer diameter of 5mm and hence an endotracheal tube of ≥5.5mm internal diameter can easily be rail-roaded over the stylet.

Most of the videostylets are battery operated and also incorporate additional features for oxygen insufflation, drug administration and suction.

Video stylets are portable, lighter to use, increase in heart rate is lesser when compared to conventional laryngoscopy, decreased incidence of sore throat, lesser degree of cervical spine movement, dental trauma and soft tissue trauma are few advantages associated with the use of optical stylet.

Oro-pharyngeal secretions, fogging of the video camera leads to distorted image on the monitor, longer intubation time, inability to perform naso-tracheal intubation and major disadvantage is failure to meticulously orient the distal end of video-stylet in accurate direction are few limitations associated with optical stylet.

In our study, ANICA videostylet was used. It has the following features:

- **MONITOR**: The monitor weighs 76 grams with width of 7.3cm and height of 5.7 cm. It is a 2.4 inch color TFT LCD monitor with auto brightness and display control with rechargeable Lithium-ion battery of 4.2V 800 mAh
- **STYLET**: The stylet weighs 28 grams with length of 33.5 cm and with outer diameter of 5.8 mm. It has CMOS camera installed at the distal end providing 54 degree field of view with white color illumination. It should be sterilized with Glutaraldehyde 2% solution.

TECHNIQUES OF USE:

- The video-stylet is prepared by attaching the semi-malleable optical stylet to the monitor.
- As soon as the stylet is attached to the monitor, the live image is displayed on the monitor.
- Hockey stick angulation of distal end of the stylet is prepared.
- Appropriate size endotracheal tube is rail-roaded over the stylet ensuring the distal end of the stylet lies within the distal end of the endotracheal tube.
- After the patient is adequately anaesthetized, the optical stylet with rail-roaded endotracheal tube is introduced into the oro-pharynx in sniffing position from the angle of the mouth with minimal jaw thrust.
- The video-stylet is progressed until the epiglottis, vocal cords and glottic structures is visualised and endotracheal tube is passed through it.

Figure 15 – Video-Stylet

MATERIALS AND METHODS

SOURCE OF DATA:

- Patients aged between 18-60 years, of all genders, belonging to ASA grade I and II and undergoing elective surgery in supine position with general anesthesia and tracheal intubation at KLE's Dr.Prabhakar Kore Hospital And Medical Research Centre, Nehru Nagar, Belagavi -10 during the period from January 2020 to March 2021.

METHODS OF COLLECTION OF DATA:

TYPE OF STUDY: Randomised clinical trial

DURATION OF STUDY AND STUDY POPULATION:

- Adult patients posted for surgery under general anesthesia between January 2020 - March 2021 at KLE'S Dr.Prabhakar Kore Hospital And Medical Research Centre, Nehru Nagar,Belagavi-10. will be recruited as per inclusion and exclusion criteria.

(Data Collection-15 Months)

INCLUSION CRITERIA:

- ASA physical status I and II
- Age between 18 to 60 years
- Patients undergoing elective surgeries under general anaesthesia
- Those who provide consent

EXCLUSION CRITERIA:

- Patient undergoing emergency surgery
- Patient who are unable to give consent
- Patients requiring rapid sequence intubation
- Patients who do not fulfil inclusion criteria.

SAMPLE SIZE CALCULATION:

- Statistical power analyses using G *Power 3.1: Tests for correlation and regression analyses (Heinrich Heine University) which came up to 19 in each group.
- To make the study more confirmative, the sample size will be raised to 30. There will be two groups with size 30 each.

SAMPLING PROCEDURE:

Randomization will be achieved by computer generated randomization chart

1. **METHODOLOGY:**
   - After attaining clearance from institutional ethical committee and written informed consent from patients, a total of sixty patients undergoing elective surgery under general anesthesia were recruited for the study.
   - After having met inclusion and exclusion criteria and the informed consent from patients, patients were randomised based on a randomization table generated based on an internet program into either

Group A (C-MAC) or Group B (Video-stylet).

- Group A: Patients in whom laryngoscopy and endotracheal intubation is done using C-MAC videolaryngoscope.
- Group B: Patients in whom endotracheal intubation is done using video-stylet.
- A thorough pre-anaesthesia evaluation of the patients was conducted the day before the surgery. Airway assessment was conducted and airway difficulty score was noted.
- The observations made were as per the table given below:

Numerical Score ranging from:

5-15 - low risk

15 - High risk for intubation

Criteria	Score 1	Score 2	Score 3
Thyromental distance	>6	5 - 6	<5
Mallampati score	I	II	III & IV
Mouth opening	>4	2-3	<1
Neck mobility	Normal	Reduced	Fixed flexion
Upper incisors	Absent	Normal	Prominent

- Before the start of the surgery, 18G or 20 G cannula was used to secure intravenous access in the pre-operative area and intravenous fluids were started.

- ASA mandated monitoring guidelines for general anaesthesia were followed before inducing general anaesthesia to the patients which included non-invasive arterial blood pressure, heart rate, ECG and oxygen saturation.
- Premedication with Injection. Glycopyrrolate 0.004 mg per kg (IV), Injection. Midazolam 0.05mg per kg (IV) and Injection. Fentanyl Citrate 2.0 mcg per kg (IV), and patients were pre-oxygenated with FIO_2 1 for a period of five minutes.
- Patients were induced with Injection. Thiopentone sodium 5 mg per kg (IV) and Injection. Succinyl-choline 2 mg per kg (IV).
- With the onset of neuro-muscular blockade, endo-tracheal intubation was performed in either of the groups using C-MAC video-laryngoscope (Group A) and intubating Video-stylet (Group B).
- Endotracheal tubes of 7.5mm ID were used for women and 8.5 mm ID for men.

The following were noted on tracheal intubation:

1) Intubation difficulty score

IDS PARAMETER	SCORE
Number of attempts > 1	N1
Number of operators > 1	N2
Number of alternative techniques	N3
Cormack Lehane Grading minus 1	N4
OPERTORS PERCEPTION OF LIFTING FORCE REQUIRED	
Normal	N5 = 0
Greater than in routine practice	N5 = 1
LARYNGEAL PRESSURE APPLIED	
Not applied	N6 = 0
Applied	N6 = 1
VOCAL CORD MOBILITY	
Abduction	N7 = 0
Adduction/ impeding tube passage	N7 = 1

Total IDS = Sum of scores N1-N7

IDS SCORE	DEGREE OF DIFFICULTY
0	Easy
1 – 5	Slightly difficult
>5	Moderate to major difficulty
∞	Impossible

2) Time taken for successful endotracheal intubation (in seconds) in this study was outlined as the time taken for transit of the laryngoscope or video-stylet tip as it surpasses the incisors till the emergence of the end- tidal Carbon dioxide tracing on the monitor.

3) Baseline Systolic and Diastolic Blood Pressure, along with Mean Blood pressure and Heart Rate at 1 minute, 3 minutes and 5 minutes after endo-tracheal intubation.
4) Any complications like desaturation / bleeding were noted.
   - After confirming bilateral equal air-entry, endo-tracheal tube was secured with tapes at appropriate length and mechanically ventilated. Maintenance of general anaesthesia with Oxygen, Nitrous oxide, Isoflurane and Injection. Vecuronium [0.08 mg per kg (IV) – 0.1 mg per kg (IV) every 20-30 minutes].
   - At the completion of the surgical procedure and after thorough oro-pharyngeal suctioning, complete neuromuscular reversal was achieved with Injection. Glycopyrrolate 0.008 mg per kg (IV) and Injection. Neostigmine 0.05 mg per kg (IV) and the endotracheal tube was then removed.

PARAMETER	BEFORE INDUCTION	AFTER INTUBATION		
		1^{ST} MIN	3^{RD} MIN	5^{TH} MIN
HEART RATE				
SYSTOLIC BP				
DIASTOLIC BP				
MAP				

ANALYSIS

- Data analysis using Shapiro Wilk and d'Agostino test.
- Parametric continuous data was analysed with ANOVA.
- Categorical data was analysed using the Chi Square test.

RESULTS

STUDY DESIGN: Randomized controlled trial.

Group A: Patients in whom laryngoscopy and endotracheal intubation is done using C-MAC videolaryngoscope

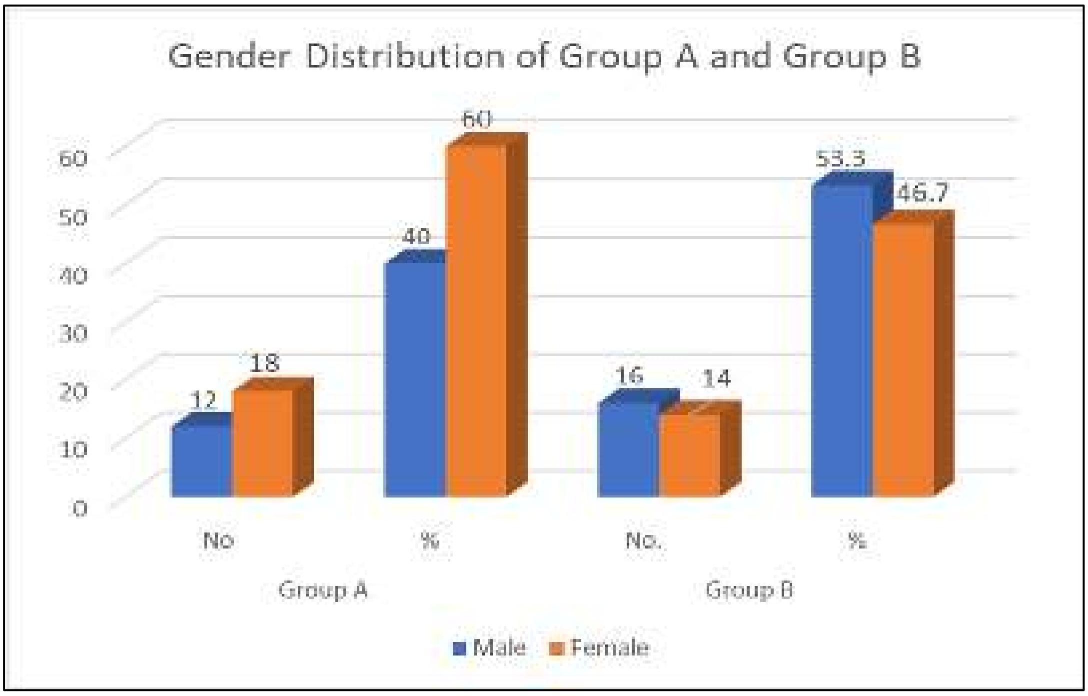
Group B: Patients in whom endotracheal intubation is done using video-stylet.

The study included 60 patients, 30 in each group ageD between 18 to 60 years of either sex belonging to ASA class I and II scheduled for elective surgeries under general anaesthesia in whom endotracheal intubation was to be performed.

Table 1: Gender Distribution Of The Patients In The Study

GENDER	GROUP A		GROUP B	
	No	%	No.	%
MALE	12	40	16	53.3
FEMALE	18	60	14	46.7
TOTAL	30	100	30	100

Graph 1: Bar graph depicting the gender distribution of patients studied.

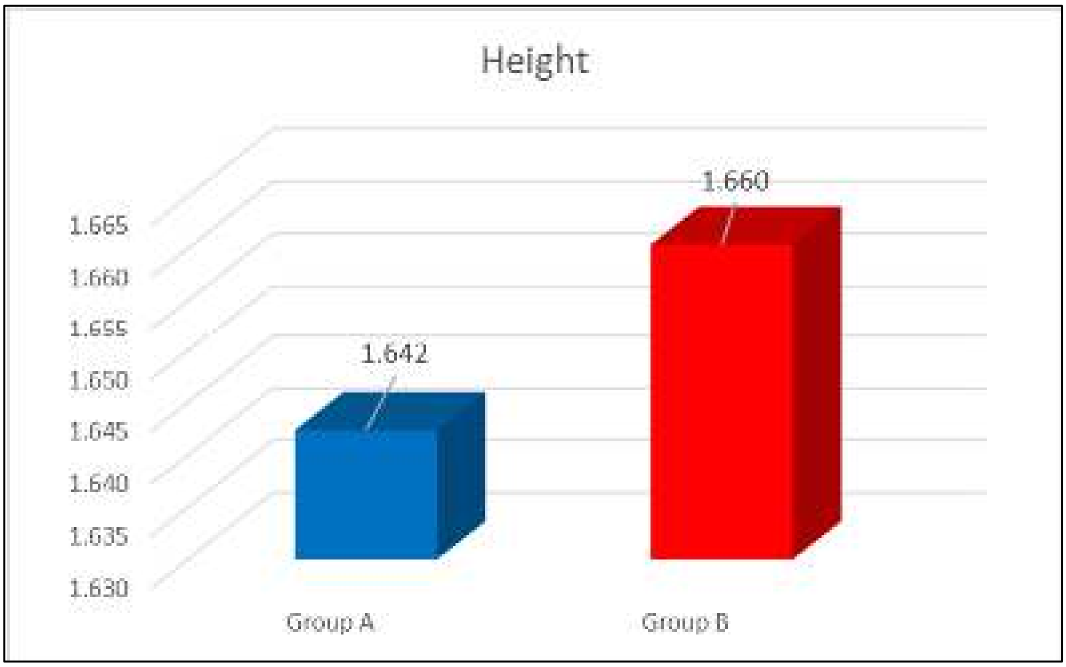


There was no extreme variation in gender distribution in the Group A and Group B in our study.

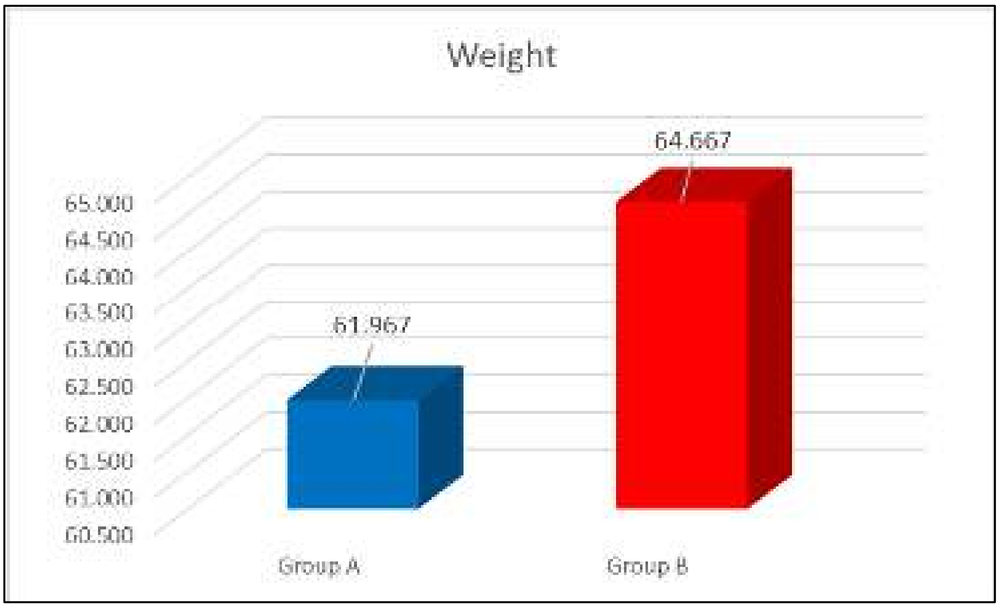
Table 2: Demographic Distribution Of The Study Population

	MEAN	SD	MIN	MAX
AGE(years)	38.03	11.86	18	60
	39.43	12.44	18	60
BMI(kg/m^2)	22.88	2.13	18.9	26.9
	23.48	1.65	19.8	26.8

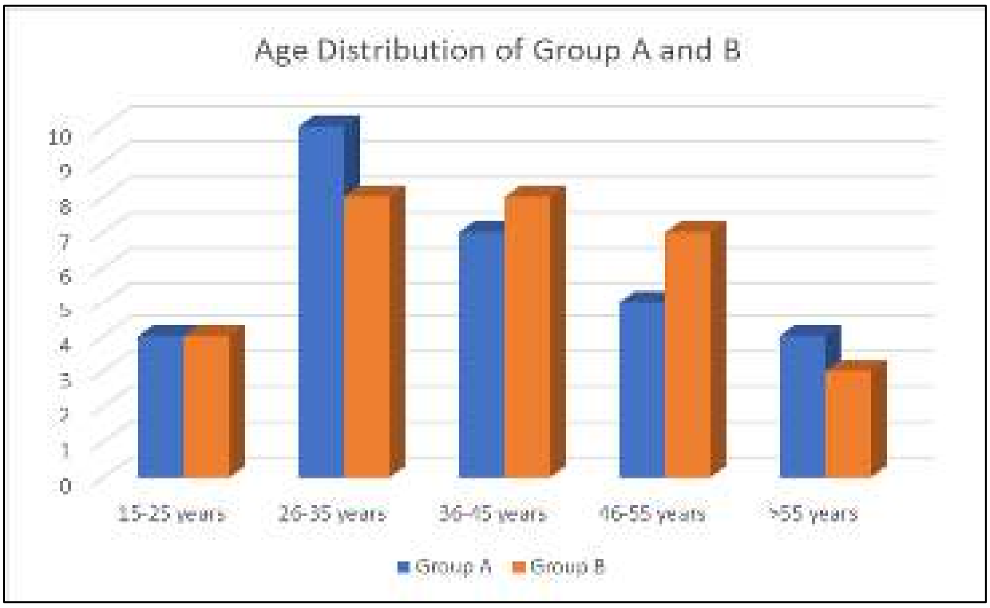
Graph 2: Bar Graph Depicting The Height Distribution Of Patients Studied.



Graph 3: Bar Graph Depicting The Weight Distribution Of Patients Studied.



Graph 4: Bar Graph Depicting The Age Distribution Of Patients Studied.

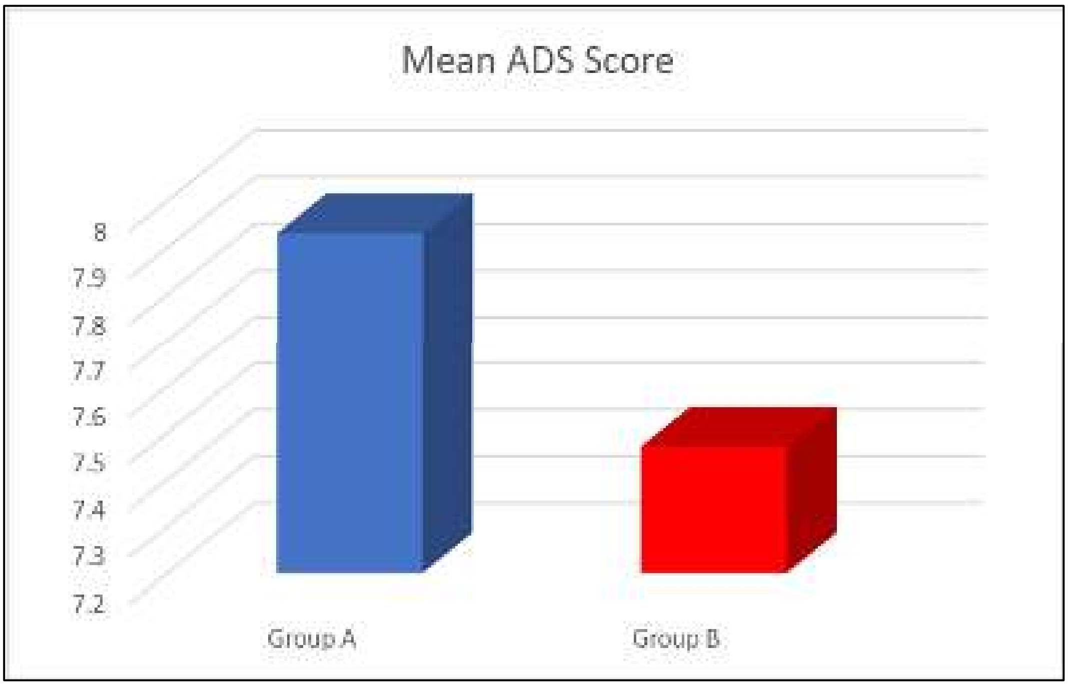


- The age of subjects of Group A and Group B was between 25-35 years
- As seen the average age of Group B (39.43 years) was more than that of Group A (38.03 years). The minimum age was 18 years and maximum age was 60 years in both the groups A and B.

Table 3: Airway Difficulty Score (ADS)

	Mean	SD	Min	Max	t- value	p-value
Group A	7.93	1.68	5	12	1.016	0.318
Group B	7.47	1.63	6	11		

Graph 5: Bar Graph Depicting The Means Of ADS.



- The t-value is 1.016. The p-value is 0.318. The result is insignificant at $p < .05$
- Patients in both Group A and group B have comparable airway difficulty characteristics.

Table 4:Intubation Difficulty Score Between Group A And Group B

IDS	Group A		Group B	
	Frequency	%	Frequency	%
0	1	3.3	10	33.3
1	11	36.7	19	63.3
2	13	43.3	1	3.3
3	5	16.7	0	0

t-Test: Paired Two Sample for Means		
	IDS Group A	***IDS Group B***
Mean	1.733333	0.7
Variance	0.616092	0.286207
Observations	30	30
t Critical one-tail	1.699127	

The t-value is 5.869. The p-value is < .00000. The result is significant at p < .05

Graph 6: Bar Graph Depicting The IDS Frequency.

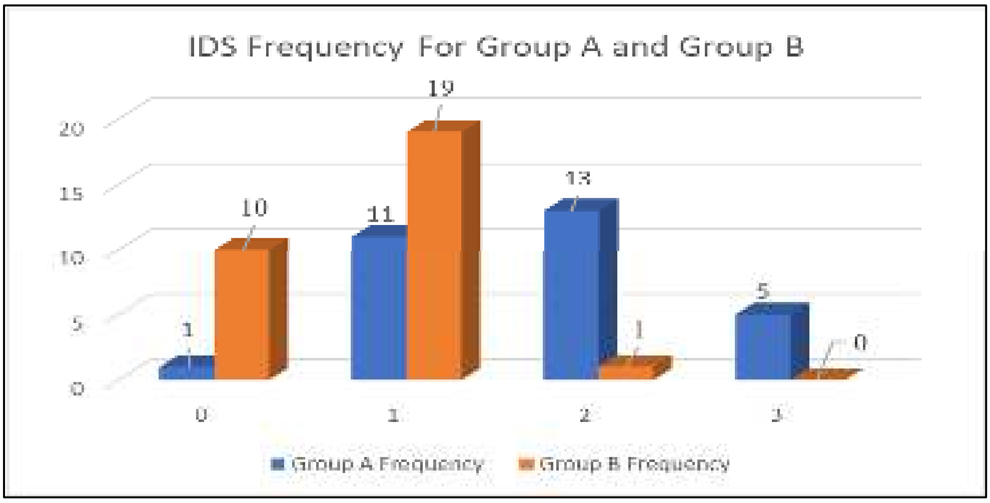
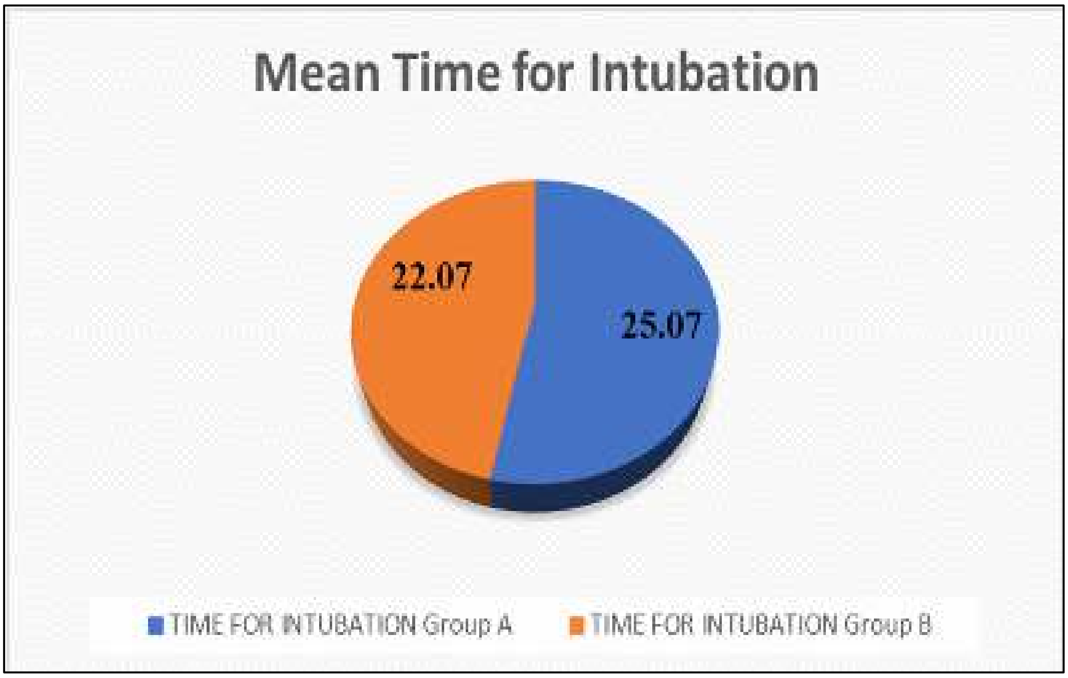


Table 5: Time For Intubation Between Group A And Group B

	MEAN	SD	MIN	MAX	t-VALUE	p-VALUE
GROUP A	25.07	1.66	22	29	6.747	.000
GROUP B	22.07	1.87	19	26		

Graph 7: Pie Chart Depicting the Mean Time for Intubation in Both Groups



The mean time for intubation in Group A was 25.07 and in Group B was 22.07. Thus, Group A was found to have higher time for intubation.

The t-value is 6.747. The p-value is < .00000. The result is significant at p < .0

Table 6: Heart Rate Comparision Between Group A And Group B Before Induction

t-Test: Paired Two Sample for Means		
	Group A	***Group B***
Mean	77.80	79.93
Std Dev	36.7861	150.823
Observations	30	30
Pearson Correlation	-0.23351	
Hypothesized Mean Difference	0	
Df	29	
t Stat	-0.78353	
P(T<=t) one-tail	0.219824	
t Critical one-tail	1.699127	

- Since the p-value 0.2198 is more than the significance level of 0.05, the difference between the means of Group A and Group B HR before induction is statistically insignificant.

Table 7: Heart Rate Comparision Between Group A And Group B After Intubation (1^{ST} MIN)

t-Test: Paired Two Sample for Means		
	Group A	***Group B***
Mean	112.4333	85.23333
Variance	82.39195	185.4264
Observations	30	30
Pearson Correlation	-0.243	
Hypothesized Mean Difference	0	
Df	29	
t Stat	8.227458	
P(T<=t) one-tail	0.0000	
t Critical one-tail	1.699127	

- Since the p-value 0.0000 is less than the significance level of 0.05, the difference between the means of Group A and Group B HR after intubation (1^{st} minute) is statistically significant.

- Hence, the increase in heart rate with video-stylet endotracheal intubation is lesser when compared to intubation with video-laryngoscope.

Graph 8: Line Graph Depicting Heart Rate Variation Before Induction And After intubation

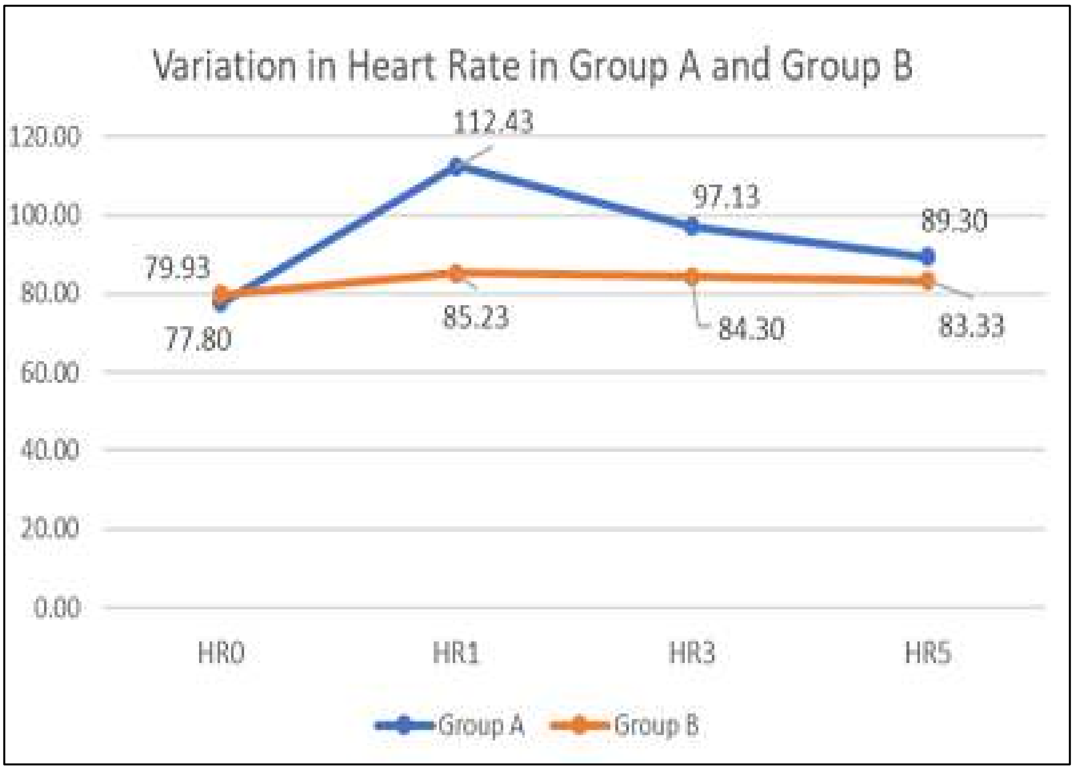


Table 8: Systolic Blood Pressure Comparision Between Group A And Group B Before Induction

t-Test: Paired Two Sample for Means		
	Group A	**Group B**
Mean	121.4	122.6667
Variance	128.869	267.954
Observations	30	30
Pearson Correlation	-0.06458	
Hypothesized Mean Difference	0	
Df	29	
t Stat	-0.3382	
P(T<=t) one-tail	0.368824	
t Critical one-tail	1.699127	

- Since the p-value 0.36882 is superior than the significance level of 0.05, the difference between the means of Group A and Group B SBP before induction is statistically insignificant.

Table 9: Systolic Blood Pressure Comparision Between Group A And Group B After Intubation (1st MIN)

t-Test: Paired Two Sample for Means		
	SBP1 A	**SBP1 B**
Mean	145.1333	129.6333
Variance	128.7402	278.3782
Observations	30	30
Pearson Correlation	-0.04072	
Hypothesized Mean Difference	0	
Df	29	
t Stat	4.130106	
P(T<=t) one-tail	0.00014	
t Critical one-tail	1.699127	

- Since the p-value 0.00014 is less than the significance level of 0.05, the difference between the means of Group A and Group B SBP after intubation (1st minute) is statistically significant.

- The rise in systolic blood pressure with video-stylet intubation was lesser when compared to intubation with video-laryngscope.

Graph 9: Line Graph Depicting Systolic Blood Pressure Before Induction And After Intubation

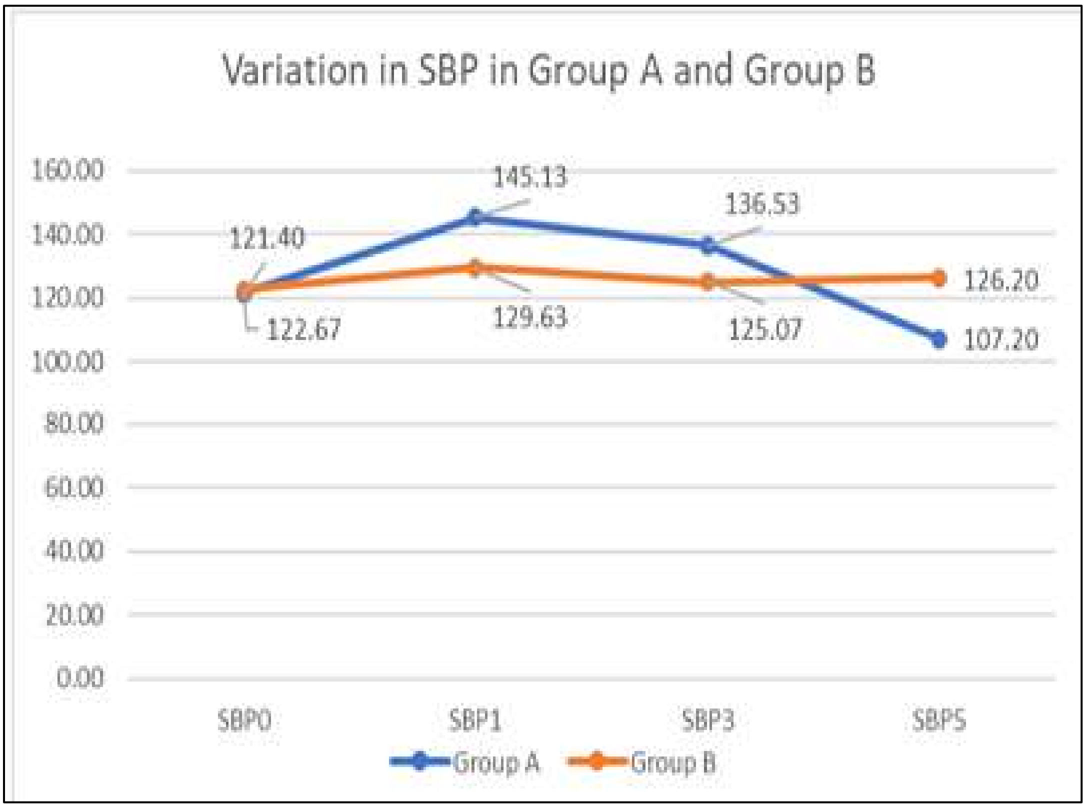


Table 10: Diastolic Blood Pressure Comparision Between Group A And Group B Before Induction

t-Test: Paired Two Sample for Means		
	DBP0 A	**DBP0**
Mean	73.93333	75.8
Variance	215.0299	75.13103
Observations	30	30
Pearson Correlation	-0.23234	
Hypothesized Mean Difference	0	
Df	29	
t Stat	-0.54711	
P(T<=t) one-tail	0.294244	
t Critical one-tail	1.699127	

- Since the p-value 0.29424 is greater than the significance level of 0.05, the difference between the means of Group A and Group B DBP before induction is statistically insignificant.

Table 11: Diastolic Blood Pressure Comparision Between Group A And Group B After Intubation (1st MIN)

t-Test: Paired Two Sample for Means		
	DBP1 A	DBP1 B
Mean	92.86667	80.13333
Variance	71.63678	106.4644
Observations	30	30
Pearson Correlation	-0.25249	
Hypothesized Mean Difference	0	
Df	29	
t Stat	4.678735	
P(T<=t) one-tail	0.00003	
t Critical one-tail	1.699127	

- Since the p-value 0.00003 is less than the significance level of 0.05, the difference between the means of Group A and Group B DBP after intubation (1st minute) is statistically significant.

Graph 10: Line Graph Depicting Diastolic Blood Pressure Before Induction And After Intubation

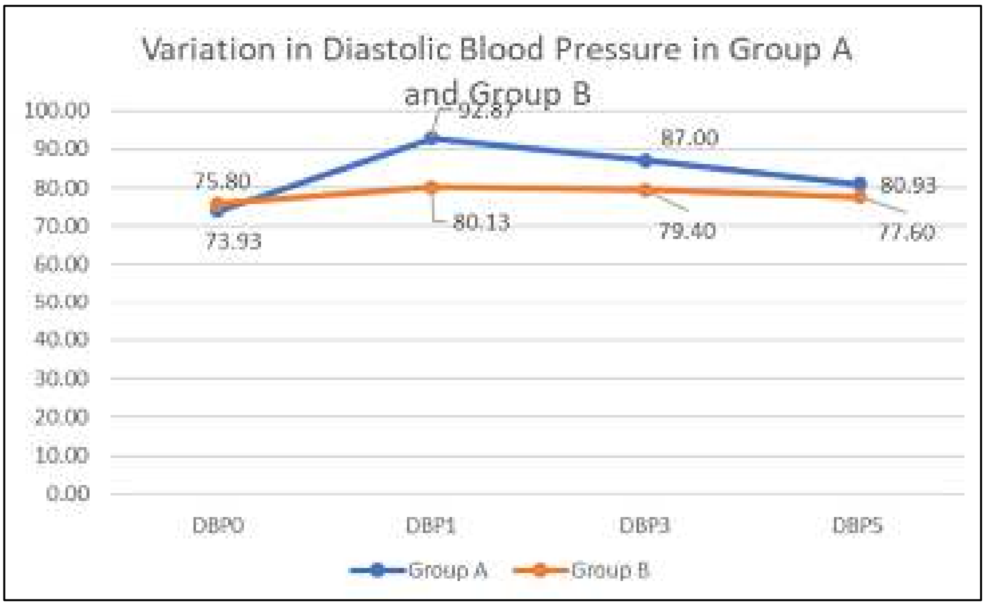


Table 12: Mean Blood Pressure Comparision Between Group A And Group B Before Induction

t-Test: Paired Two Sample for Means		
	Group A	**Group B**
Mean	90.46667	91
Variance	69.84368	127.3793
Observations	30	30
Pearson Correlation	-0.04241	
Hypothesized Mean Difference	0	
Df	29	
t Stat	-0.20UTN 391	
P(T<=t) one-tail	0.419923	
t Critical one-tail	1.699127	

- Since the p-value 0.419923 is greater than the significance level of 0.05, the difference between the means of Group A and Group B MAP before induction is statistically insignificant.

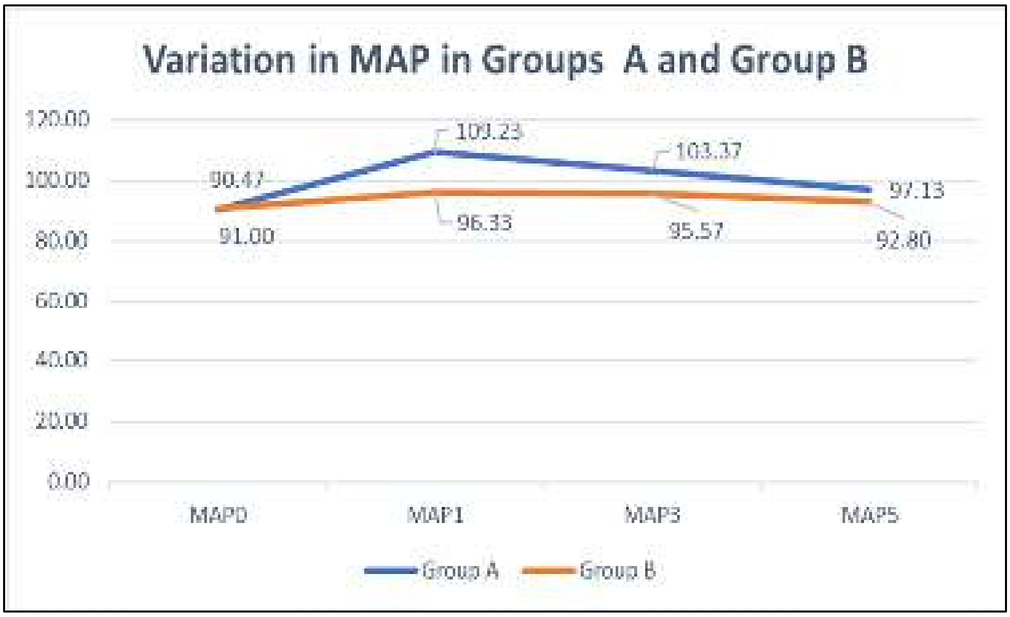
Table 13: Mean Blood Pressure Comparision Between Group A And Group B After Intubation (1st Min)

t-Test: Paired Two Sample for Means

	Group A	Group B
Mean	109.2333	96.33333
Variance	96.46092	147.7471
Observations	30	30
Pearson Correlation	-0.19045	
Hypothesized Mean Difference	0	
df	29	
t Stat	4.151371	
P(T<=t) one-tail	0.000132	
t Critical one-tail	1.699127	

- Since the p-value 0.000132 is less than the significance level of 0.05, the difference between the means of Group A and Group B MAP after intubation (1st Minute) is statistically significant.

Graph 11: Line Graph Depicting Mean Blood Pressure Before Induction And After intubation



DISCUSSION

Endotracheal intubation remains the mainstay for securing airway of patients undergoing general anaesthesia for surgical procedures. Over the years, Macintosh laryngoscope made endotracheal intubation easier but it did come with limitations. 2-9% of intubations were found to be difficult in general anaesthesia practice and had far reaching complications perioperatively. This was imperative for anaesthesiologists to take a straightforward approach collaborating with technology to invent video-laryngoscopes and video-stylets to visualize the airway and make intubations easier to perform and make modifications when difficult airway was encountered.

The use of video camera to procure live images of the trachea during intubation had positive implications on the overall success of endotracheal intubation with reduced hemodynamic response, lesser airway trauma and complications. Indian population being diversified, may provide normal intubation scenarios as well as unanticipated difficult airway scenarios which can be mitigated by the use of video-stylet or video-laryngoscopes for better visualization and securing airway in emergency.

Hence, we commenced a hospital centered randomized control trial in the Department of Anaesthesiology, KLE's Dr Prabhakar Kore Hospital and Medical Research Centre starting from January 2020 to March 2021. The study included a total of 60 adult patients aged between 18 years of age to 60 years of age, posted for surgeries under general anaesthesia. 30 patients each were randomly distributed into two groups according to computer generated randomized table. Group A included patients undergoing endotracheal intubation with C-MAC videolaryngoscope and group B had patients in whom endotracheal intubation was performed using the video-stylet.

In our study, among 30 patients enrolled under group A (C-MAC videolaryngoscope group), 12 were male and rest 18 were female. In group B (Video-stylet group), 16 were male and 14 were female. The mean of BMI in group A (C-Mac videolaryngoscope group) was 22.88(±2.13) kg/m^2 and 23.38(±1.65) kg/m^2 in group B (Video-stylet group). The mean age in group A was 38.03 (±11.86) years while in group B it was 39.43(±12.44) years. Hence, we can conclude from above finding that the patients enrolled exhibited comparable demographic elements regarding gender distribution, BMI and age across the two groups.

In our study, 66.7% of patients were ASA 1 and 33.3% were ASA 2 physical status in group A (C-MAC videolaryngoscope) while 63.3% of patients with ASA 1 and 36.7% ASA 2 patients in group B (Video-stylet). The mean of ADS (Airway Difficult Score) in C-MAC Videolaryngoscope group was 7.93(±1.68) while ADS in Video-stylet group was 7.47(±1.63).Both the groups in our study were comparable in terms of ASA grading and the ADS scores of the patients.

The ease of insertion being the primary objective of the study, in C-MAC videolaryngoscope group, it was easier to intubate in one patient whereas slight difficulty was experienced with the rest of the 29 patients according to IDS (Intubation Difficulty Score) due to slipping of endotracheal tube into the esophagus or with more than one attempt required for intubation. In comparison, 10 patients were found to be intubated easily using the video-stylet and slight difficulty was experienced in 20 patients with video-stylet based intubation ($P<0.0001$), it was probably because jaw thrust was required for manoeuvring the semi-malleable stylet into the oro-pharynx. These results were statistically significant suggesting that video-stylet was superior to C-MAC videolaryngoscope for endotracheal intubation.

The intubation time using Video-stylet in our study was 22.07(±1.87) seconds (P- 0.000) when compared to a study conducted by Syed Hussain Amir et al[24] on eighty patients with normal airway to compare fibre-optic bronchoscope with video-stylet, it was observed that the time taken for intubation in video-stylet group was significantly less compared to fibre-optic bronchoscope (Mean of 19.7 seconds vs 38.2 seconds with P=0.0001) which was similar to our study where the mean time for endotracheal intubation was significantly less in the video-stylet group which might be due to J-angulation or hockey stick angulation of the distal end of video-stylet which was tailored according to the patient's anatomy prior to endo-tracheal intubation which facilitated earlier and easier visualization of the glottic opening.

The intubation time using C-MAC video-laryngoscope in our study was 25.07 seconds (P- 0.000) when compared to a study as observed by A. Jungbauer et al[40] was 40(31, P¼0.017) seconds and another study by Micheal F Aziz et al[41] having intubation time with C- MAC videolaryngoscope being 46 seconds (P<0.001), was statistically significant. These findings of shorter intubation with C-MAC videolaryngoscope can be attributed to visualisation of a clearer image of glottic opening and also considering the easy to slight difficult intubation cases in our study.

One of the major advantages of using video-stylet for endotracheal intubation being the reduced hemodynamic response when compared to response caused by rigid laryngoscope intubation or C-MAC assisted intubation was supported by our study.

The increase in heart rate measured before induction and after 1 minute of intubation revealed statistically significant (P<0.000) rise in heart rate in group A (C-MAC Videolaryngoscope) when compared to group B (Video-stylet). The rise in systolic blood pressure, diastolic blood pressure and mean blood pressure after 1 minute of intubation in C-MAC video-laryngoscope when compared to video-stylet group showed statistically significant (SBP- p<0.0014, DBP- p<0.00003, MAP- p<0.000132) results, denoting that the stress response to intubation was higher in comparison to video-stylet group.

A study conducted by Duk Dong Ko et al[29] showed that the time for intubation using Optiscope video-stylet was 20.5 seconds, and there was a statistically significant increase in hemodynamic variables one minute after intubation than before induction. When compared to our study, the time for intubation using video-stylet was 22.7 seconds and the hemodynamic response to intubation was statistically comparable with the video-stylet based intubation.

In another study by Hyun-Kyu Yoon et al[45] on comparing McGrath video-laryngoscope with Optiscope video-stylet in manual inline cervical stabilized patients, the time for intubation between the two groups (Group M 35.7 ± 27.8 vs Group O 49.2 ± 43.8) were significantly higher when compared to our study (C-Mac videolaryngoscope 25.07 seconds Vs Videostylet group 22.7 seconds). The hemodynamic response comprising of HR and MAP in the two groups before induction and one minute after intubation were not statistically significant while in our study the rise in HR and MAP were significantly higher in videolaryngoscope group than the video-stylet group. This suggests that attenuation of stressor response can be achieved efficiently with video-stylet due to decreased manipulation of pharyngeal tissues without lifting the epiglottis to visualise the vocal cords.

All the intubations using the video-stylet were successful in our study. It suggests that even though it might be a novel device for endotracheal intubation, it offers an easier learning curve and is advantageous for novice learners to use the device for intubation which was further substantiated by Jieun Youn et al[25] in their study (mean intubation time of 24 seconds and success rate of 96.4% with video-stylet).

Cricoid pressure is one of the aspects of intubation during routine as well as difficult laryngoscopy. Indirect laryngoscopy with the use of C-MAC video-laryngoscope as well as video-stylet confers the advantage of non-usage of cricoid pressure for intubation as live visual images of the larynx. These observations were further confirmed in our study with none of the intubations requiring cricoid pressure during intubation either with video-laryngoscope or video-stylet but Yen Chu Lin et al[36] in their study suggested alternate findings, stating that cricoid pressure would be handy for intubation even with usage of video intubating systems·

Securing airway with endotracheal tube can be achieved successfully either with direct or indirect laryngoscopy. Indirect laryngoscopy with live imaging of laryngeal aperture and passing the endotracheal tube is considered gold standard in clinical practice. The video-stylet with endotracheal tube rail-roaded over it can offer a significant advantage of being used as a single device or in tandem with direct laryngoscopy for endotracheal intubation. This could be made use of in elective as well as emergency situations as confirmed by Markus Weiss et al[30] in their study. So, we can conclude that the use of video-stylet can further be extended to use in emergency scenarios and in difficult laryngoscopy cases for securing airway endoscopically as it does not hinder conventional laryngoscopy.

Hoarseness of voice, sore throat and bleeding in pharynx are possible post operative concerns regarding the use of direct or indirect laryngoscopy. These complications could perhaps be due to the diameter of the endotracheal tube, the cuff pressure and design, inadequate depth of anaesthesia allowing movement of vocal cords, or manipulation of the epiglottis and laryngeal structures as a whole during direct laryngoscopy. Reducing the time for intubation with videolaryngoscope can further decrease the damage caused by camera lens to the pharyngeal tissue as attributed by De Xing Liu et al[39] and Ji Yeon Lee et al[37] in their study. In our study the time taken for intubation with videolaryngoscope and video-stylet was shorter and hence the incidence of complications was nil. There were no post operative complications noted in our study and is comparable with H.T Hsu et al[38], as all the necessary precautions were taken and manoeuvring the endotracheal tube only after adequate visualisation of the laryngeal inlet.

LIMITATIONS:

There were a few limitations in our study.

1. Primarily, all the intubations were done by a single investigator in both the groups, hence performer bias could not be ruled out. However the results concerning our primary objectives did not diverge from other previous studies where indirect laryngoscopy with video-laryngoscope or video-stylet was used, meaning performer bias could be minimal.
2. Secondly, Percentage of Glottic opening (POGO) scoring should have been considered as an objective scoring system for visualization of glottic opening and the implications of its use in videolaryngoscope and video-stylet.

CONCLUSION

From our study we conclude that the ease of intubation using video-stylet is superior when compared to intubation with C-MAC video-laryngoscope

The time taken for intubation using video-stylet was comparatively lesser than C-MAC videolaryngoscope.

The hemodynamic stressor response to intubation with video-stylet was significantly lesser when compared to C-MAC videolaryngoscope.

There was no complication noted in either of the two groups.

SUMMARY

In this study titled **"COMPARISON OF EASE OF TRACHEAL INTUBATION USING INTUBATING VIDEO-STYLET WITH C-MAC VIDEO LARYNGOSCOPE: A ONE YEAR RANDOMISED CLINICAL TRIAL",** we have studied the ease of intubation using Intubation Difficulty Score(IDS), the time for insertion of endotracheal tube, the hemodynamic response to intubation and the incidence of complications with the use of two devices.

In our study, a total of sixty patients aged between eighteen and sixty years belonging to ASA category I and II, all of whom met the inclusion criteria were enrolled. After being randomly divided into two groups, patients were individually intubated with the C-MAC videolaryngoscope in Group A or Video-stylet in Group B device. All the variables were measured and tabulated separately.

All the patients in this study were comparable in terms of age, BMI, gender distribution and ASA physical status across the two groups. The patients enrolled into the study had mean Airway Difficult Score of 7 in either group and the mean intubation time was significantly higher with video-laryngoscope when compared to video-stylet group. The Intubation Difficulty Score was significantly lesser in the video-stylet group when compared to the C-MAC video-laryngoscope group. The stressor response (HR, SBP, DBP) to intubation with video-stylet was negligible in contrast to the higher hemodynamic response to intubation with C-MAC video-laryngoscope. No complications were observed in the study.

Hence, we concluded from our study that video-stylet offered better intubating conditions in terms of ease of intubation, time for endotracheal intubations and better hemodynamic stressor response when compared to the C-MAC video-laryngoscope.

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ANNEXURE-I

CONSENT FORM

Mr/Mrs/Miss. ______________________________ we are requesting you to enrol you in study titled **"COMPARISON OF EASE OF TRACHEAL INTUBATION USING INTUBATING VIDEO-STYLET WITH C-MAC VIDEO LARYNGOSCOPE: A ONE YEAR RANDOMISED CLINICAL TRIAL,** conducted by Dr. Darshan R.L Post Graduate in M.D. Anaesthesiology under the guidance of Dr. Manjunath C. Patil$_{M.D}$ Professor, Department of Anaesthesiology, J.N. Medical College, Belagavi under KLE University, Belagavi.

Respected Sir/Madam We request you 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 this 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.

INTRODUCTION AND PURPOSE:

The present study is conducted among adult patients scheduled for various elective surgeries under general anaesthesia with endotracheal intubation under Department of Anaesthesiology at KLE's Dr. Prabhakar Kore Charitable Hospital and Medical Research Centre, Belagavi. You are requested to participate in the study and your participation is completely voluntary.

The aim of the study is to find out the ease of tracheal intubation and time taken to intubate with intubating video stylet and the C-MAC video laryngoscope. This will help to compare both the instruments for endotracheal intubation and determine which instrument helps in securing the airway in lesser time and in preventing stressor response during intubation.

PROCEDURE:

If you agree to participate in the study, the relevant data will be collected as per the proforma. Once the patient is inducted in the study he/she will be randomly allocated to either one of the study groups and intubation will be performed based on the assigned group. Ease of endotracheal intubation using both the instruments will be assessed using Intubation Difficulty Score and Time for Endotracheal intubation will be recorded along with Heart Rate, Blood pressure and incidence of complications.

BENEFITS:

Patient will not be eligible for any kind of monetary benefits or free services by virtue of your participation in the study.

RISKS:

Methods applied to do the study are safe.

COST OF PARTICIPATION:

The cost of the investigation will be borne by the study subject. The other indirect expenses will be borne by the investigator.

PRIVACY AND CONFIDENTIALITY:

The results of the study may be published in journals for scientific purposes. However, your identity will not be revealed. All information collected will be coded so that no one other than the investigator will know your identity.

WITHDRAWAL FROM THE STUDY:

You can withdraw from the study at any time if you wish to do so.

ALTERNATIVES:

In case you opt out of the study, you will get the routine line of management and it will not affect your relationship with KLE's Dr. Prabhakar Kore Hospital.

AUTHORIZATION TO PUBLISH RESULTS:

The researcher may use the information gathered from this study for presentation in scientific meetings. However, your identity will not be revealed. Any information that is obtained in connection with this study and that can be identified with your identity will remain confidential.

INSTITUTIONAL/ SPONSORS POLICY:

In the event of any injury related to this study, no reimbursement or compensation will be given by law. However, treatment will be made available at KLE's Hospital & MRC, Belgaum. If you face any untoward event, you may contact _____________, Post Graduate student, Department of Anaesthesiology under the guidance of ______________, Professor, Department of Anaesthesiology, J.N. Medical College, Belagavi under KAHER, Belagavi.

LEGAL RIGHTS:

By signing this consent form, you are not waiving any of your legal rights.

QUERIES AND CONTACT:

If you have any queries about your rights as research participant, you can contact **Dr. Roopa Bellad M.D,** Professor, Dept of Paediatrics and chairman, J.N Medical College Institutional Ethical Committee for Human Subjects Research.

CONSENT SUMMARY:

I have been explained all the contents of this consent form in my vernacular language and having understood and clarified all my queries about the study to the best of my knowledge, I hereby give my voluntary consent for participation in the study. I do sign the informed consent form in front of an eye witness whom I recognize.

Subject Name: ____________________

Signature/Left Thumb Print: _____________

Investigators Name: ____________ Signature: ______________

Witness Name: ________________ Signature: ______________

Date: ________________ Place : ______________

CONSENT STATEMENT TO PARTICIPATE IN RESEARCH STUDY

I, Mr/Mrs ___________________________voluntarily agree for the participation as a subject for the study. By signing this consent form, I am not giving up any of my legal rights. I may withdraw from the study any time. I am signing the consent form after having read or been read to me in my vernacular language, including the risk and the benefits and having all my queries cleared.

Name of study patient: ____________________

Signature or the left thumb impression: _______________

Name and signature of witness: ___________________

Name and signature of investigator: __________________

Date:___________ Place:_____________

ANNEXURE-II

PROFORMA

"COMPARISON OF EASE OF TRACHEAL INTUBATION USING INTUBATING VIDEO-STYLET WITH C-MAC VIDEO LARYNGOSCOPE": A ONE YEAR RANDOMISED CLINICAL TRIAL"

Name	:	Age	:
Gender	:	Weight	:
Height	:	Date of Examination	:
Address	:	Occupation	:

Pre examination evaluation

Past History

- HTN / DM/ IHD / Arrhythmia / LVH / Valvular heart diseases.
- H/o previous surgery/(s) where airway difficulty was encountered.

General physical examination

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

Systemic examination:

RS : CNS :

CVS : GIT :

Preoperative physical status ASA Grade I II III IV V

Inclusion Criteria:

- ASA physical status 1 and 2.
- Age between 18 to 60 years.
- Patients undergoing elective surgeries under general anesthesia.
- Provides consent

Exclusion Criteria:

- Patient undergoing emergency surgery.
- Patient who are not able to give consent.
- Patients requiring rapid sequence intubation.
- Patients who do not fulfill inclusion criteria.

METHODOLOGY:

After obtaining the approval of ethical committee and written informed consent, a total of 60 patients undergoing surgery under general anesthesia will be included in the study.

After having met inclusion and exclusion criteria and having obtained informed consent, patients will be randomised based on computer generated randomization table into one of the two groups.

Group A: Patients in whom laryngoscopy and endotracheal intubation is done using C-MAC videolaryngoscope.

Group B: Patients in whom endotracheal intubation is done using video-stylet.

A through pre-anesthetic evaluation will be done on the day before surgery. Airway assessment will be done and airway difficult score noted. The observations made is as per the table given below:

Numerical Score ranging from 5-15

5- low risk

15-high risk of intubation

Airway difficult score (ADS)[8]

Criteria	Score 1	Score 2	Score 3	Observations
Thyromental distance	>6	5-6	<5	
Mallampatti score	I	II	III&IV	
Mouth opening	>4	2-3	<1	
Neck mobility	Normal	Reduced	Fixed flexion	
Upper incisors	Absent	Normal	Prominent	
TOTAL AIRWAY DIFFICULT SCORE				

On the day of surgery, intravenous access will be secured using 18G or 20 G iv cannula and iv fluids will be started.

Standard monitoring devices are attached before induction of anesthesia, including non-invasive arterial blood pressure, heart rate, ECG and oxygen saturation.

Patients will be premedicated with Injection. Glycopyrrolate 0.004mg/kg and Injection. Midazolam 0.05mg/kg and Injection. Fentanyl citrate 2.0 mcg/kg and pre-oxygenated with 100% oxygen for 5 mins.

Patients will be induced with Injection. Thiopentone sodium 5 mg/kg and Inj. Succinyl-choline 2 mg/kg. With the onset of neuro-muscular blockade, endo-tracheal intubation is done in either of the groups using C-MAC video-laryngoscope (Group A) and intubating Video-stylet (Group B).

Tracheal tubes of internal diameter 7.5mm were used for women and 8.5 mm for men. The following will be noted on tracheal intubation:

IDS parameter	Score	Observations
Number of attempts >1	N1	
Number of operators >1	N2	
Number of alternative techniques	N3	
Cormack Lehane Grading minus 1	N4	
Operator's perception of lifting force required		
Normal	N5=0	
Greater than in routine practice	N5=1	
Laryngeal Pressure applied		
Not applied	N6=0	
Applied	N6=1	
Vocal cord mobility		
Abduction	N7=0	
Adduction/ impending tube passage	N7=1	
TOTAL SCORE AFTER INTUBATION		

1. Time taken for successful intubation (in seconds) defined as the time from the passage of the laryngoscope or video-stylet tip past the incisors to the appearance of the end- tidal Carbon-dioxide trace.

   Time taken for intubation _____________ seconds.

2. Baseline Heart Rate, Systolic Blood Pressure, Diastolic Blood Pressure and Mean Blood Pressure and same variables at 1^{st} minute, 3^{rd} minute and 5^{th} minute after endo-tracheal intubation will be noted as follows:

PARAMETER	BEFORE INDUCTION	AFTER INTUBATION		
		1^{ST} MIN	^{3RD} MIN	5^{TH} MIN
HEART RATE				
SYSTOLIC BP				
DIASTOLIC BP				
MEAN BP				

3. Any complications like desaturation / bleeding will be noted.

After confirming bilateral equal air-entry, endo-tracheal tube was secured with tapes at appropriate length and mechanically ventilated.

Patients will be maintained with Oxygen, Nitrous oxide, Isoflurane and Injection. Vecuronium(0.08 mg/kg – 0.1 mg/kg).

At the end of the procedure, patients will be reversed with Injection. Glycopyrrolate 0.008 mg/kg and Injection. Neostigmine 0.05 mg/kg and extubated after thorough suctioning.

- SIGNATURE OF THE ANAESTHESIOLOGIST - _____________________
- SIGNATURE OF THE WITTNESS - ________________________________
- SIGNATURE OF THE PRINCIPAL INVESTIGATOR - _________________

ANNEXURE III ETHICAL CLEARANCE

K.L.E. ACADEMY OF HIGHER EDUCATION AND RESEARCH
(Deemed - to- be- University)
Accredited 'A' Grade by NAAC (2nd Cycle) Placed in Category 'A' by MHRD (GoI)

JAWAHARLAL NEHRU MEDICAL COLLEGE,
NEHRU NAGAR, BELAGAVI-590010 (KARNATAKA-INDIA)

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Ref: MDC/DOME/ 162 **Date: 24/12/2019**

To,

REG NO. BA0119004
PG student in Anaesthesiology,
J.N.Medical College,
BELAGAVI.

Sub: Institutional Ethical Clearance for the study.

With reference to the above, we wish to inform you that your proposed research project titled **"COMPARISON OF EASE OF TRACHEAL INTUBATION USING INTUBATING VIDEO-STYLET WITH C-MAC VIDEO LARYNGOSCOPE: A ONE YEAR RANDOMISED CLINICAL TRIAL "**, is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee on Human Subjects Research.

(Dr. Anita Dalal)
Member Secretary
JNMC Institutional Ethics Committee
on Human Subjects Research,
J.N.Medical College, Belagavi.

(Dr. Roopa M Bellad)
Chairman,
JNMC Institutional Ethics Committee
on Human Subjects Research,
J.N.Medical College, Belagavi.

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ANNEXURE –IV PHOTOGRAPHS

Photographs No.1 C-Mac Videolaryngoscope

Photographs No.2 Video-Stylet

Photographs No.3 Glottic view using Video-Stylet

ANNEXURE-V

KEY TO MASTER CHART

F	-	Female
M	-	Male
ASA	-	American Society of Anaesthesiologists status
m	-	Metre
kg	-	kilograms
BMI	-	Body Mass Index
Kg/m^2	-	Kilograms per square meter
ADS	-	Airway difficulty Score
IDS	-	Intubation Difficulty Score
SEC	-	Seconds
HR	-	Heart Rate
Bpm	-	beats per minute
SBP	-	Systolic Blood Pressure
DBP	-	Diastolic Blood Pressure
MBP	-	Mean Blood Pressure
mm hg	-	Millimetre of mercury

ANNEXURE-VI- MASTER CHART

GROUP A

										BEFORE INDUCTION				AFTER INTUBATION (1ST MINUTE)				AFTER INTUBATION (3RD MINUTE)				AFTER INTUBATION (5TH MINUTE)			
SLNO	AGE(yrs)	SEX	ASA	HEIGHT(m)	WEIGHT(kg)	BMI(kg/m2)	ADS	IDS	TIME FOR INTUBATION(sec)	HR(bpm)	SBP(mm hg)	DBP(mm hg)	MAP(mm hg)	HR(bpm)	SBP(mm hg)	DBP(mm hg)	MAP(mm hg)	HR(bpm)	SBP(mm hg)	DBP(mm hg)	MAP(mm hg)	HR(bpm)	SBP(mm hg)	DBP(mm hg)	MAP(mm hg)
1	23	F	1	1.58	48	19.2	6	1	25	72	110	78	88	108	140	98	112	94	134	88	103	80	120	84	96
2	28	M	1	1.68	70	24.8	6	2	25	74	110	70	82	110	140	98	112	92	126	84	101	86	122	76	89
3	31	F	1	1.6	56	21.9	5	2	23	76	130	80	96	116	164	104	124	100	146	92	109	86	142	86	100
4	48	M	2	1.7	66	22.8	8	2	24	80	140	90	106	104	172	110	132	86	156	104	120	96	150	96	112
5	42	F	2	1.58	60	24	8	2	25	78	126	78	94	120	150	90	110	98	138	88	107	88	140	84	103
6	47	F	2	1.61	58	22.4	9	1	24	82	128	78	94	120	150	92	111	97	144	88	105	96	140	84	102
7	36	F	1	1.58	52	20.8	8	2	23	78	108	72	88	116	140	98	112	99	130	80	99	88	120	78	97
8	32	F	1	1.6	54	21.1	8	3	25	80	110	66	80	114	140	98	112	101	132	92	105	85	122	70	86
9	28	M	1	1.73	68	22.7	6	1	26	86	118	78	91	124	138	80	99	104	138	84	102	98	134	80	98
10	36	M	1	1.69	74	25.9	9	1	28	76	116	66	82	106	136	78	97	90	130	74	93	86	126	70	89
11	45	M	1	1.76	73	23.6	6	1	25	78	122	72	88	110	144	92	109	95	134	88	103	78	120	68	85
12	30	M	1	1.7	64	22.1	6	1	25	78	110	70	83	105	138	92	107	90	130	84	99	92	136	90	105
13	30	F	1	1.59	59	23.3	8	1	26	72	120	80	93	102	140	90	106	90	136	88	104	90	138	88	104
14	51	F	2	1.61	65	25.1	11	3	29	78	138	84	102	114	160	98	118	102	152	96	116	88	146	90	109
15	38	F	1	1.63	58	21.8	8	2	26	80	116	8	84	125	136	80	100	108	130	76	96	96	126	72	92
16	56	M	1	1.72	68	23	6	1	24	58	126	78	94	88	136	88	104	80	126	84	101	70	112	78	89
17	22	M	1	1.69	54	18.9	6	1	24	80	120	72	88	126	144	88	106	104	138	82	100	96	134	76	96
18	35	F	1	1.62	58	22.1	8	2	25	72	116	74	88	112	136	90	96	100	130	86	101	82	126	84	97
19	48	F	2	1.55	62	25.8	8	2	24	84	122	78	92	117	146	98	106	102	140	92	102	98	136	84	99
20	35	F	1	1.59	55	21.8	6	1	26	82	128	82	97	123	152	96	113	110	140	94	110	96	138	88	106
21	30	F	1	1.58	55	22	8	2	25	76	116	78	90	104	144	100	115	96	130	88	103	86	126	84	99
22	31	F	1	1.61	58	22.4	8	2	23	78	118	70	86	100	140	84	103	86	136	80	99	88	130	76	96
23	18	F	1	1.58	48	19.2	9	2	24	80	104	70	80	112	128	84	96	100	122	80	92	96	118	76	88
24	60	F	2	1.59	68	26.9	9	3	28	82	110	60	76	115	136	88	104	99	130	80	99	96	122	66	84
25	18	F	1	1.53	48	20.5	8	1	23	82	104	68	78	119	130	80	92	102	124	76	88	96	122	72	84
26	59	M	2	1.76	78	25.2	9	0	22	80	130	90	98	111	142	92	104	97	146	92	109	86	152	86	100
27	38	M	2	1.76	70	22.6	12	2	26	78	126	68	86	104	144	92	109	92	120	70	86	78	120	68	85
28	58	M	2	1.75	82	26.8	9	3	26	64	140	90	106	104	164	106	126	90	156	104	120	96	150	92	112
29	46	M	2	1.7	72	24.9	11	3	28	90	150	90	108	130	172	110	131	110	156	104	120	96	150	96	112
30	42	F	1	1.6	58	22.7	9	2	25	80	130	80	96	114	152	92	111	100	146	92	109	86	142	86	100

GROUP B

										BEFORE INDUCTION				AFTER INTUBATION (1ST MINUTE)				AFTER INTUBATION (3RD MINUTE)				AFTER INTUBATION (5TH MINUTE)			
SLNO	AGE(yrs)	SEX	ASA	HEIGHT (m)	WEIGHT(kg)	BMI (kg/m2)	ADS	IDS	TIME FOR INTUBATION (sec)	HR(bpm)	SBP (mm hg)	DBP (mm hg)	MAP (mm hg)	HR(bpm)	SBP(mm hg)	DBP(mm hg)	MAP(mm hg)	HR(bpm)	SBP(mm hg)	DBP(mm hg)	MAP(mm hg)	HR(bpm)	SBP(mm hg)	DBP(mm hg)	MAP(mm hg)
1	39	F	2	1.6	59	23	8	1	22	82	118	78	91	108	140	92	108	104	138	88	104	96	130	84	94
2	32	F	1	1.62	56	21.3	6	0	19	75	110	60	76	76	114	66	82	78	120	70	86	80	120	70	86
3	60	M	2	1.68	65	23	9	1	23	80	150	90	110	84	158	96	116	84	154	96	115	82	150	92	111
4	34	M	1	1.72	70	23.7	7	1	19	78	110	70	84	78	110	70	84	80	112	72	86	80	114	76	88
5	35	F	1	1.62	58	22.1	8	1	23	60	100	60	73	66	110	70	83	64	10	70	83	64	106	60	75
6	36	M	1	1.75	70	22.9	6	0	22	80	150	90	110	84	158	96	116	84	154	96	115	82	150	92	111
7	27	M	1	1.71	70	23.9	6	1	22	78	110	70	84	78	110	70	84	80	112	72	86	80	114	76	88
8	31	M	1	1.77	72	23	6	0	20	72	120	80	93	76	120	78	92	78	118	78	91	76	116	80	92
9	48	F	1	1.62	62	23.6	9	1	24	74	120	70	86	78	126	76	92	78	126	78	94	76	124	72	90
10	45	F	1	1.58	58	23.2	6	1	23	84	130	80	96	82	140	90	106	78	138	90	106	84	136	84	102
11	46	F	1	1.57	58	23.5	6	0	22	100	126	78	94	108	133	86	104	110	140	90	106	110	136	84	101
12	60	M	2	1.7	65	22.5	10	1	25	56	146	80	102	60	150	84	106	62	150	80	103	62	148	80	102
13	55	F	2	1.6	52	20.3	8	1	22	72	120	80	93	76	120	78	92	78	118	78	91	76	116	80	92
14	45	M	2	1.62	64	24.4	9	1	23	78	132	78	98	86	142	80	101	84	142	80	100	84	138	78	98
15	60	M	2	1.77	76	24.3	9	1	23	84	150	90	110	89	154	94	114	85	154	90	111	85	150	92	112
16	20	F	1	1.76	75	24.2	6	1	19	106	110	78	88	106	110	78	88	104	106	72	84	100	104	70	82
17	27	F	1	1.55	55	22.9	6	1	20	84	130	80	96	82	140	90	106	78	138	90	106	79	136	94	102
18	47	F	2	1.7	58	20.1	6	1	22	82	118	78	91	108	140	92	108	104	138	88	104	96	130	84	94
19	18	M	1	1.61	65	25.1	6	1	24	90	110	70	84	96	118	78	92	94	118	74	88	94	114	74	87
20	21	M	1	1.57	60	24.3	9	0	19	68	92	58	69	73	110	58	73	70	104	54	68	70	104	54	68
21	38	M	1	1.62	68	25.9	11	2	26	56	106	70	73	66	110	70	83	64	110	70	83	64	106	60	75
22	25	M	1	1.74	76	25.1	6	0	20	78	126	78	94	84	116	76	89	82	110	76	89	82	112	78	89
23	49	F	2	1.59	65	25.7	9	1	25	76	148	80	102	86	150	82	104	84	148	82	104	82	148	80	102
24	26	M	1	1.7	64	22.1	6	1	22	77	92	58	69	73	110	58	73	70	104	54	68	70	104	54	68
25	45	M	2	1.74	82	26.8	10	1	24	78	140	80	100	80	148	88	107	82	144	86	109	82	144	84	104
26	38	M	1	1.76	75	24.2	6	0	22	106	110	78	88	106	110	78	88	104	106	72	84	100	104	70	82
27	30	F	1	1.62	52	19.8	6	0	21	100	126	78	94	108	138	86	104	110	140	90	106	110	136	84	101
28	55	F	2	1.58	62	24.8	9	0	23	80	130	82	98	86	138	78	97	84	136	78	97	84	136	76	96
29	37	F	1	1.6	58	22.7	6	0	21	74	120	70	86	78	126	76	92	78	126	78	94	76	124	72	90
30	54	M	2	1.74	70	23.1	9	1	22	90	130	82	98	96	140	90	106	94	138	90	106	94	136	94	102

Introduction

Objectives

Review of Literature

Basic Sciences

Methodology

Results

Discussion

Conclusion

Summary

Bibliography

Annexure-I

Annexure-II

Annexure-III

Annexure-IV

Annexure-V

Annexure-VI