DISSERTATION ON

A PROSPECTIVE STUDY COMPARING ACROMIO AXILLO SUPRASTERNAL NOTCH INDEX AND MODIFIED MALLAMPATI TEST IN PREDICTING THE DIFFICULTY IN VISUALIZATION OF LARYNX

Dissertation submitted in partial fulfillment
of the regulations for the award of the degree of

M.D. DEGREE, BRANCH – X

ANESTHESIOLOGY

Of

TAMIL NADU Dr. M.G.R. MEDICAL UNIVERSITY

CHENNAI, TAMILNADU

ESIC- MEDICAL COLLEGE & POSTGRADUATE INSTITUTE
OF MEDICAL SCIENCE AND RESEARCH,
KK NAGAR, CHENNAI- 78.

APRIL 2016

ENDORSEMENT BY THE DEAN/
THE HEAD OF THE INSTITUTION

This is to certify that this dissertation titled **"A PROSPECTIVE STUDY COMPARING ACROMIO AXILLO SUPRASTERNAL NOTCH INDEX AND MODIFIED MALLAMPATI TEST IN PREDICTING THE DIFFICULTY IN VISUALIZATION OF LARYNX"** submitted by **Dr.P.Ravindra Kumar,** appearing for M.D Degree Branch – X ANESTHESIOLOGY examination in April 2016 is a bonafide record of work done by him in partial fulfillment of the regulations of Tamilnadu Dr. M.G.R Medical University, Chennai. I forward this to the Tamilnadu Dr. M.G.R Medical University, Chennai Tamilnadu, India.

DEAN
Dr. SRIKUMARI DAMODARAM,
M.S.,M.Ch(SGE), M.A.M.S.,
F.A.C.S., F.I.C.S., F.M.M.C
ESIC Medical College and PGIMSR
K.K. Nagar, Chennai – 78.

DATE:

PLACE:K.K. Nagar

CERTIFICATE BY HEAD OF THE DEPARTMENT

This is to certify that dissertation entitled **"A PROSPECTIVE STUDY COMPARING ACROMIO AXILLO SUPRASTERNAL NOTCH INDEX AND MODIFIED MALLAMPATI TEST IN PREDICTING THE DIFFICULTY IN VISUALIZATION OF LARYNX"** is a bonafide research work done by **Dr.P.RAVINDRA KUMAR,** in partial fulfillment of the requirement for the degree of M.D. in Anesthesiology

Signature

DATE:

PLACE: KK Nagar

Prof.S.Gayathri, M.D.,D.A.,

Professor and HOD,

Department of Anesthesiology

ESIC MC & PGIMSR

K.K Nagar, Chennai- 78

BONAFIDE CERTIFICATE

This is to certify that the dissertation named **"A PROSPECTIVE STUDY COMPARING ACROMIO AXILLO SUPRASTERNAL NOTCH INDEX AND MODIFIED MALLAMPATI TEST IN PREDICTING THE DIFFICULTY IN VISUALIZATION OF LARYNX"** is a bonafide work performed by Dr.P.Ravindra Kumar, postgraduate student, Department of Anesthesiology, ESIC Medical college & PGIMSR, Chennai – 78, under my guidance and supervision in fulfillment of regulations of The Tamilnadu Dr. M.G.R Medical University for the award of M.D. Degree during the academic year 2014 – 2016.

GUIDE:

Dr. Ilango Ganesan, M.D.,
Associate Professor,
Department of Anesthesiology,
ESIC Medical College & PGIMSR,
Chennai – 78.

CO-GUIDE:

Dr. K. Radhika, M.D.,
Associate Professor,
Department of Anesthesiology,
ESIC Medical College & PGIMSR,
Chennai – 78.

DECLARATION

I solemnly declare that this dissertation entitled **"A PROSPECTIVE STUDY COMPARING ACROMIO AXILLO SUPRASTERNAL NOTCH INDEX AND MODIFIED MALLAMPATI TEST IN PREDICTING THE DIFFICULTY IN VISUALIZATION OF LARYNX"** has been conducted by me at ESIC Medical College & PGIMSR, Chennai, under the guidance and supervision of **Dr. ILANGO GANESAN, M.D.,** and **Dr.K.RADHIKA, M.D.,** Department of Anesthesiology, ESIC Medical College & PGIMSR, Chennai. This dissertation is submitted to **The Tamil Nadu Dr. M.G.R. Medical University, Chennai** in partial fulfillment of the University regulations for the award of the degree of **M.D. Branch X (Anesthesiology).**

Date :

Place : Chennai **(Dr. P.Ravindra Kumar)**

ACKNOWLEDGEMENTS

It is my immense pleasure to thank everybody who contributed in compilation of this study.

I express my deep debt of gratitude to our respected Dean **Dr.Srikumari Damodaram, M.S., M.Ch (SGE),** M.A.M.S., F.A.C.S., F.I.C.S., F.M.M.C., for permitting me to carry out this study.

I would like to thank **Prof. Kamalini Sridharan, M.D., D.A,** former HOD, Department of Anesthesiology, ESIC MC & PGIMSR for her immense support and encouragement for the study.

I express my deep sense of gratitude and indebtedness to my guide **Dr.Ilango Ganesan, M.D.,** for suggesting the topic and for his scholarly guidance, dynamic interest and clinical acumen. His considerable time and effort enabled me to give this study its ultimate shape.

I acknowledge my heartfelt gratitude to my co-guide **Dr.K.Radhika, M.D.,** who provided valuable suggestions, guidance and encouragement to help me do better.

I am grateful in every possible way to the Assistant professors, Specialists, Medical Officers, Senior Residents and the postgraduates of the Department of Anesthesiology for helping me to conduct this study.

Many sincere thanks in particular to the statistician **Dr. Aruna Patil, Ph.D.,** for her guidance regarding the sample size and data analysis.

I am thankful to the Institutional Ethical Committee for their guidance and approval for the study.

I also thank the theatre staff nurses and technicians for their help. I would fail in my duty if I forget to thank all the patients for their participation and co-operation.

I am thankful to my affectionate mother, beloved wife for their constant support and encouragement, my daughters for their unconditional love, all my family members and friends for their love and support throughout my postgraduation.

DR.P.RAVINDRA KUMAR

CERTIFICATE OF APPROVAL

To

Dr. P. Ravindra Kumar,
PG in Department of Anesthesia,
ESIC Medical College & PGIMSR,
KK Nagar, Chennai-78.

Dear Dr. P. Ravindra Kumar,

The Institutional Ethical Committee of ESIC Medical College & PGIMSR reviewed and discussed your application for approval of the proposal entitled **"A Prospective study comparing Acromio axillo suprasternal notch index and modified mallampati test in predicting the difficulty in visulaization of larynx"** at ESIC Medical College & PGIMSR, K K Nagar, Chennai 600 078, No. **14/27/10/2014.**

The following members of the Ethical Committee were present in the meeting held on 27.10.2014 conducted at ESIC Medical College & PGIMSR, KK Nagar, Chennai-78.

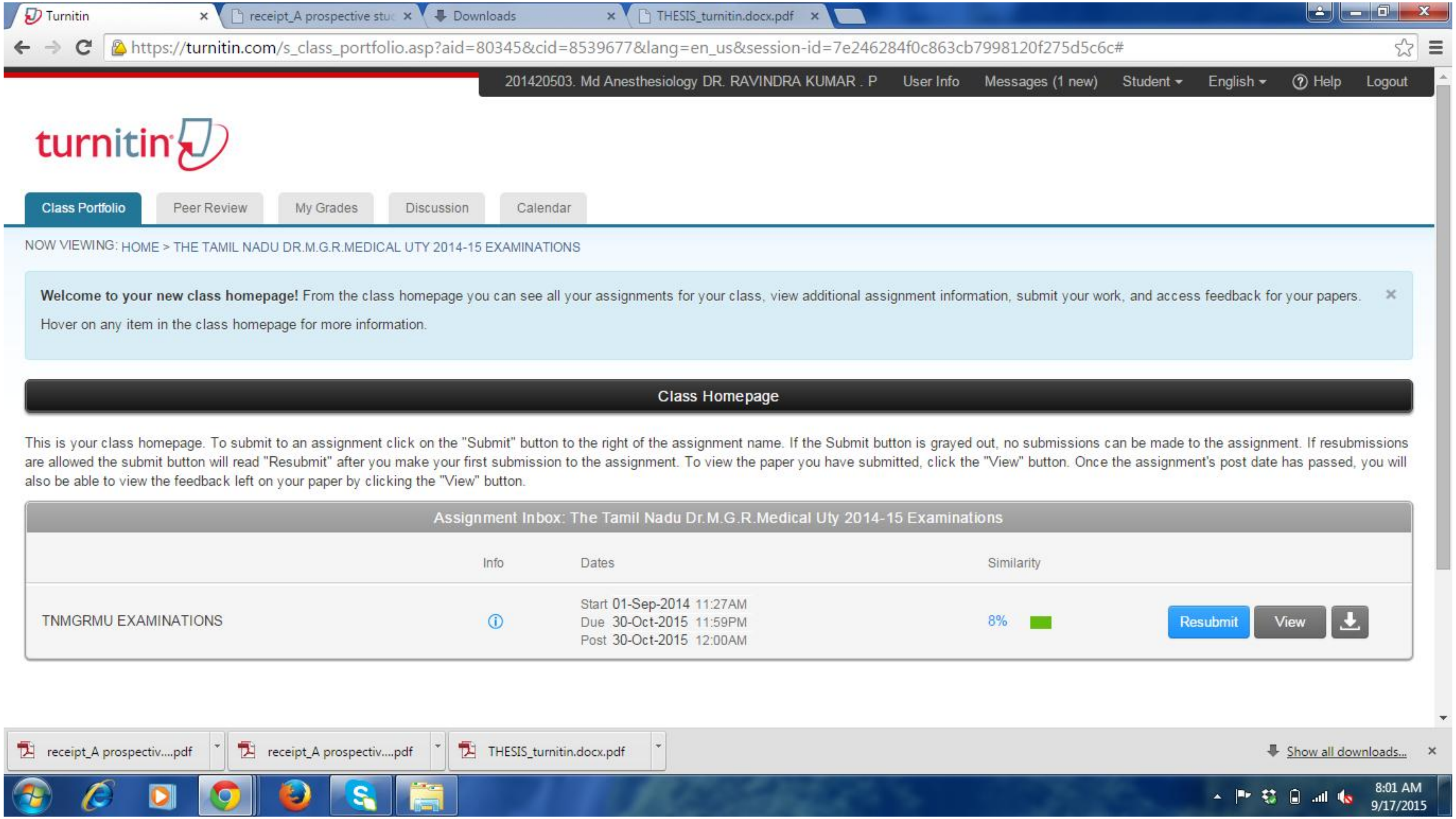
S.No.	ETHICAL COMMITTEE MEMBERS
1.	Prof. A.V. Srinivasan, Chairperson, EC Member EMERITUS Professor, The Tamilnadu Dr. MGR Medical University Former Prof. & HOD., of Institute of Neurology, Madras Medical College
2.	Prof. V. Rajalakshmi, Vice Principal, ESIC Medical College & PGIMSR, EC Member
3.	Prof. M. Kanaheswari, Medical Superintendent, ESIC Medical College & PGIMSR, EC Member
4.	Prof. Kamalini Sridharan, Registrar, ESIC Medical College & PGIMSR, EC Member
5.	Prof. S. Seethalakshmi, Prof. & HOD, Department of Pharmacology, ESIC Medical College & PGIMSR, EC Member
6.	Prof. S. Malliga, Prof. & HOD, Department of Biochemistry, ESIC Medical College & PGIMSR, EC Member
7.	Prof. Sowmya Sampath, Prof. & HOD, Department of Paediatrics, ESIC Medical College & PGIMSR, EC Member
8.	Prof. Usha Kothandaraman, Prof. & HOD, Department of Anatomy, ESIC Medical College & PGIMSR, EC Member
9.	Dr. Aruna Patil Bholenath, Assistant Professor, Department of Community Medicine, ESIC Medical College & PGIMSR, EC Member
10.	Dr. A. Sundaram, Dept. of Medicine [Diabetologist], EC Member
11.	Dr. O.L. Naganath Babu, Dept. of Surgical Gastroenterology, EC Member
12.	Dr. S. Dhanalakshmi, Dept. of OBG, EC Member
13.	Dr. Rajkumar Williams, Dept. of Surgery, EC Member
14.	Prof. C. Rajendiran, Department of General Medicine, EC Member
15	Dr. C.V. Aravindan, Scientist, EC Member
16.	Shri. K M Venugopal, Advocate, EC Member

The proposal is approved to be conducted in its presented form.

The Institutional Ethical Committee expects to be informed about the progress of the study and significant adverse effects occurring in the course of the study, any changes in the protocol and patients information / informed consent and asks to be provided a copy of the final report.

[DR. A.V. SRINIVASAN]
CHAIRPERSON
ETHICAL COMMITTEE

Date : 27.10.2014
Place : Chennai 78


Turnitin
receipt_A prospective stu
Downloads
THESIS_turnitin.docx.pdf
https://turnitin.com/s_class_portfolio.asp?aid=80345&cid=8539677&lang=en_us&session-id=7e246284f0c863cb7998120f275d5c6c#
201420503. Md Anesthesiology DR. RAVINDRA KUMAR . P
User Info
Messages (1 new)
Student
English
Help
Logout
turnitin
Class Portfolio
Peer Review
My Grades
Discussion
Calendar
NOW VIEWING: HOME > THE TAMIL NADU DR.M.G.R.MEDICAL UTY 2014-15 EXAMINATIONS
Welcome to your new class homepage! From the class homepage you can see all your assignments for your class, view additional assignment information, submit your work, and access feedback for your papers.
Hover on any item in the class homepage for more information.
Class Homepage
This is your class homepage. To submit to an assignment click on the "Submit" button to the right of the assignment name. If the Submit button is grayed out, no submissions can be made to the assignment. If resubmissions are allowed the submit button will read "Resubmit" after you make your first submission to the assignment. To view the paper you have submitted, click the "View" button. Once the assignment's post date has passed, you will also be able to view the feedback left on your paper by clicking the "View" button.
Assignment Inbox: The Tamil Nadu Dr.M.G.R.Medical Uty 2014-15 Examinations
Info
Dates
Similarity
TNMGRMU EXAMINATIONS
Start 01-Sep-2014 11:27AM
Due 30-Oct-2015 11:59PM
Post 30-Oct-2015 12:00AM
8%
Resubmit
View
receipt_A prospectiv....pdf
receipt_A prospectiv....pdf
THESIS_turnitin.docx.pdf
Show all downloads...
8:01 AM
9/17/2015

Turnitin Document Viewer - Google Chrome

https://turnitin.com/dv?o=571465429&u=1043012332&s=&student_user=1&lang=en_us

The Tamil Nadu Dr.M.G.R.Medical... | TNMGRMU EXAMINATIONS - DUE 30-...

Originality | GradeMark | PeerMark

A prospective study comparing Acromio axillo suprasternal notch index and Modified

BY 201420503. MD ANESTHESIOLOGY DR. RAVINDRA KUMAR . P

turnitin

8% SIMILAR

-- OUT OF 0

A PROSPECTIVE STUDY COMPARING ACROMIO AXILLO SUPRASTERNAL NOTCH INDEX AND MODIFIED MALLAMPATI TEST IN PREDICING THE DIFFICULTY IN VISUALIZATION OF LARYNX

ESIC MEDICAL COLLEGE & POSTGRADUATE INSTITUTE OF MEDICAL SCIENCE AND RESEARCH, KK NAGAR, CHENNAI-78.

MD ANESTHESIOLOGY

BRANCH-X

THE TAMIL NADU Dr. M.G.R. MEDICAL UNIVERSITY

1

No Service Currently Active

PAGE: 1 OF 88

8:04 AM
9/17/2015

CONTENTS

ABSTRACT

TITLE :

A prospective study comparing Acromio axillo suprasternal notch index and Modified mallampati test in predicting difficulty in visualization of larynx.

SUBMITTED BY:

DR. P. RAVINDRA KUMAR

GUIDE :

DR. ILANGO GANESAN, MD

CO- GUIDE :

DR.K.RADHIKA, MD

DEPT. OF ANAESTHESIOLOGY,

ESIC MC AND PGIMSR,

CHENNAI 78.

EMAIL :

dr.prk77@yahoo.co.in

BACKGROUND:

The management of the airway is the primary responsibility of the anesthesiologist. Endotracheal intubation remains the gold standard in maintaining definitive airway and is conventionally facilitated by direct laryngoscopy. The Modified mallampati (MMP) test is a standard tool in the airway assessment and its low sensitivity is always a deterrent. Kamranmanesh MR et al tested a new simple bedside screening tool called Acromio Axillo Suprasternal notch index (AASNI) for airway assessment.

AIM:

To compare the AASNI and MMP in predicting the "Difficult visualization of the larynx".

METHODS:

A total of 173 adult patients of ASA 1 and 2 (18 to 50 years), who were candidates for tracheal intubation in elective surgery were enrolled in this prospective observational study. Preoperative airway assessment was carried out with AASNI and MMP. After induction of anesthesia, direct laryngoscopy was done and the laryngeal view was recorded according to the Cormacke Lehane grading system.

+

RESULTS:

The validity of AASNI and MMP are analysed with Open epi (ver.2), SPSS software (ver.16) and Microsoft excel. The sensitivity, specificity, positive predictive value, negative predictive value of AASNI vs MMP are 70.5 vs 29.4, 84.6 vs 95.5, 33.3 vs 41.6, and 96.3 vs 92.5 % respectively. Thus, AASNI had better sensitivity and negative predictive value than MMP but lower specificity and positive predictive value than MMP.

CONCLUSION:

This study concludes that AASNI can be used as a predictive tool for 'Difficult visualization of larynx' (DVL). The higher sensitivity of AASNI makes it a better tool than MMP for screening DVL. As no single test predicts DVL precisely, AASNI can be used in conjunction with standard tool like MMP to increase the validity. AASNI may be investigated as a part of multivariate index to predict DVL.

KEYWORDS:

Acromio axillo suprasternal notch index, Modified mallampati test, difficult visualization of larynx, intubation, laryngoscopy, airway assessment.

INTRODUCTION

The management of the airway is the primary responsibility of the anesthesiologist. It includes maintaining airway patency, thereby ensuring adequate ventilation and oxygenation. Airway management is encountered by the anesthesiologist during the conduct of anesthesia or resuscitation of the critically ill patients every day.

Traditionally, the airway is maintained by mask ventilation and tracheal intubation with endotracheal tubes. In modern day practice the Supraglottic airway devices like laryngeal mask airway (LMA) play a crucial role in airway management.

Endotracheal intubation remains the gold standard in maintaining definitive airway, inspite of many advances. The endotracheal intubation is conventionally facilitated by direct laryngoscopy[1]. The alternate methods include tracheal intubation using fibreoptic bronchoscope, video laryngoscopy, video endoscopy, intubating LMA and various other airway adjuncts. However the cost and availability of these airway adjuncts force the anesthesiologist to use conventional laryngoscopes routinely.

Hence, assessing the airway and predicting the difficulty in mask ventilation or intubation is of utmost importance.

Difficult Airway (DA) is defined as “the clinical situation in which a conventionally trained anesthesiologist experiences difficulty in ventilation of upper airway via a mask , difficulty in tracheal intubation or both”[1].

Difficult Laryngoscopy (DL) is defined as a situation where “It is not possible to visualize any portion of the vocal cords after multiple attempts at conventional laryngoscopy”[2]. Difficult laryngoscopy implies “Difficult visualization of larynx” (DVL). Failed intubation occurs in 75% of Difficult laryngoscopy (DL) cases and only in 3 % of Easy Laryngoscopy (EL) cases.

Failed or Difficult intubation may lead to a “Cannot intubate - Cannot ventilate” (CICV) situation[3]. CICV is a life threatening situation. Failure to ensure adequate oxygenation either by mask ventilation or intubation may lead to oxygen desaturation[4].

ASA closed claims study in 1990 revealed that the “adverse respiratory events” is the major contributor (34%) among the total claims related to anesthesia. Death occurred in 85% of these cases. The major causes were lack of adequate ventilation (38%), intubation into esophagus (18%) and difficult tracheal intubation (17%)[5].

Prior recognition of difficult airway may help to minimize the above adverse effects.

The purpose of preoperative airway assessment is to diagnose the potential for difficult airway which facilitates ‘preparedness’ such as:

1. Proper selection of airway equipments and techniques,
2. Procuring additional airway adjuncts and
3. Participation of experienced anesthesiologist in the management when needed.

Anticipation and preparedness decreases the incidence of catastrophic events due to difficult Airway. Surgical airway can be avoided by predicting difficult airway and planning alternate method of intubation.

The detailed history and physical examination will figure out the risk factors that may predict a ‘Difficult airway’. Various scores and tests have been used to assess the ‘Difficult airway’ but none can prove to be precise.

The Mallampati test was proposed on the basis that the size of the tongue in relation to the oropharynx may influence the laryngoscopy and hence intubation[6]. Various other factors weren't taken into account by the Mallampati test.

The Modified mallampati (MMP) test is a standard tool in the airway assessment and widely used for a long time. The low sensitivity of MMP is always a deterrent for the anesthesiologist in predicting 'Difficult airway'.

The ability to achieve Sniffing position (SP) or Magill's position could be assessed by measuring the degree of atlanto-occipital joint extension. The mandibular space can be assessed by thyromental distance (TMD), sternomental distance (SMD), mandibulo hyoid distance (MHD) and inter incisor distance (IID)[7].

As a diagnostic tool of DL, we need a predictor with higher sensitivity, and specificity. Various predictors have been tested since then either individually or together in the search for an ideal predictor.

Mohammad R.Kamranmanesh et al felt that DL is common in people whose neck appear to be situated deep in the chest. Based on this hypothesis, they tested a new screening tool for predicting DA and compared it along with MMP[8]. It was called Acromio Axillo Suprasternal notch index (AASNI). AASNI is a simple bedside test and claimed to have higher sensitivity, specificity and predictive values than MMP.

A test / predictor with higher validity could help the fraternity of anesthesiology in optimizing the resources and modify the plan of airway management.

This study is intended to find out the validity of the new test (AASNI) in prediction of DL or DVL and compare it with a standard test like MMP.

Aim and Objectives

AIM OF THE STUDY

To compare Acromio axillo suprasternal notch index and Modified Mallampati test in predicting the "Difficult visualization of the larynx".

PRIMARY OBJECTIVE

To test the validity (Sensitivity, Specificity, Positive predictive value, Negative predictive value) of Acromio axillo suprasternal notch Index and Modified mallampati test in predicting “Difficult visualization of larynx”.

Review of Literature

REVIEW OF LITERATURE

When the United Kingdom was recording an average of 14 maternal deaths per year in the era of 1980’s during obstetric anesthesia, difficult intubation was the commonest cause for the deaths. The US was also following a similar trend. There wasn’t a consensus regarding the difficult intubation or its management although a drill for failed intubation suggested by Tunstall was becoming popular. **R.S.Cormack and J.Lehane**[9] in their article published in “Anesthesia” (1984, volume 39) discussed about the issues and the basics of anatomy of difficult intubation. “Although people with thick or short neck, receding jaw, prominent incisors can be identified, the size and mobility of the tongue is difficult to assess” the authors quote.

As long as the cases of difficult intubation aren’t easily predictable and definable, the recommendations even if made cannot be implemented practically. Hence the author suggested a laryngoscopy view grading system to classify or define easiness of intubation.

Grades 1 to 4 laryngoscopy views were defined and the probable line of management for grade 3 or grade 4 views were also discussed in the article. Grade 1 was described as “most of the glottis visible”, grade 2 as “only posterior extremity of glottis visible”, grade 3 as “no part of the epiglottis seen” and grade 4 as “not even epiglottis exposed”. The management may be easy (grade 1), slightly difficult (grade 2), fairly severe difficulty (grade 3), impossible except by special methods (grade 4).

In 1985, **S.Rao Mallampati et al**[6] tested his hypothesis of predicting intubation difficulty by assessing visibility of pharyngeal structures in a total number of 210 patients (47 men and 163 women) at Brigham and women hospital, Massachusetts. The mean age of the study group was 39.32 years, mean height was 163.81 cms and mean weight was 70.33 Kg.

All the above patients belonged to ASA physical status 1 or 2 and were devoid of respiratory or cardiac problems. Four patients were obese and underwent gastroplasty. Patients with Rheumatoid arthritis were included in the group but however they didn’t have limitation of joint mobility. Four of 210 patients had moderate limitation in neck movement.

Both the assessment of pharyngeal aperture (Mallampati scoring) and intubation were done by same anesthesiologist. The scoring was done twice to avoid any erroneous observation. Visualization of pharyngeal structures were done with patient seated, mouth opened widely and tongue protruded maximally.

Mallampati et al described Class 1 as visualization of all structures, viz- “faucial pillars, soft palate and uvula”, Class 2 as visualization of “faucial pillars and soft palate” but not uvula which was masked by base of tongue and class 3 as visualization of “soft palate only”.

Direct laryngoscopy was done using size 3 Macintosh blade with patient in “air sniffing position”. The laryngoscopy views described similar to Cormack Lehane (CL) grading. The ease / difficulty in intubation were described in terms of adequate (grade 1 or 2) or less than adequate (grade 3 or 4) exposure of pharyngeal structures.

S.Rao Mallampati et al observed that the visualization of pharyngeal structures correlated significantly with the ease of laryngoscopy. If the pharyngeal visualization was class 1 (155 patients), the laryngoscopy was either grade 1 (80.6%) or 2 (19.3%). In other words class 1 means easy laryngoscopy. Twenty six patients of class 2 had easy laryngoscopy and fourteen had difficult one. Only one of 15 had easy exposure in class 3.

Mallampati et al claimed that their classification of pharyngeal aperture significantly predicts difficult laryngoscopy and hence aids in anticipation of difficult intubation in those cases. The article was published in Canadian Anesthesia society journal, volume 32.

It should be noted that there was no standardized definition of 'Difficult airway' until 1993.

G.L.T.Samsoon and J.R.B.Young[10] did a retrospective analysis of airway structures in the patients who had experienced difficult/impossible intubation earlier in the years between 1982 and 1985. Even though started with obstetric patients the study was extended to non obstetric patients too. Seven among 1980 obstetric patients and six among 13380 non obstetric patients have encountered failed intubation. The incidence of failed intubation in non obstetric cases (1 in 2230) is less than obstetric cases (1 in 280). All were operated in St.Mary hospital, Portsmouth. All the difficult intubations were unexpected and those patients had class 4 MMP scoring.

The patients were recalled and oral / pharyngeal aperture examined as suggested by Mallampati et al. But the original Mallampati classification was modified and 4 classes were defined. It should be noted that the examination was repeated after asking the patient to relax for 1 minute to confirm the classification.

S.Pilkington et al[11] developed a photographic version of Mallampati test. It was tested in 242 pregnant patients at 12 weeks and 38 weeks gestational age. They found that the Mallampati class increases with gestational age and correlates well with the weight gain. The study supported the fluid retention concept (pharyngeal edema) for difficult intubation in pregnant patients.

The impact of obesity on the ease of intubation is always challenging. The obese patients especially with thick neck circumference may be difficult to intubate. The relationship of anterior neck thickness was studied by **T.Ezri et al**[12] in 50 morbidly obese patients at Wolfson medical center, Israel (2003). The study also included measurement of TMD, mouth opening, MMP, upper abnormal tooth, limited neck mobility, neck circumference, and h/o sleep apnea.

Of the 50 cases, nine (18%) had difficult laryngoscopy. Seven of the DL cases had h/o sleep apnea, whereas only 2 of other 41 had the h/o sleep apnea. The neck circumference (50 vs. 43.5 cms) and pre tracheal thickness (28 vs. 17.5 cms) completely delineated DL and EL cases. However the other factors didn't prove to be valuable predictor for difficult laryngoscopy.

D.R.Hillman, P.R.Platt, and P.R.Eastwood[13] in their study (2003) emphasized the importance of h/o snoring, obstructive sleep apnea in addition to the previous anesthetic history and examination of upper airway in the preoperative evaluation. Factors like obesity, maxillary / mandibular abnormality, nasal obstruction – adenotonsillar hypertrophy also significantly increases the risk.

The authors suggested that it may be difficult to maintain the (upper) airway in these patients and hence airway may be secured prior to anesthetizing the patient if needed.

In Nigeria, **N.A.Merah, D.J.O.Foulkes-Crabbe, O.T.Kushimo and P.A.Ajayi**[14] studied (2004) a group of 80 consecutive obstetric patients over a period of one year to compare the Modified Mallampati test, thyromental distance, sternomental distance, horizontal lenghth of mandible and interincisor gap in prediction of difficult airway. Of 80, eight patients had difficult airway (10%). They analysed and compared the five bedside tests in terms of sensitivity, specificity, positive predictive value and concluded that MMP can be used as a single bedside screening test to predict difficult airway in nigerian obstetric population. They also concluded that except MMP and thyromental distance, no other tests predicts difficult airway significantly.

The search for newer bedside screening tests was evident when **Leopold.H.J.Eberhart et al**[15] published an article on Upper lip bite test (ULBT) in “Anaesth Analg” journal of 2005. In the test 1425 patients were asked to cover upper lip with lower incisors and graded 1, 2, and 3 in addition to the Mallampati test. Then the ease of laryngoscopy was assessed. They concluded that both ULBT and Mallampati were poor predictors for difficult laryngoscopy as single screening tests.

Dr.Sunanda gupta, Dr.Rajesh Sharma, Dr.Dimpel Jain reviewed the conditions that predispose to difficult airway and the tests or factors that are used to predict difficult airway[7]. The review article was published in IJA 2005 Vol.49 (4). The importance of securing the airway was emphasized by the point that 28 % of anesthesia related deaths are attributed to inability to intubate and ventilate.

The authors even proposes the idea of “Difficult airway clinics” to detect patients prone for difficult airway so that preparation of the patient, equipments could be optimal and participation of experienced anesthetist can be ensured.

The article lists many factors such as patency of nares, mouth opening, abnormal dentition, high arched palate, large tongue, prognathism, TM joint mobility, neck thickness, sub mental distance, any infection of airway, obesity, pregnancy which should be noted in PAC.

The difficulty in mask ventilation following difficult intubation further endangers the patient's life. Factors such as beard, BMI>28, absence of teeth, age > 60 years, h/o snoring, jewellery in lips, cheek make the ventilation difficult.

The anatomical tests include MMP, atlanto occipital joint mobility, indicators of mandibular space (thyromental distance, sternomental distance, mandibulo hyoid distance, and interincisor distance), LEMON score, and radiological assessment (mandibulo hyoid distance, atlanto occipital gap, C2-C3 gap, depth of mandible).

The article discussed about airway evaluation in diabetic and pediatric cases.

Toshiya Shiga, Zen'ichiro Wajima, Tetsuo Inoue, Atsuhiro Sakamoto in 2005 did a meta analysis of 35 studies comprising 50,760 patients, to determine the accuracy of bedside tests in predicting difficult intubation in the patients whose airway is normal[16]. The data were obtained from electronic databases. The tests analyzed were MMP, thyromental distance, sternomental distance, mouth opening, Wilson's scoring. The individual tests showed poor promise but the combination of MMP and thyromental distance exhibited some usefulness in predicting difficult intubation. Hence they concluded that the clinical usefulness of bedside screening tools remains limited in prediction of difficult intubation in normal patients.

One should not forget that a difficult intubation doesn't lead to catastrophe by itself but only when it is followed by difficult mask ventilation. Recognizing the importance of Mask Ventilation (MV) **Sachin Kheterpal** et al did a prospective observational study to identify cases of difficult mask ventilation (grade 3 or grade 4) as well as difficult intubation[17]. The incidence and predictors of impossible mask ventilation and intubation were analyzed in a group of 22660 patients, which ended up in 313 cases of grade 3 mask ventilation, 37 cases of grade 4 mask ventilation, and 84 cases of grade 3 or 4 mask ventilation with difficult intubation.

The risk factors for grade 3 MV were identified as BMI > 30, beard, MMP 3 or 4, age >57 years, snoring, severely limited jaw protrusion. Snoring along with thyromental distance > 6 cms were identified as risk factors for grade 4 MV. BMI>30, snoring, sleep apnea, abnormal neck, limited mandibular protrusion were identified as risk factors for grade 3 or grade 4 MV with difficult intubation.

The beard is the only modifiable risk factor among the others and the mandibular protrusion shouldn’t be missed in preop airway examination - the authors concluded. The study was published in 2006 Anesthesiology journal.

In 2009, **Zahid Hussain khan et al** studied in a group of 380 patients comparing the composite score of ULBT, sternomental distance, thyromental distance, inter incisor distance to individual scores in predicting the difficult laryngoscopy[18]. They concluded that the ULBT is superior to others in airway assessment. However the composite score proved even better than the individual ones.

M.Boutonett, V.Faitot, A.Katz, L.Salomon, H.Keita (2010) evaluated the change in Mallampati class in pregnant women before, during and after labour[19]. The Mallampati class was assessed at four points – 8th month of pregnancy, epidural catheter insertion, 20 minutes after delivery and 48 hours after delivery. 87 pregnant patients underwent the study. They observed that Mallampati class increased during labour (63% of patients) and the reversal of changes not observed before 48 hours.

In the same year (2010), 24 years after the original Cormack Lehane article (1984) **R.Krage et al** revisited[20] the Cormack Lehane classification in the article published in British journal of Anesthesia 105 (2). The validity of the CL classification is supported by fewer studies, the authors claim. The widespread use of the CL classification and the limited evidence of validity of the test prompted the authors to revisit the classification. They conducted interviews among one hundred and twenty practicing anesthesiologists regarding the knowledge about CL classification of laryngoscopy view. Twenty anesthesiologists who were familiar about CL grading were asked to do 100 intubations in patient simulators and which gave some surprising results.

Among the interviewed 89 % claimed that they know a classification of laryngoscopy view only 53 % were able to name it. And only 25 % could describe 4 grades of CL classification in detail. Hence they concluded that the knowledge of CL classification is poor among anesthesiologists and the reproducibility is even more limited.

The Mallampati test and it's modification by Samsoon and Young were used as the screening tool for prediction of difficult airway. Both tests were done with the patient being seated. The requirement of seating position makes the test impossible in patients with spine injuries or multiple fractures and hence a major limitation. Various studies have been done to evaluate the impact of position during the tests. **Ashish Bindra et al** from India did a prospective study in this regard[21]. A group of 123 patients were involved in the study done at AIIMS. They found that MMP test done in supine position has a higher positive predictive value than in seated position. The results were published in Journal of Anesthesia (2010).

The modified Mallampati test is put to test again in 2010 in Czech republic by a team of people in hospital of University of Palacky[22]. The article written by **Milan Adamus et al** explores the use of modified mallampati test as a single screening tool to detect patients with difficult airway. A group of 1538 patients, all above 18 years planned for elective surgery under general anesthesia were included in the study. In the preoperative assessment, Modified Mallampati scoring was done for all patients as described by Samsoon and young. In the OT, following intubation and paralysis direct laryngoscopy was done for intubation and

CL grade noted. They described unanticipated difficult intubation as CL grade 3 or 4. They analyzed the relationship between predictor (MMP) and predicted parameter (CL) using fisher exact test. Similarly they also analyzed the data of the original Mallampati test using the same statistical tests and a comparison was made.

The advantage over original study was that the study group was larger (1518 vs. 210 patients). However the authors claim there is a possibility of bias in the results as the study was done in a short period of 2 months and same anesthesiologist who did MMP scoring did the CL grading too (not blinded).

The incidence of Unanticipated DA differs significantly between this and the original one (48 of 1518 vs. 28 of 210 or in other terms 3.2 % vs. 13.3 %).

After studying the sensitivity, specificity, predictive values, accuracy of the MMP test, they concluded that the MMP test has limited value as a single screening tool for predicting UDA and hence cannot be relied upon.

In the same year, **Arun kr Gupta et al** published an article in British journal of medical practioners (2010) highlighting “Predictors of difficult intubation” based on their study in kashmiri population[23]. The predictors taken into account were head and neck movements, thyromental distance, high arched palate, wide and short neck, grading of prognathism, MMP, inter incisor gap, obesity.

A group of 600 ASA 1 and 2 patients were studied and CL grading of laryngoscopy view was recorded. The incidence of difficult intubation was 3.2 % in the study. The sensitivity, specificity, predictive values of predictors in relation to CL grading was analyzed.

The various cut off points were described in the article as follows:

MMP test	:	class 1, 2 and class 3, 4
Inter incisor gap	:	class 1 > 4 cms and class 2 < 4 cms
Obesity	:	BMI < 25, and BMI > 25
Thyromental distance	:	class 1 > 6 cms, class 2 < 6 cms
High arched palate	:	yes / no
Prominent incisors	:	yes / no
Prognathism	:	Easy (class 1, 2) / difficult (class 3, 4)

Head / neck movements : Easy: Class 1 > 90° and

Difficult: Class 2, 3 < 90°

Wide and short neck : Neck body ratio > 1: 13

At the end, MMP test, high arched palate, thyromental distance found to be best predictors for difficult intubation.

Once again the correlation between MMP and CL grading was tested in a group of 120 patients in Pakistan institute of Medical sciences, Islamabad from Nov 2004 to Mar 2007. The results were published in the ‘Rawal Med Journal’ in 2011 by **Khawaja Kamal Nasir, Arshad Saleem Shahani, Muhammad Salman Maqbool**[24]. In their study, among 122 patients in 83.60 % of cases, MMP classification correlated with CL 1 and 2. They concluded that MMP is a good predictor for difficult intubation however grade to grade correlation isn’t seen.

L.H.Lundstorm et al conducted a meta analysis of 55 studies involving 177088 patients to ascertain whether modified mallampati test is adequate as a standalone factor in prediction of difficult laryngoscopy or tracheal intubation[25].

The area under the receiver operating characteristic curve for MMP was 0.75. The sensitivity, specificity of pooled estimates was 0.91 and 0.35. The odds ratio was 5.89. They concluded that the prognostic value of MMP test in the prediction may be worse than that quoted in the earlier meta analyses. Even though it is inadequate as a standalone predictor the meta analyses says that it can be a part of multivariate model in predicting difficult intubation or laryngoscopy.

The success of laryngoscopy and intubation depends on many modifiable factors and positioning the patient for laryngoscopy / intubation considered an important factor among them. Traditionally the anesthesiologists around the world are using “Morning air sniffing position”. **Mohammad El-Orbany, Harvey Woehlck, and M.Ramez Salem** from the Department of Anesthesiology from the University of Wisconsin and Illinois in their review article published in analgesia-anesthesia (2011 July volume 11) aims at highlighting the scientific facts behind the SP (sniffing position) and their validity in everyday practice[26]. Although Sir Ivan Magill was the original anesthesiologist who described SP, it is only Horton et al who accurately described the degree of neck flexion and head extension, the author recollects. A neck flexion of 30° and head extension of 15° may be defined as a standard

SP based on the original studies to achieve optimal exposure of glottis during laryngoscopy. The science behind the success of SP was attributed to the “Three axes alignment theory” (TAAT). The author was surprised that the SP and TAAT were accepted for practice based on observations, logic, clinical experiences rather than on scientific clinical trials. The article also reviews the study of Adnet et al who questioned the advantage of SP over other positions. After reviewing many previously published studies on this subject the authors finally recommends the SP for direct laryngoscopy and intubation, however emphasize that the position should be ascertained by bringing the external auditory meatus and sternum in a horizontal line. The above emphasize is more relevant in obese patients.

W.H.Kim et al from Samsung medical center, Seoul, South Korea conducted a prospective observational study in 123 obese and 125 non obese patients[27]. Their purpose was to assess whether intubation in obese patients is more difficult than non obese and the usefulness of a new index namely ratio of neck circumference to thyromental distance (NC/TD) in prediction of difficult intubation.

Other factors like MMP, BMI, Wilson's score, sternomental distance, mouth opening, neck circumference, previous h/o difficult intubation were also recorded. Difficult intubation was assessed by intubation difficulty score (IDS) (=/>5).

The IDS includes many factors – number of intubation attempts, number of additional personnel, number of alternative techniques used, Cormack and Lehane grading of glottic view, lifting force used, whether external laryngeal pressure applied, and position of vocal cords on intubation.

The new index (NC/TD) was compared to all the established indices. They concluded that difficult intubation is more common in obese patients and NC/TD is a better index than others in prediction of difficult intubation of obese patients.

Smita Prakash et al., from Vardhman Mahavir medical college and Saftarjang hospital analysed the various clinical and anatomical factors in Indian population which helps in predicting difficult laryngoscopy or intubation[28]. The results were published in 2013 issue of Indian journal of anesthesia. The factors analyzed are age, sex, BMI, MMP 3 & 4, inter incisor distance <3.5 cm, sternomental distance, thyromental distance, RHTMD (ratio of height to thyromental distance), short neck, limited mandibular protusion, neck movement < 80°, cervical spondylosis, receding mandible, beard, snoring history, malformation of face.

The intubation was assessed by intubation difficulty score which also includes CL grading. In this study the incidence of difficult laryngoscopy (CL 3, 4) was 9.7 % and incidence of difficult intubation was 4.5 %. The results were analyzed by multivariate analysis. Mallampati class 3 & 4, neck movements < 80°, IID < 3.5 cms and h/o snoring are the four risk factors identified for difficult laryngoscopy. The article also compares Indian population with non Indian one form the results of previously done studies worldwide and says that the standard threshold values applicable to other populations may not be suitable for Indian population.

Mohammad R.Kamranmanesh et al., wanted to compare a new test (Acromio axillo suprasternal notch index) with Modified Mallampati test in predicting the difficult visualization of larynx[8]. The new test was designed on the authors experience that patients with sloping clavicle (neck positioned deep into the chest) are prone to have difficult visualization of larynx. He therefore devised a new screening tool based on the surface anatomy. The fraction of arm chest junction which was above the suprasternal notch was measured and used to calculate AASNI. The index was compared to Modified Mallampati score since it was a previously established screening tool for predicting difficult laryngoscopy.

A total no of 603 patients scheduled for elective surgery under general anesthesia in the age group of 20-65 years, either sex belonging to ASA 1 and 2 were taken into the study group. Patients who refused to consent for the study, who had obvious anatomical abnormality, tumors involving upper airway (tongue, maxillofacial), had recent history of head and neck surgery, belonged to ASA 3 or 4, and inability to open the mouth are excluded from the study group.

Both AASNI and MMP were scored prior to surgery as described in the materials and methods.

They premedicated the patients with Midazolam, Fentanyl and induction was done with thiopentone sodium and atracurium. After ventilating the patient with 100 % O2 until the loss of 4rth twitch, they did the laryngoscopy with the patient's head in sniffing position and using Macintosh blade no 3. The CL grading assessed and recorded.

38 patients had 3 or 4 CL grades which made the incidence of difficult laryngoscopy as 6.3 %.

The SPSS software version 6 was used to interpret the data and sensitivity, specificity, predictive values of AASNI, MMP were derived. Also accuracy, odds ratio and likelihood ratios were calculated. AASNI and MMP were compared using ROC curves.

AASNI ≤ 0.49 (~ 0.5) was defined as best cutoff point using discriminatory analysis. The area under the ROC curve was higher for AASNI than MMP.

Hence they concluded that AASNI, a new test has got a better predictive value than MMP. However they also observed that no single test is reliable predictor for DVL.

The lack of a standardized protocol based airway evaluation and the often incomplete assessment of airway made **D.Cattano et al** from University of Texas medical health school, Houston to design a study that investigates the impact of a new airway assessment form for use by residents in prediction of difficult airway[29]. More than 8000 patients were studied and analyzed during the period august 2008 to may 2010. Residents were made into two groups – control group (used existent anesthesia record) and experimental group (used comprehensive airway assessment form in addition to the existent one). The new form included all ASA’s risk factors for difficult airway. A common form was used to record postoperative outcome data.

The author defines DMV (difficult mask ventilation), DSGA (difficult supraglottic airway), DI (difficult intubation) and DSA (difficult surgical airway) for the purpose of the study in their article.

Incomplete assessments were excluded from the study. The incidence of DMV was 7.17 to 8.19 %, DDL: 5.54 to 5.69 %, DI: 4.09 to 4.98 %, DSGA: 1.38 to 1.43 %. No DSA was noted during the study. Although the use of new comprehensive assessment form increased the completeness of the airway assessment form it doesn’t have any clinically significant impact on the prediction of difficult airway, the authors conclude. The limitations of the study were noted as “single institutional study”, “inter observer variation”, and “time between study design and study period”. The article was published in British journal of Anesthesia in 2013.

The poor prediction of difficult airway may result in impossible intubation and consequently a catastrophic situation. **A.Sillen** from Abu dhabi in his letter to the editor, British journal of Anesthesia (2014) drews his attention towards a novel tool for dealing with unanticipated difficult airway. It’s called Vortex approach[30]– use of face mask, LMA, tracheal tubes before heading out for ESA (emergency surgical airway). Three attempts at securing each device permitted of which atleast one should be done by an experienced anesthetist. Manipulation of head / neck / larynx / device, use of adjuncts / suction and change in size / type of devices are allowed in the Vortex approach.

Liaskou chara et al from Aretaiau hospital and medical college, Athens university in 2014 published the results of their study assessing the impact of thyromental distance, sternomental distance, ratio of TMD to SMD, neck circumference on the laryngoscopy[31]. They studied the ROC curve, sensitivity, specificity values among many others for each test. They found that all the above four tests were poor predictors for DVL as single tests. However a predictive model created by multivariate analysis with logistic regression had a significant predictive accuracy (AUC – 0.68, $P < 0.001$). The predictive accuracy improved in women when gender specific cut off points were used.

Bhavdip patel, Rajiv khandekar, Rashesh Diwan, Ashok shah wanted to analyze the effect of combining various factors in prediciting difficult intubation, viz – MMP, TMD, SMD[32]. They studied a group of

135 patients and analyzed the results using univariate analysis (parametric method). They found that MMP has got a high specificity among the individual tests, but the combined score of the three has got a greater validity than the MMP test. Hence they concluded that all the parameters should be tested to assess for difficult intubation. The study was published in IJA 2014.

History of Airway Management

HISTORY OF AIRWAY MANAGEMENT

Creation

"Our very breath, pre-language of the lingus,

Unspoken and unseen, lies all around us;

It tunnels through a darkened path to bring us

Before the guarded gates that would confound us:

Dentition, palate, epiglottic folds

Are navigated as the case is started

And followed through to cartilage that holds

The two true cords, those gleaming pillars, parted;

Here human hands, left trembling with creation,

Are re-creating life as it began,

Beginning with the step of intubation,

The God-breathed breath of life blown into man"

Stephen Harvey

We are witnessing the modern era of in the history of airway management. It is useful to remember the basic principles behind the origin and advancement of airway management during the 18th and 19th centuries.

It all started with "aspera arteria" which means cannulation of trachea, originally described by Robert hook for Positive pressure ventilation[33].

The description was as follows:

> *"… the Dog being kept alive by the Reciprocal blowing up of his Lungs with bellowes, and they suffered to subside, for the space of an hour or more, after his Thorax had been so display'd, and his Aspera Arteria cut off just below the epigolotis, and bound on upon the nose of the Bellows"*

In 1858, John snow reported the use of anesthetics through a tracheostomy and cannulation in "On chloroform and other anesthetics"[34] on a spontaneously breathing rabbit. In 1869, Trendelenberg reported the human tracheostomy for protection against aspiration in addition to anesthesia[35].

In the forthcoming years the practice of tracheostomy for various medical and surgical indications grew popular.

During the World War I numerous soldiers were operated for facial and mandibular injuries in England. Sir Ivan Magill was the anesthetist in Sidcup hospital used endotracheal intubation for many cases and wrote many descriptive treatises on it[36].

One among the treatises is:

> *"The maintenance of a free airway has long been recognized as a first principle in general anesthesia and the danger of complete laryngeal obstruction has always been obvious. On the other hand, the cumulative effects of partial respiratory obstruction have, in the past, been frequently overlooked and it is not improbable that many of the surgical difficulties, postoperative complications, and even fatalities attributed to the anesthetic agent have been primarily due to an imperfect airway. It may be said without exaggeration that in remedying this defect endotracheal anesthesia has proved as great a factor in the advances of anesthesia as the discovery of new drugs or the development of improved apparatus"*

Following which immediately, Sir Ivan Magill inserts a warning note:

> *"… owing to the ease of control it affords, there is a tendency towards its employment in every operation, regardless of other considerations. This tendency is to be deprecated, especially in the teaching of students. The novice should learn airway control by simple methods in the first instance, for he may be called to administer an anesthetic in circumstances in which artificial devices are not available. Moreover, as the method involves instrumentation, which is not devoid of the risk of trauma, even though it may be slight, intubation should only be attempted when the necessity for it has been considered carefully"*

The lesson learnt from the history is that the endotracheal intubation has become standard of care in airway management. However, it's invasive nature and associated risks should be weighed against the benefits of intubation.

Airway Anatomy

AIRWAY ANATOMY

Anesthesiologists secure airway for delivering anesthetic gases during anesthesia. They are also called upon for emergency airway management in dire situations. Hence a thorough knowledge about the airway anatomy and physiology is warranted for any practicing anesthesiologist.

The airway consists of passage through which the inhaled air passes from nostril till the bronchioles. For descriptive purposes, it may be classified into upper airway and lower airway. The upper airway consists of airway from nostril till glottis or thoracic inlet and thereafter trachea, bronchi, bronchioles constitutes lower airway.

NASAL FOSSA:

Phylogeneticaly nose is the structure intended for breathing. However during exertion, mouth also serves as passage for breathing. The nasal fossae (two in number) extend from nostril till nasopharynx and measure 10 – 14 cms. They are divided by a midline quadrilateral cartilagenous septum and a medial portion of lateral cartilage. The septum comprises of perpendicular plate of ethmoid bone descending from cribriform plate, septal cartilage and omer **(Figure 1).**

Figure 1

NASAL SEPTUM

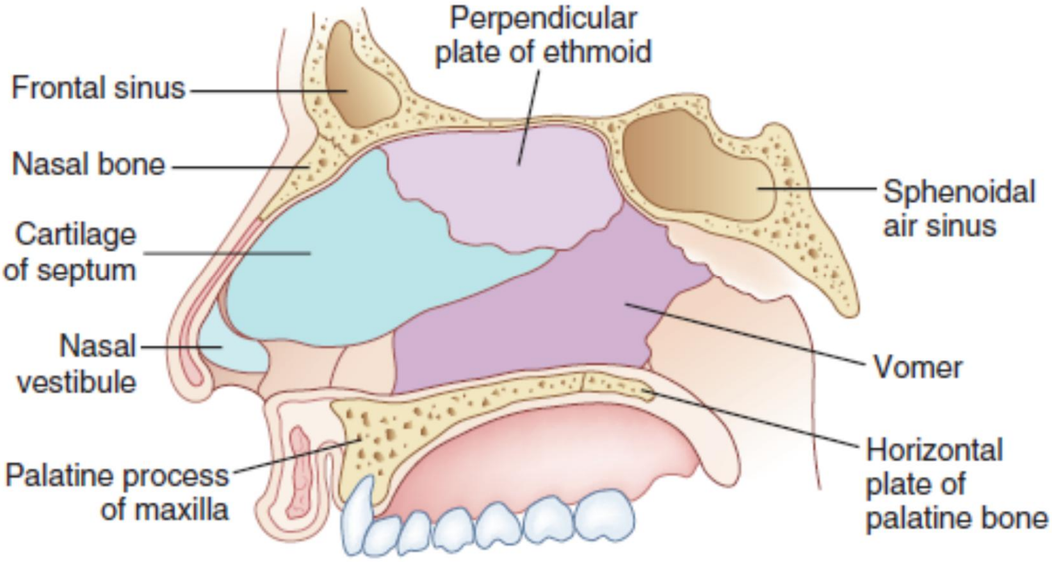
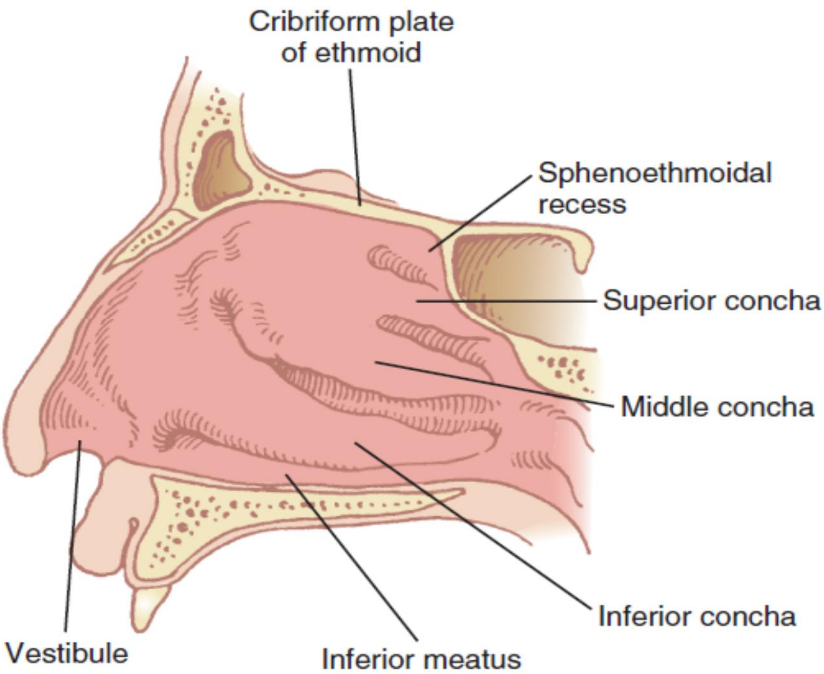


Figure 2

LATERAL WALL OF NOSE



Each nasal fossa is bounded by superior, middle and inferior turbinate laterally **(Figure 2).** The inferior turbinate may interrupt with the insertion of ETT nasally and vigorous attempts at ETT insertion may lead to injury to the lateral wall.

In addition to the kiesselbach plexus, the highly vascular mucosa over the turbinate may bleed profusely if injured during nasal intubation.

The septal deviation may lead to obstruction in nasal fossa while trauma induced posterior septal deviation and choanal atresia may lead to obstruction at the level of nasopharynx.

PHARYNX:

The pharynx is a passage 12-15 cms long that extends from base of skull to cricoid cartilage and C6. It can be divided into nasopharynx, oropharynx and laryngopharynx **(Figure 3)**.

The nasopharynx extends from point where turbinates end till the soft palate. From the soft palate oropharynx extends till superior edge of epiglottis. The laryngopharynx or hypopharynx extends from C4-C6 superiorly from edge of epiglottis till lower border of cricoid cartilage which then continues as oesophagus.

Figure 3

OROPHARYNX, NASOPHARYNX, LARYNGOPHARYNX

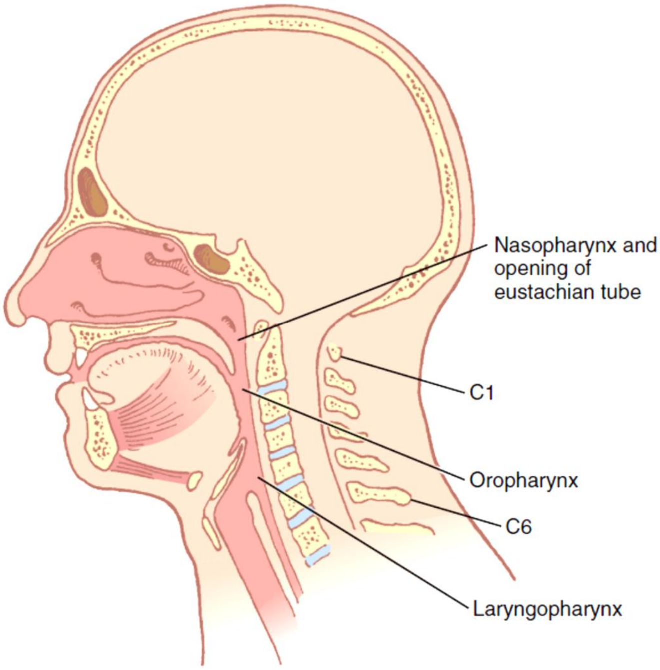
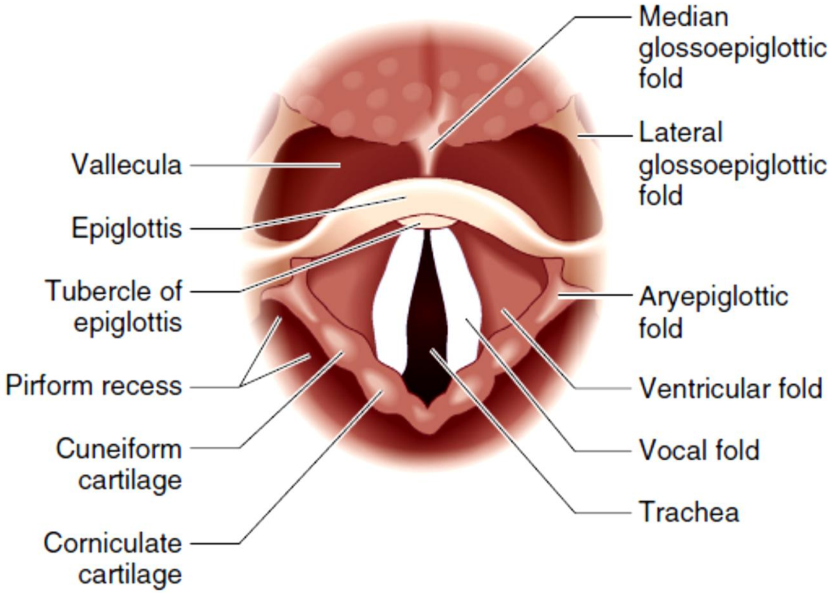


Figure 4

GLOTTIC VIEW DURING DIRECT LARYNGOSCOPY



The airway obstruction during sedation and anesthesia was attributed to the loss of tone of genioglossus muscle and hence the posterior displacement of tongue on the airway. Recently the focus has shifted to velopharyngeal segment of airway adjacent to soft palate.

Understanding of the distance relationship between the structures from oropharynx and trachea is very important while placing the ETT to avoid complications like endobronchial intubation and cuff leak.

LARYNX:

The larynx is also called the “watchdog” of the airway which allows only air to pass into the trachea but not food, secretions, and foreign bodies. It extends from level of C3 – C6.

The laryngeal aperture is bound superiorly by epiglottis, laterally by aryepiglottic folds, posteriorly by corniculate cartilage and interarytenoid notch. The part of larynx below the laryngeal inlet is called laryngeal cavity and one above is called vestibule. The ventricular folds or false vocal cords are the superior most structure of the laryngeal cavity. True vocal cords are seen below the ventricular folds and attached anteriorly to thyroid cartilage where they form the anterior commissure and posteriorly to arytenoid cartilage. The space between the true vocal cords is called glottis **(Figure 4).**

The visualization of the structures in glottis during direct laryngoscopy is important during intubation.

Assessment Of Airway

ASSESSMENT OF AIRWAY AND PREDICTORS OF DIFFICULT AIRWAY:

The ASA practice guidelines mentions guidelines / recommendations for airway assessment and management.

Guidelines for Airway assessment:

History

A detailed history taking should obtain details of the patient characteristics like age, h/o snoring, h/o obstructive sleep apnea, previous h/o difficult intubation or laryngoscopy, disease states like ankylosing spondylitis, degenerative osteoarthritis, lingual tonsillar hypertrophy, Treacher Collin syndrome, Pierre Robin syndrome.

Examination

Physical features suggestive of upper airway anatomical abnormality or pathology should be looked for.

Additional

History and physical examination may give indication to additional diagnostic testing like radiological imaging, CT scan, and fluoroscopy.

<u>Recommendations for Airway assessment:</u>

History

To detect medical, surgical, anesthetic factors that may indicate a difficult airway. A history of previous difficult intubation / laryngoscopy / mask ventilation may be the most valuable clue to difficult airway. History and records should be verified with this regard.

Physical examination

Look for anatomical abnormalities of face and neck, ability to extend neck, long upper incisors, relationship between upper and lower incisors during jaw closure, protrusion of mandible, interincisor distance, visibility of uvula, palate characteristics, thyromental distance, mandibular space, length and thickness of neck, range of motion of head and neck.

Preoperative airway assessment by specific test / index of Difficult Airway should follow a general examination. If time permits, more than one assessment method should be done to increase the accuracy of airway assessment, as no single test predicts DA accurately (100%).

The specific tests include:

1. Interincisor gap (< 3 cms indicates DL)
2. Protrusion of mandible (class B and C indicates DL)
3. Modified mallampati test (class 3 and 4 indicates DL)
4. Extension of upper cervical spine (<90° indicates DL)
5. Thyromental distance (<6 cms indicates DL)
6. Sternomental distance (<12.5 cms indicates DL)
7. WILSON's score (≥ 2 indicates DL)

Ideal Predictor:

The ideal test (predictor) should have the following characters:

1. The test should be painless as patients will not tolerate discomfort for Difficult Airway screening.
2. The test should be simple, consume little time and should require nil or simple equipments.
3. If any calculation involved, it should be easy to perform.
4. It should be possibly a bedside test.

5. The test should be objective with nil or minimal inter observer variability and should be reproducible.

6. The test should be economical too.

7. Higher Sensitivity and positive predictive values are desirable.

Syndromes associated with Difficulty Airway:

Congenital	**Acquired**
Pierre Robin syndrome	Croup
Treacher Collins syndrome	Ludwig’s angina
Goldenhar syndrome	Intraoral or retropharyngeal abscess
Downs syndrome	Rheumatoid arthritis
Klippel Feil syndrome	Ankylosing spondylosis
Alpert syndrome	Cystic hygroma / adenoma / goiter
Beckwith syndrome	Distortion of airway
Cretinism	Carcinoma tongue / thyroid / larynx
Cri du chat syndrome	Trauma – Head / facial
Von Reckinghauswen disease	Morbid obesity
Hurler / Hunter syndrome	Acromegaly
Pompe’s disease	Acute burns

Airway Management

AIRWAY MANAGEMENT

The airway can be secured by either an invasive (tracheostomy) or less invasive (endotracheal tubes, LMA) among which endotracheal tube intubation remains the preferred method even after the advent of supraglottic devices.

The laryngoscopy and intubation may be easy or difficult. The understanding of the technique of intubation requires thorough knowledge of the airway anatomy.

While doing a direct laryngoscopy or endotracheal intubation, one have to encounter various structures like teeth, tongue, epiglottis, vocal folds and many. Hence the anatomical abnormality of these structures may contribute to difficult intubation.

Moreover understanding the orientation of oral, pharyngeal and laryngeal axis is important when it applies to bringing all 3 axes in line. The process of neck flexion and extension at atlanto occipital joint during the positioning undoubtedly helps to bring them in line and factors altering or limiting these movements may contribute to difficult intubation.

General Anesthesia

GENERAL ANESTHESIA

General Anesthesia (GA) comprises reversible loss of consciousness, amnesia, and analgesia with or without muscle relaxant. The GA may be characterized by impairment of ventilatory function, need for assistance in maintenance of a patent airway, need for positive pressure ventilation, drug induced skeletal muscle relaxation, and impairment of cardiovascular function.

The drugs commonly used for GA may be categorized into premedication drugs, intravenous (IV) induction agents, inhalational or volatile agents, analgesics, muscle relaxants and reversal agents.

Premedication drugs are mainly given to reduce anxiety, reduce secretions, decrease volume and acidity of gastric content, act as analgesics, and anti emetics. It includes anticholinergics (glycopyrrolate), anxiolytics (midazolam), opioids (morphine, fentanyl), anti histamines (ranitidine), anti emetics (metoclopromide).

Induction agents may be IV or Inhalational. IV induction agents are thiopentone sodium, propofol, ketamine and etomidate. inhalational or volatile induction agents are halothane and sevoflurane. The volatile agents (halothane, sevoflurane, isoflurane and desflurane) are commonly used for maintenance of anesthesia throughout the surgery.

Commonly used analgesics are opioids like morphine, fentanyl, pethidine and others.

Muscle relaxants commonly used are classified into two categories. They are depolarizing relaxants like Succinylcholine and non depolarizing agents like vecuronium, rocuronium, atracurium. all muscle relaxants except succinylcholine are used for maintenance through the intraoperative period.

Reversal agents include anti cholinesterase (neostigmine) and anti cholinergic drugs (glycopyrrolate, atropine).

Succinylcholine:

Succinylcholine is the only depolarizing muscle relaxant in clinical use. It is chemically known as 'Diacetylcholine' (2 molecules of acetylcholine joined together) or Suxamethonium.

Ultra rapid onset (30-60 seconds) and ultra short duration (less than 10 minutes) are the most important advantages of succinylcholine. Hence, traditionally succinylcholine was the drug of choice for tracheal intubation.

It is metabolized by plasma cholinesterase (also called as pseudo cholinesterase) and there is genetic variability for the enzyme.

The intubating dose is 1-1.5 mg/kg IV.

The adverse effects are hyperkalemia, fasciculations, rhabdomyolysis, trigger for malignant hyperthermia, increased intracranial tension (ICT) and intraocular tension (IOT). Repeat dose or higher dose of succinyl choline may lead to phase 2 blockade.

In view of the above adverse effects, non depolarizing muscle relaxants have slowly replaced succinylcholine for the purpose of elective tracheal intubation.

However, the advantage of ultrashort action and rapid recovery from muscle paralysis gives succinyl choline an edge over non depolarizing muscle relaxants for intubation in case of CICV situations.

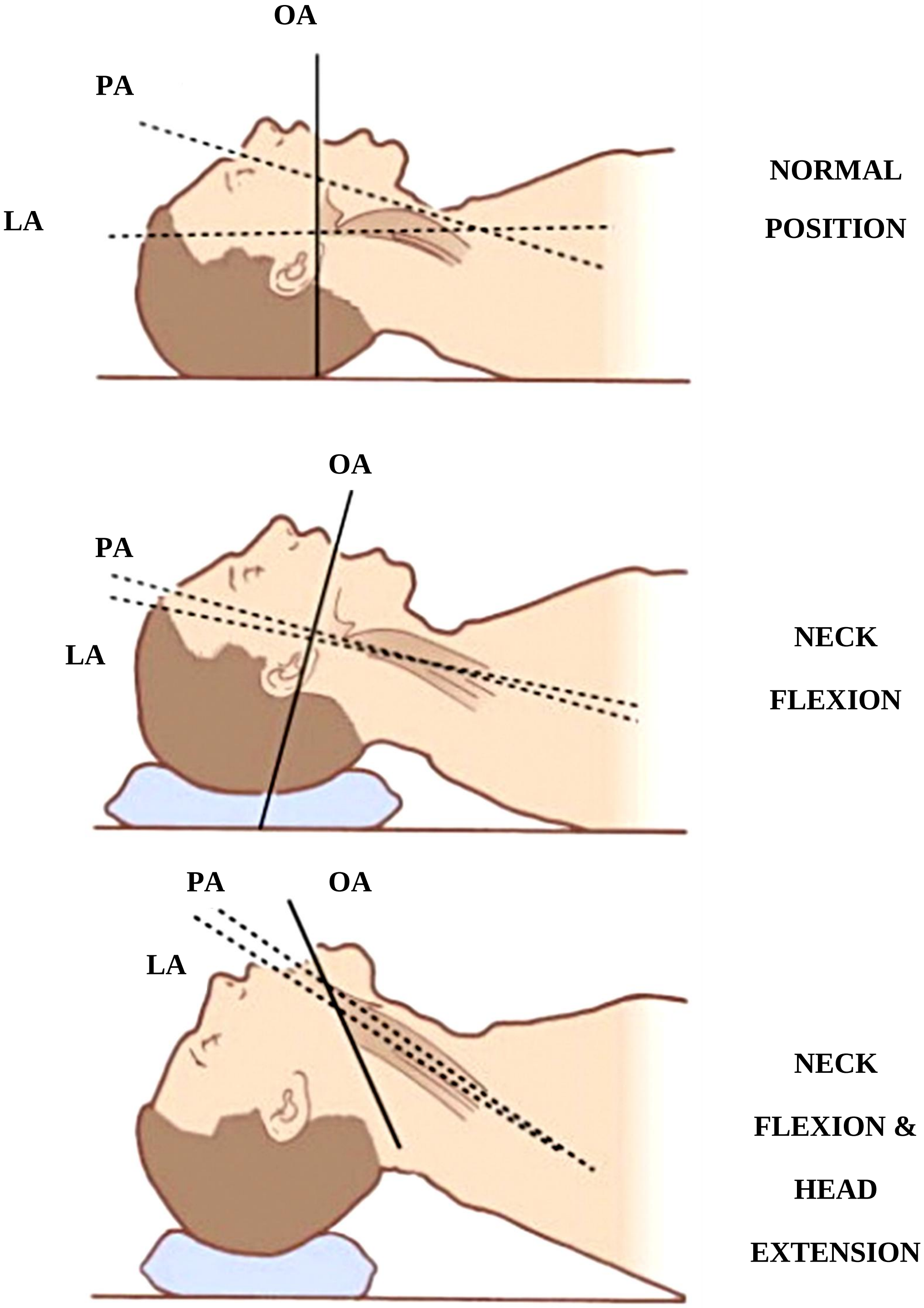
Direct Laryngoscopy

Direct Laryngoscopy involves direct visualization of the glottis using a laryngoscope. It facilitates endotracheal intubation and is the most common technique used for it.

During direct laryngoscope, the anatomic axes – oral, pharyngeal and laryngeal axes are distorted, brought into a single axis and tongue is displaced to produce a direct line of visibility form operator’s eye to the larynx **(Figure 5).**

Figure 5

ORAL PHARYNGEAL LARYNGEAL AXES IN DIFFERENT POSITIONS



The normal angle between oral and pharyngeal axis is 90°. Maximal extension of atlanto occipital joint increases the angle by 35° and makes it 125°.

The 3 axes can be brought together near a single line by SP (sniffing position) as described by Sir Ivan Magill. Sniffing position is described as a neck flexion of 35° (by placing pillow under occiput) and head extension 15° (by extension of atlanto occipital joint).

An alternate position which is useful especially in obese people is EAM-SN (External auditory meatus – sternal notch) position.

All the efforts are oriented towards creating an in line space towards laryngeal aperture for tracheal intubation, the end point being visualization of glottis. A complete visualization of glottis leads to successful tracheal intubation.

After positioning the patient, the head is fixed in extended position by anesthesiologist's dominant hand and using finger the lower jaw is opened (if not passively open) to increase the inter incisor distance.

The Macintosh curved blade is commonly used for adult patients. The blade is introduced into the mouth and the tongue is displaced to opposite side with the flange of the blade to create space. The tip of the Macintosh blade is placed in the vallecula and the blade is lifted anterior - caudad direction **(Figure 6).**

The operator should carefully avoid any rotating the wrist and laryngoscope blade in a cephalad direction. This will cause the blade to injure the upper incisors which is not desirable. Extending blade too deeply can place the blade tip to rest under the larynx and forward pressure may lift entire larynx away from the view.

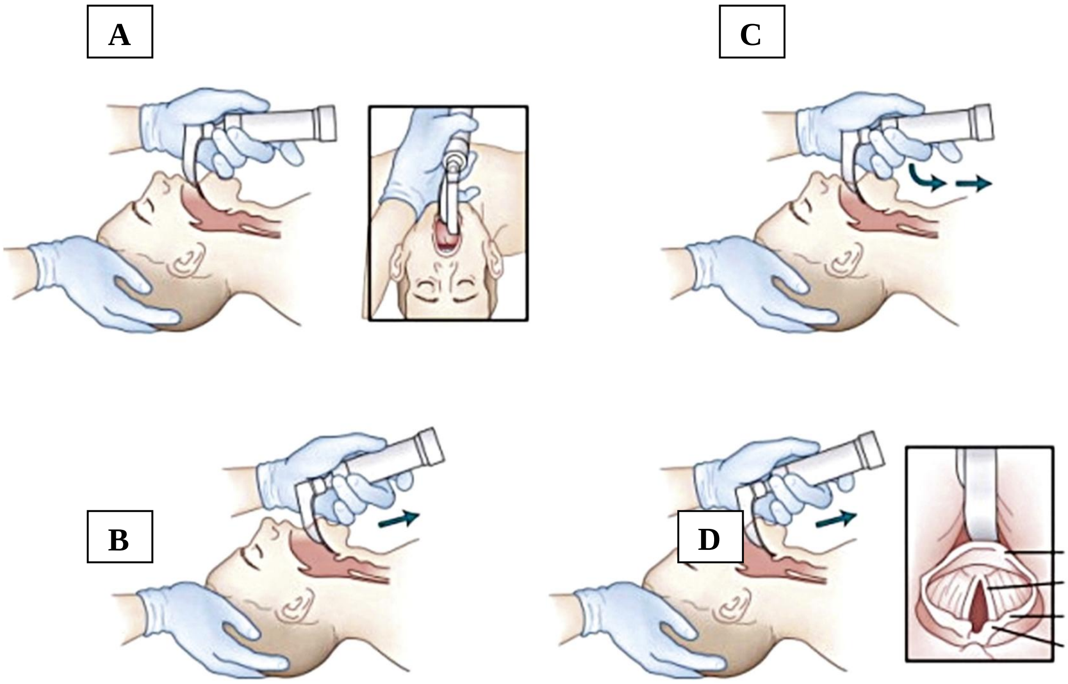
An alternate to Macintosh blade is a Miller's straight blade.

During laryngoscopy, if satisfactory view is not obtained, an "optimal external laryngeal manipulation" (OLEM) as described in Benumof and Hagberg's textbook of Airway management[37] can be used. It involves applying pressure posteriorly and in the cephalad direction over the thyroid, hyoid, and cricoid cartilages. BURP (Backward-Upward-Rightward pressure) maneuver is the typically the most useful OELM applied.

Figure 6

CONVENTIONAL DIRECT LARYNGOSCOPY

WITH MACINTOSH BLADE



A – Laryngoscopy blade inserted into right side of mouth sweeping the tongue to the left side of flange

B – Blade is advanced in midline towards base of tongue by rotating wrist so that laryngoscope handle becomes more vertical

C – The laryngoscope is lifted at 45’ as tip of the blade is placed in the vallecula

D – Continued lifting of the handle until visualization of laryngeal aperture

When the glottis is visible the endotracheal tube is inserted into it under vision of the operator. Care should be taken not to obscure the view of larynx when inserting the endotracheal tube. The tube should be inserted to a depth of 2 cms after disappearance of the cuff. This allows the tip of the ETT to be positioned in mid trachea.

Commonly a size 7 - 8 ID ETT is used in adult female and size 8 - 9 ID ETT in adult male. Typically the length at which ETT is fixed (at upper incisors) is 20-22 cms and 18-20 cms in adult male and female respectively.

Confirmation of a successful ETT placement is done by various methods. The gold standard methods are placement of ETT under direct vision and capnography.

Five point auscultation of the chest, visualization of chest expansion, observation of tube condensation, self inflated bulbs, lighted stylet, fibreoptic devices, ultrasonography and chest x-ray are other methods.

The alternate to direct laryngoscopy is image guided laryngoscopy which may herald the future in the art of tracheal intubation.

Materials And Methods

MATERIALS AND METHODS

The study was done in the Department of Anesthesiology, ESIC MC and PGIMSR, K.K. Nagar, Chennai from October 2014 to August 2015.

Study design : Prospective Observational double blind study.

Participants : Patients undergoing elective surgery requiring GA with endotracheal intubation.

Sample : Sample size of 173 is calculated by using nMaster 1.0 software (PPV - 33, precision - 7%, confidence level - 95%)

The aim, objectives, materials and methods were submitted to the Institutional ethics committee and approval was obtained. 173 patients were selected in accordance with inclusion and exclusion criteria for the study.

Inclusion criteria:

1. 18 – 50 years of either sex
2. ASA physical status I, II
3. Patient undergoing elective surgeries under General anesthesia requiring endotracheal intubation

Exclusion criteria:

1. Consent not given.
2. Obvious anatomical abnormality of face, head, neck and shoulder.
3. Upper airway abnormality (e.g., tongue tumor, maxillofacial tumor, or fracture)
4. Recent head and neck surgery
5. Inability to open mouth

Pre Anesthetic Assessment:

As per the departmental protocol the patients posted for elective surgery were investigated for pre-operative biochemical tests (renal function tests and liver function tests), hematological tests (hemoglobin, total count, differential count, platelet count), Chest x-ray (PA view) & 12 lead Electrocardiograph and assessed in the pre-anesthetic assessment clinic.

The patients on arrival to the operating theatre complex were reviewed immediately prior to surgery.

Airway assessment:

All patients underwent airway examination prior to surgery during which Acromio axillo suprasternal notch index (AASI) and Modified Mallampati test (MMP) were assessed by an anesthesiologist and recorded in the proforma.

Modified mallampati test: The standard test

MMP score (the oropharyngeal view) was measured while patients were sitting, with a fully protruded tongue without saying “ah”. MMP classification **(Figure 7)** is as follows:

I : Full view of soft palate, uvula, tonsillar pillars

II : Soft palate and upper portion of uvula

III : Soft palate

IV : Hard palate only

Acromio Axillo Suprasternal Notch Index (AASI):

With the patients lying in a supine position and their upper extremities resting at the sides of the body **(Figure 8),** AASNI was calculated based on the following measurements: (1) using a ruler, a

Figure 7

MODIFIED MALLAMPATI CLASSIFICATION

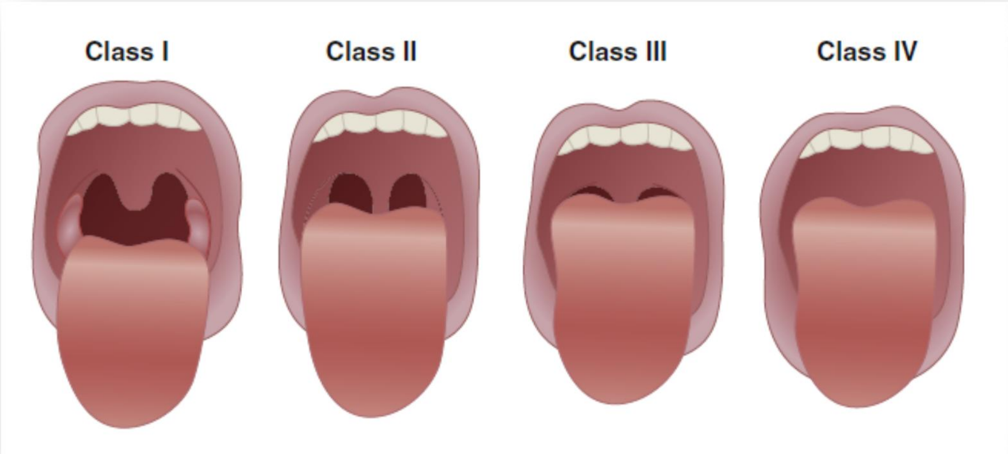
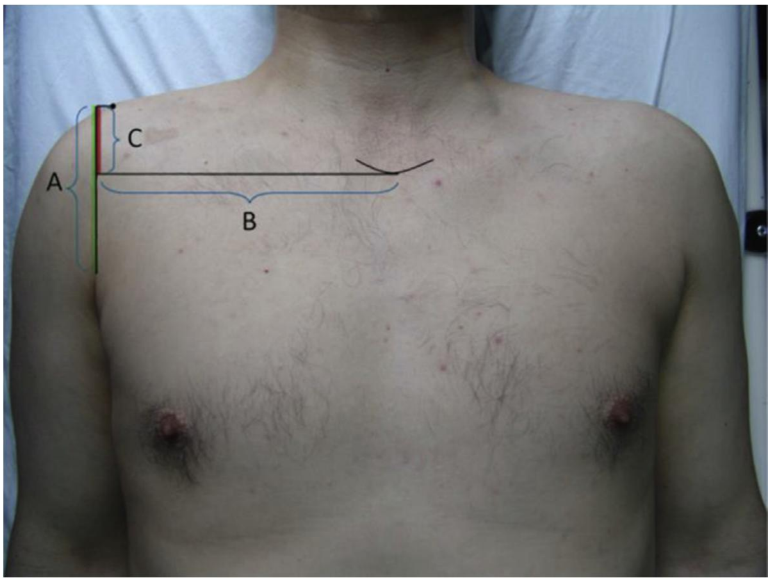


Figure 8

ACROMIO AXILLO SUPRASTERNAL NOTCH INDEX



vertical line was drawn from the top of the acromion process to the superior border of the axilla at the pectoralis major muscle (line A); (2) a second line was drawn perpendicular to line A from the suprasternal notch (line B); and (3) the portion of line A that lay above the point at which line B intersected line A was line C. AASNI was calculated by dividing the length of line C by that of line A (AASNI = C/A).

Preparation:

After airway assessment patients shifted into operating room and minimum mandatory monitors such as pulse oximetry (SpO2), non invasive blood pressure (NIBP), and electrocardiogram (ECG) were attached.

Baseline pulse rate, blood pressure and oxygen saturation were recorded.

An intravenous (IV) line was secured and Ringer lactate / Normal saline (depending on the diabetic status of patient) started before the procedure.

Standard preparations and precautions were taken for general anesthesia with endotracheal tube intubation and controlled mechanical ventilation for all the patients.

The airway cart was kept ready which consists of manual resuscitator bag, anatomical masks of all sizes, oropharyngeal and nasopharyngeal tubes of all sizes, suction canula of all sizes, laryngoscope handle with blades of all sizes, McCoy blade, ETT of all sizes, LMA of all sizes, ILMA (intubating LMA), stylet, ventilating bougie, emergency cricothyrotomy set, and emergency tracheostomy set.

The availability of fibreoptic bronchoscope was ensured whenever we encountered a suspected case of Difficult airway.

Premedication and Induction:

All patients received premedication with Glycopyrrolate (0.2 mg), midazolam (2 mg) and fentanyl (2 mcg/kg) intravenously. After pre-oxygenation (100% O2 for 3 minutes) patients induced with propofol (2.5 mg/kg) and paralysed with succinylcholine (1.5 mg/kg) intravenously.

After ventilation for 1 minute with 100 % O2, with a 10cm pillow under the head and the head in the sniffing position, direct laryngoscopy was done by an experienced anesthesiologist. Direct laryngoscopy was performed with a Mackintosh blade (No. 3) and Cormack Lehane grade was assessed.

Cormack Lehane grading system:

The laryngeal view is graded according to this system on direct laryngoscopy **(Figure 9).**

Grade 1 - visualization of the entire glottic aperture,

Grade 2 - visualization of only the posterior aspects of the glottic aperture,

Grade 3 - visualization of the tip of the epiglottis,

Grade 4 - visualization of no more than the soft palate.

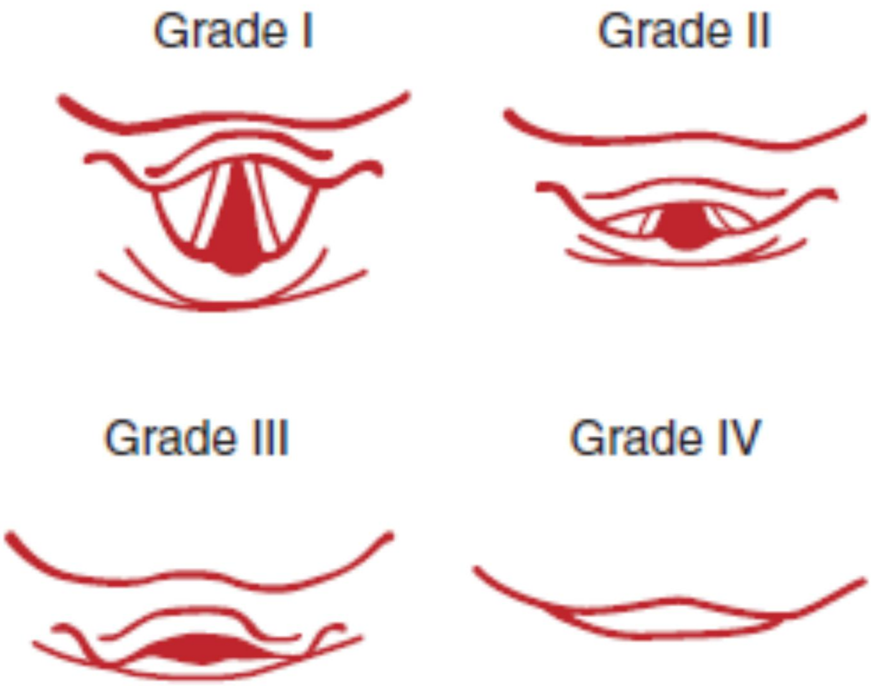
Cormack Lehane grades 1 and 2 were considered as “Easy visualization of larynx (EVL)” and grades 3 and 4 as “Difficult visualization of larynx (DVL)”.

Whenever intubation wasn’t possible with conventional laryngoscopy, other measures such as using blade 4 or McCoy, bougie, stylet, external laryngeal pressure were used to intubate the patients.

After endotracheal intubation further anesthetic management was continued as per the requirements and standard. Vital parameters were observed throughout the procedure at regular intervals as needed and recorded.

<u>Figure 9</u>

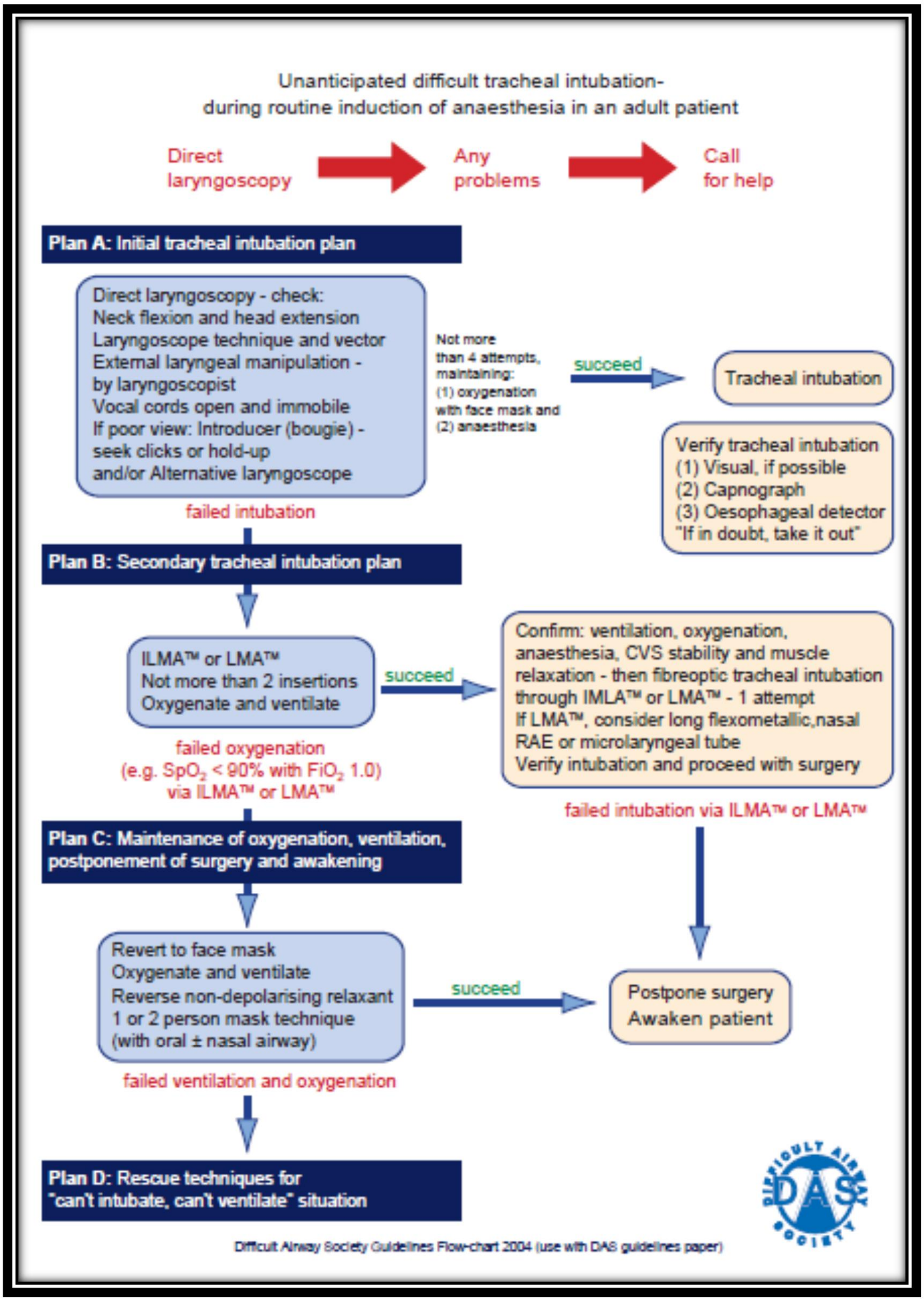
CORMACK LEHANE (CL) GRADING SYSTEM OF LARYNGOSCOPIC VIEW



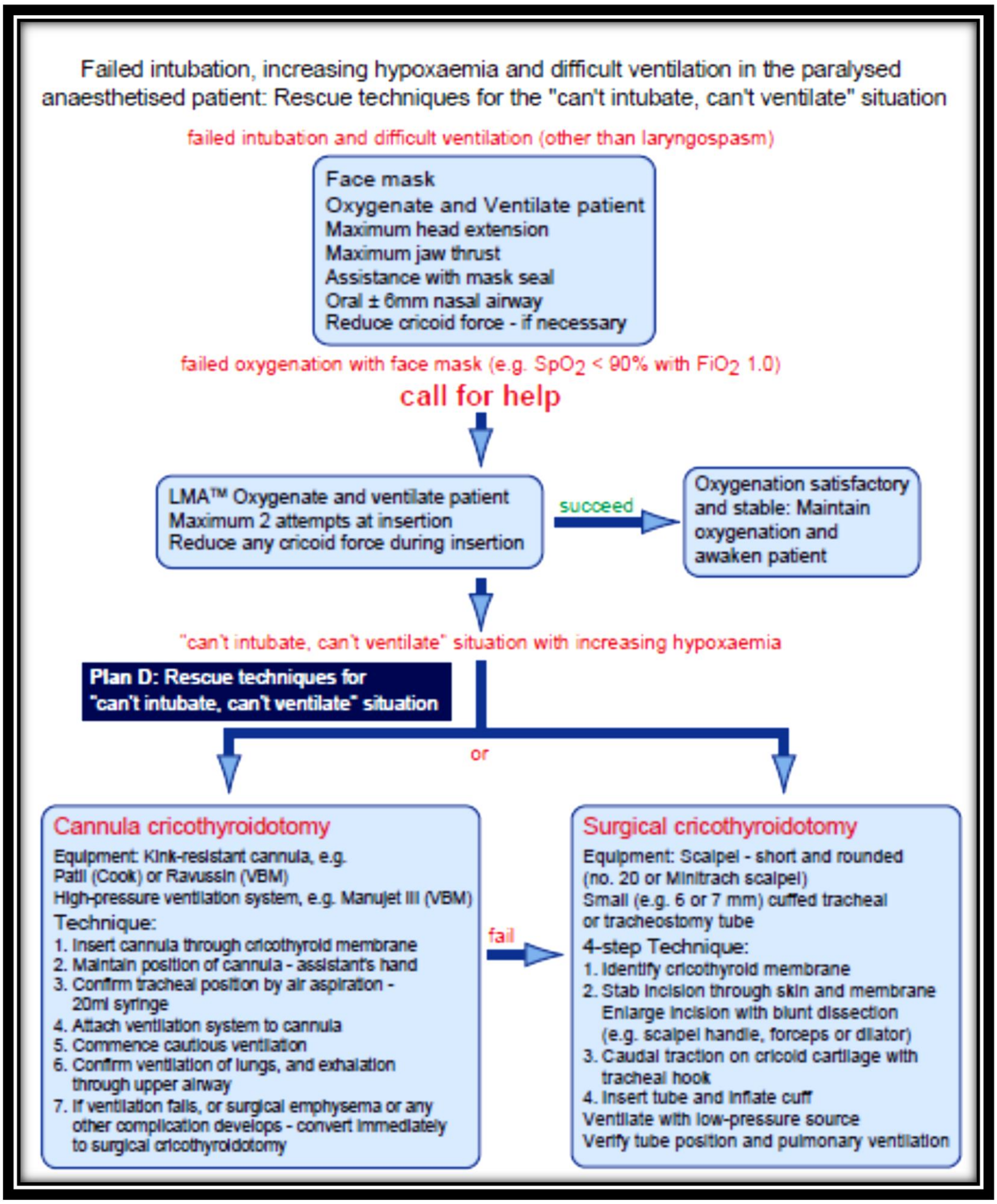
No failed intubation was encountered during the study. The plans to mask ventilate and recover the patient didn’t happen since all patients in the study group were successfully intubated. However the anesthesia team was ready to manage a “Cannot Intubate Cannot Ventilate” situation by the DAS (Difficult airway society) guidelines.

DAS GUIDELINE FOR

"UNANTICIPATED DIFFICULT TRACHEAL INTUBATION"



DAS ALGORITHM FOR "FAILED INTUBATION AND DIFFICULT VENTILATION"



PATIENT FLOW CHART:

ASSESMENT CLINIC

(18-50 years of either sex, ASA I and ASA II patients selected for study based on inclusion and exclusion criteria)

Informed consent

ON THE DAY OF SURGERY- IMMEDIATE PREOP EVALUATION

AIRWAY ASSESSMENT

(Acromio axillo suprasternal notch index and Modified Mallampati test done)

Patient shifted to the operation room by trained personnel in a trolley

INSIDE THEATRE : WHO CHECK LIST

(Monitors connected, difficult airway cart and rescue measures, intravenous line secured)

Premedication, Preoxygenation Induction and Paralysis

DIRECT LARYNGOSCOPY

DIFFICULTY IN VISUALIZATION OF LARYNX ASSESSSED

(Cormack and Lehane grade 3, 4 indicates difficulty)

Observation And Results

OBSERVATION AND RESULTS

173 patients were enrolled into this prospective observational study after obtaining informed consent.

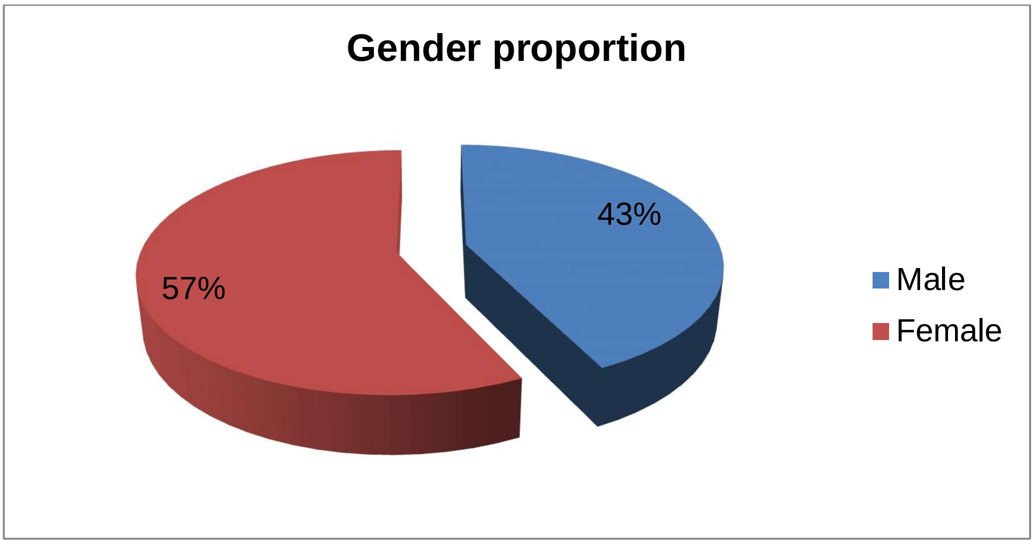
Gender Distribution:

Among 173 patients, 74 patients (43%) were male and 99 patients (57%) were female **(Table 1 and Pie chart 1).**

Table 1

Gender	Number	Percentage
Male	74	43%
Female	99	57%
Total	**173**	**100%**

Pie Chart - 1



Demography:

Table 2

Characteristics	No.	Minimum	Maximum	Mean	Std error	Std Deviation
Age (year)	173	18	50	35.1	0.7	9.4
Height (meter)	173	1.47	1.72	1.6	0.0	0.1
Weight (kg)	173	37	92	59.7	0.8	10.9
BMI	173	16	36	23.1	0.3	3.4

Age:

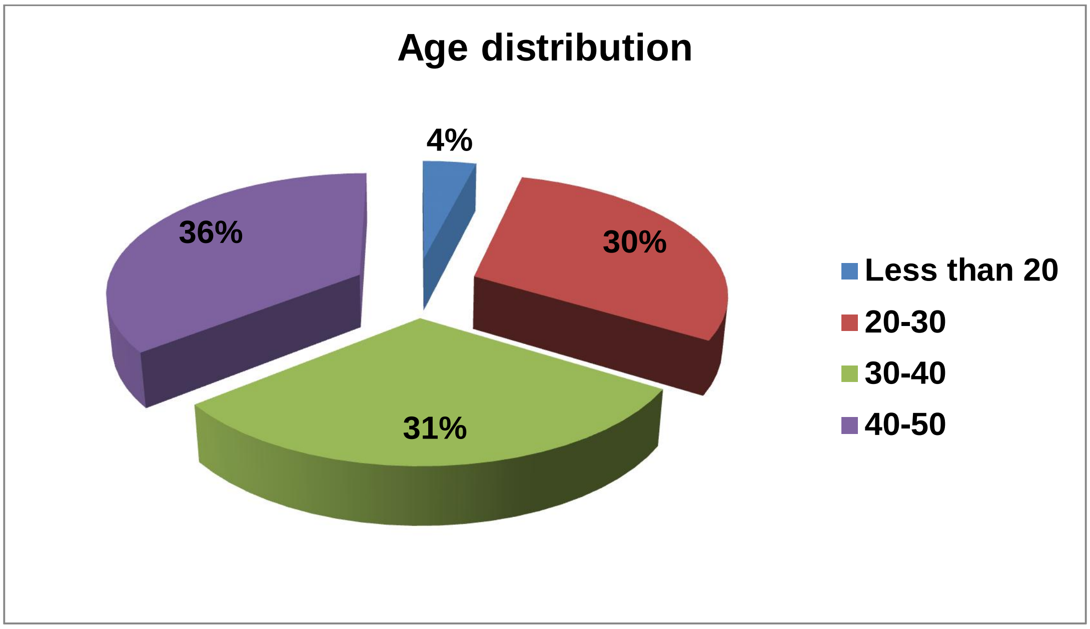
The age of the patients ranges from 18 (minimum) and 50 (maximum). The mean was 35.1, standard error being 0.7 and standard deviation is 9.4 **(Table 2).**

Majority of the patients (36%) belong to the age group 40-50 years. 3 % belong to 18-20 years group, 30% belong to 20-30 years, and 31 % belong to 30-40 years age group **(Table 3 and Pie chart 2).**

Table 3

Age group (years)	Number	Percentage
< 20	6	4%
20--30	51	30%
30--40	54	31%
40--50	62	36%
Total	173	100%

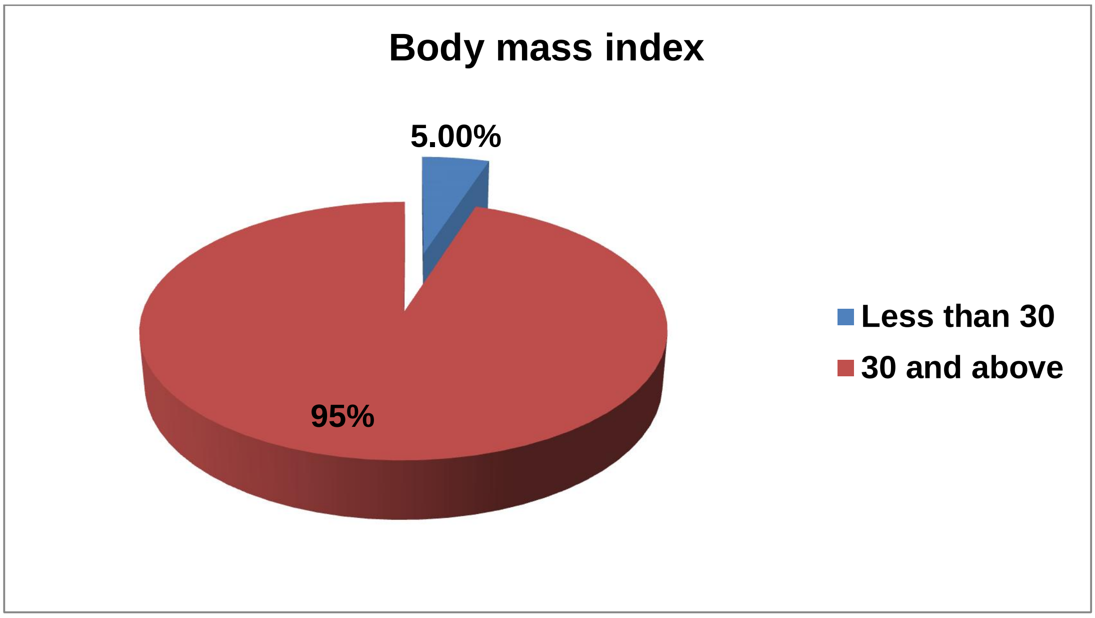
Pie Chart : 2



Body Mass Index (BMI):

The BMI of the patients ranged from 16 to 36. The mean was 23.1, standard error was 0.3, and standard deviation was 3.4 **(Table 2).** Patients with BMI >= 30 (obese) are 8 in number and BMI< 30(non obese) are 165 in number **(Pie chart 3).**

Pie Chart : 3



Obese patients (BMI >=30%) had higher incidence of AASNI>=0.5 (50%) than non obese patients (19%). Obese patients have higher incidences of DVL (25%) than non obese patients (9%).

Blood investigations details:

Table 4

Characteristics	No.	Minimum	Maximum	Mean	Std error	Std. Deviation
Hb (g/dl)	173	9.3	16.3	12.7	0.1	1.5
RBS (mg/dl)	173	64	156	103.5	1.3	17.2

Hemoglobin:

The hemoglobin values of the patients ranged between 9.3 to 16.3 g/dl. The mean was 12.7 g/dl, standard error was 0.1, and standard deviation was 1.5 **(Table 4).**

Blood sugar:

Blood sugar values of the patients was recorded, the least being 64 mg/dl, the highest value 156 mg/dl, mean was 103 mg//dl, standard error was 1.3, and standard deviation was 17.2 **(Table 4).**

The renal function of all the patients are normal as only ASA 1 or 2 patients were selected. The ECG of all patients was either normal or declared as non specific changes by physicians. The CXR of all patients were normal in terms of cardiac shadow.

Baseline vital parameters:

Table 5

Characteristics	No.	Minimum	Maximum	Mean	Std error	Std Deviation
SBP (mmHg)	173	90	170	122.13	.98	12.9
DBP (mmHg)	173	51	101	78.5	0.7	9.7
MAP (mmHg)	173	67	123	93.08	0.78	10.22
PR (per min)	173	52	118	81.9	0.7	9.3
RR (per min)	173	10	20	13.4	0.1	1.6
Spo2 (%)	173	98	199	100.3	0.6	7.6

The systolic blood pressure (SBP) recorded in mmHg was documented. The minimum value was 90 mmHg and the maximum was 170 mmHg, the mean calculated was 122.13, the standard error was 0.98, standard deviation 12.9 **(Table 5).**

The diastolic blood pressure (DBP) varied between 51 mmHg and 101 mmHg. The mean value was 78.5, standard error being 0.7 and standard deviation was 9.7 **(Table 5).**

The Mean blood pressure (MAP) was calculated by the formula MBP = ((DBP X 2) + SBP) / 3. The highest MAP was 123 and lowest was 67. The mean value was 93.08, standard error was 0.78, and the standard deviation was 10.22 **(Table 5).**

The Pulse rate (PR) in beats per minute (bpm) varied between 52 and 118. The mean was 81 and standard error – 0.7, standard deviation – 9.3 **(Table 5).**

The Respiratory rate (RR) in cycles per minute varied between 10 to 20. The mean was 13.4, standard error was 0.1 and standard deviation was 1.6 **(Table 5).**

The SpO2 (oxygen saturation) recorded on finger ranged between 98 to 100 %. The mean was 100, standard error being 0.6 and standard deviation was 7.6 **(Table 5).**

AIRWAY ASSESSMENT:

Acromio Axillo Suprasternal Notch Index (AASNI):

The details of AASNI are given in **Table 6**

Table 6

Characteristics	N	Minimum	Maximum	Mean	Std error	Std. Deviation
Line C	173	2	10	4.1	0.1	1.5
Line A	173	7	14	10.0	0.1	1.7
AASNI	173	0.2	0.9	0.4	0.0	0.1

The line C which was the distance between the height of acromion and the intersecting point between the line A and line B was documented for all patients **(Table 6)** and ranged from 2 cms to 10 cms. The line A, the measurement from the height of acromion process to the superior edge of axillary fold was also documented for all patients. The distance varied between 7 cms to 14 cms.

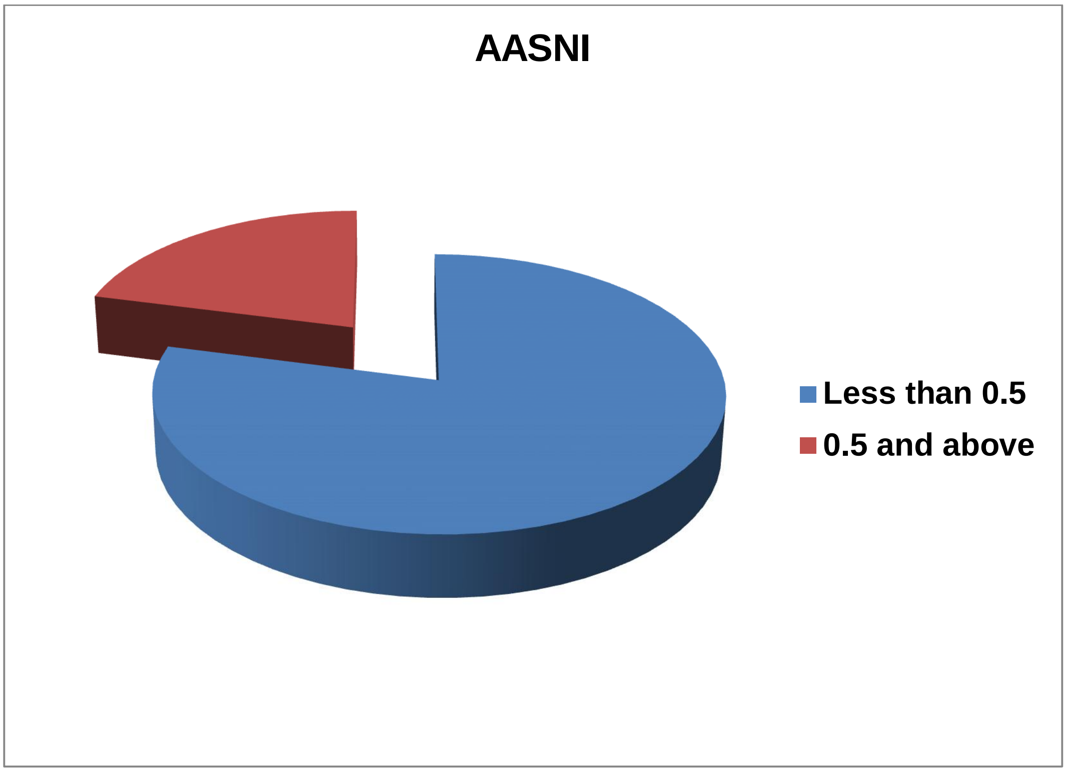
The AASNI which is calculated by the formula AASNI = Line C / Line A is also derived for all patients. The highest one was 0.9 and lowest being 0.2. The mean was found to be 0.4, standard error was 0.0 and standard deviation was 0.1 **(Table 6).**

AASNI was less than 0.5 in 137 patients (79%) and equals or more than 0.5 in 36 patients (21%) **(Table 7, Pie chart 4).**

Table 7

AASNI	Number	Percentage
≥ 0.5	36	21%
< 0.5	137	79%
TOTAL	**173**	**100%**

Pie Chart 4



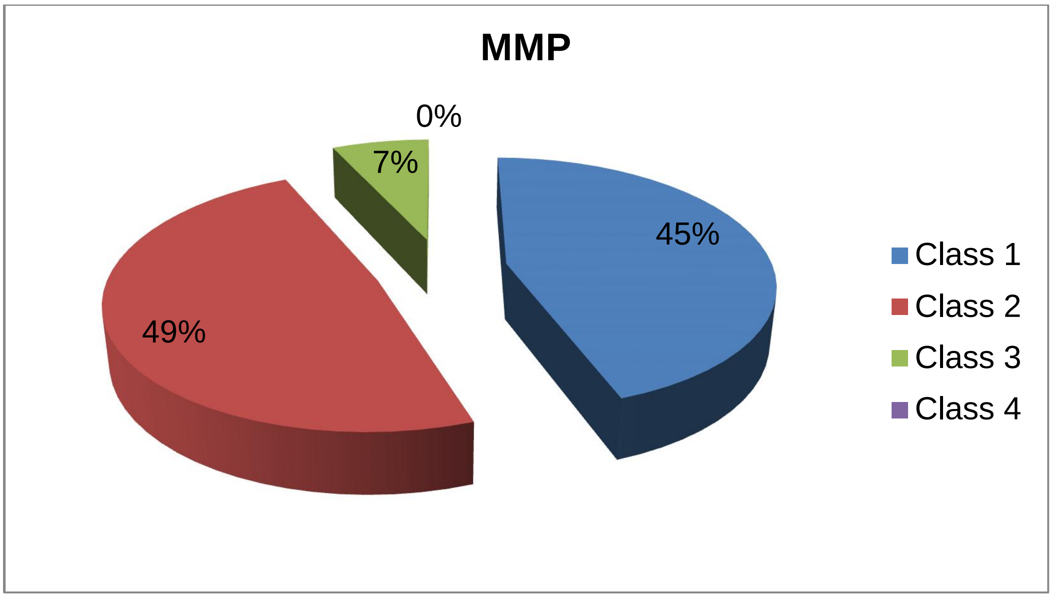
Modified Mallampati Test (MMP):

Modified Mallampati Test revealed class 1, 2 and 3 MMP score among patients. 77 patients (45%) belonged to class 1 MMP score, 84 patients (49%) to class 2 score and 12 patients (7%) to class 3. No patient had class 4 score **(Table 8, Pie chart 5).**

Table 8

MMP class	Number	Percentage
1	77	45%
2	84	49%
3	12	7%
4	0	0%
Total	**173**	**100%**

Pie chart 5



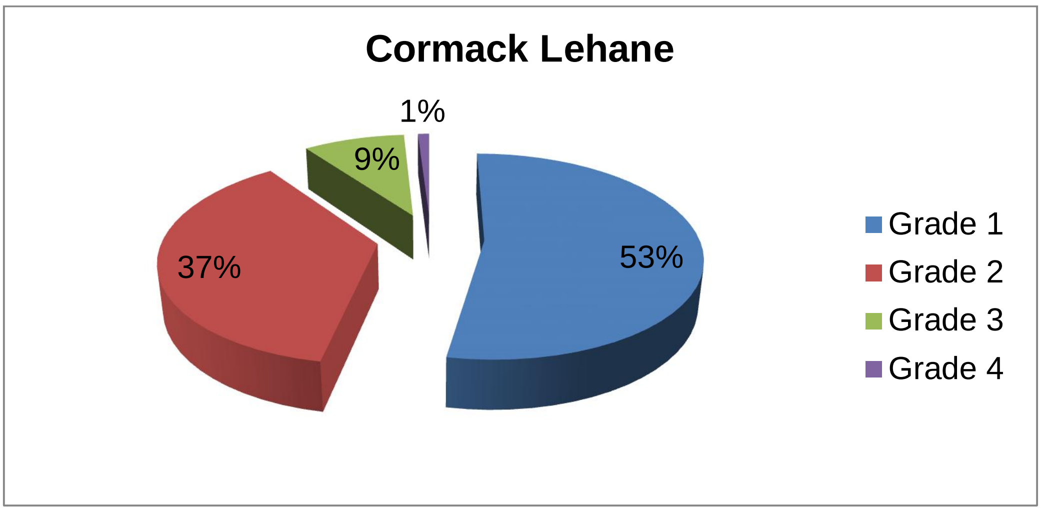
Cormack Lehane (CL) grade of laryngoscopy view:

On direct laryngoscopy, CL grade were recorded as grade 1, 2, 3 or 4. 92 patients (53%) had grade 1 score, 64 patients (37%) had grade 2, 16 patients (9%) had grade 3 and 1 patient (1%) had grade 4 laryngoscopy **(Table 9, Pie chart 6).**

Table 9

CL	Number	Percentage
1	92	53%
2	64	37%
3	16	9%
4	1	1%
Total	**173**	**100%**

Pie chart 6

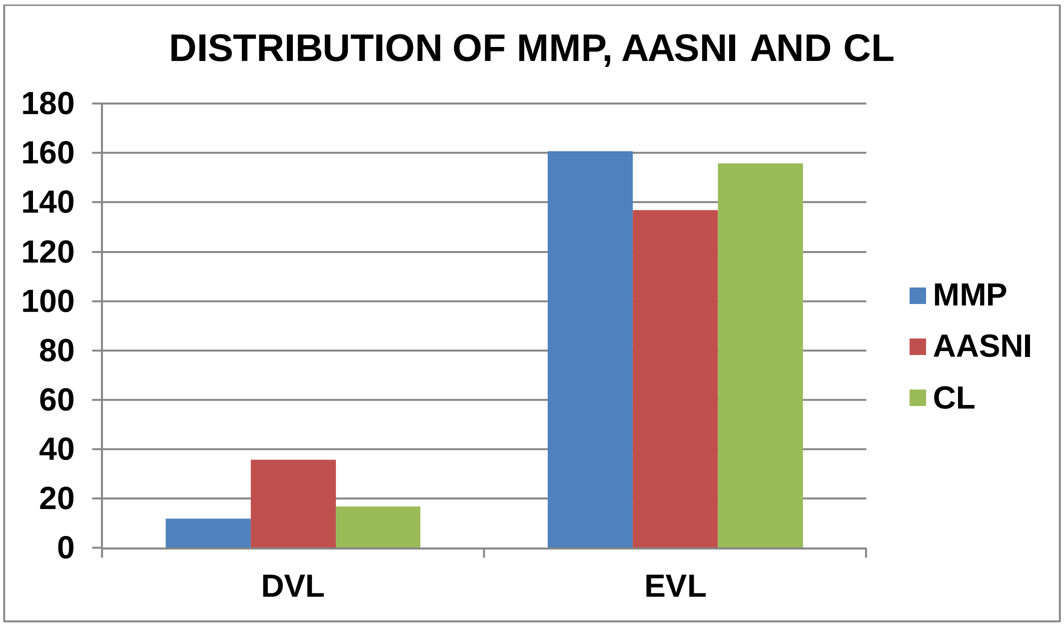


In terms of visualization of larynx (EVL and DVL), the distribution of MMP, AASNI and CL is given below **(Table 10, Bar chart 1):**

Table 10

	MMP	**AASNI**	**CL**
DVL	12 (7%)	36 (21%)	17 (10%)
EVL	161 (93%)	137 (79%)	156 (90%)
TOTAL	**173(100%)**	**173(100%)**	**173(100%)**

Bar chart 1



Interpretation:

For interpretation purposes, MMP score 1 and 2 are considered as a single class together as both predicts EVL. MMP 3 and 4 considered as one class predicting DVL.

Similarly, AASNI < 0.5 (cut off derived from previous study) assumed to predict EVL and AASNI ≥ 0.5 assumed to predict DVL.

On direct laryngoscopy, CL 1 and 2 grades are considered as “Easy visualization of the larynx” (EVL), while CL grades 3 and 4 are considered as “Difficult visualization of the larynx” (DVL).

Statistical Inference:

As the aim of the MMP or AASNI is to predict DVL (CL 3 or 4), the observations were interpreted in the following way:

True positives:

1. The patient with MMP 3 or 4 and CL 3 or 4 (DVL).
2. The patient with AASNI ≥ 0.5 and CL 3 or 4 (DVL).

False positives:

1. The patient with MMP 3 or 4, but CL 1 or 2 (EVL).
2. The patient with AASNI ≥ 0.5, but CL 1 or 2 (EVL).

True negatives:

1. The patient with MMP 1 or 2 and CL 1 or 2 (EVL).

2. The patient with AASNI < 0.5 and CL 1 or 2 (EVL).

False negatives:

1. The patient with MMP 1 or 2 and CL 3 or 4 (DVL).

2. The patient with AASNI ≥ 0.5 and CL 3 or 4 (DVL).

Observation:

The distribution of MMP and AASNI with regard to CL is given below

MMP and CL

(**Table 11**)

	DVL (CL 3 or 4)	**EVL (CL 1 or 2)**	**Total**
MMP 3 or 4	5 (TP)	7 (FP)	12
MMP 1 or 2	12 (FN)	149 (TN)	161
Total	**17**	**156**	**173**

AASNI and CL (Table 12):

	DVL (CL 3 or 4)	EVL (CL 1 or 2)	Total
AASNI >= 0.5	12 (TP)	24 (FP)	36
AASNI < 0.5	5 (FN)	132 (TN)	137
Total	**17**	**156**	**173**

Statistical analysis:

The statistical analysis was done with Open Epi (version 2); Open source calculator (diagnostic test) and statistical software SPSS (version 16.0) and Microsoft excel windows.

Validity – Comparison between MMP and AASNI:

The comparison between MMP and AASNI in terms of sensitivity, specificity, and predictive values ratio is given in **Table 13.**

Table 13

	Sensitivity	Specificity	Positive predictive value	Negative predictive value
MMP	29.4	95.5	41.6	92.5
AASNI	70.5	84.6	33.3	96.3

The Specificity and positive predictive values for MMP (95.5%, 41.6%) are greater than AASNI (41.6%, 33.3%).

The Sensitivity and Negative predictive values of MMP (29.4%, 92.5%) are lower than AASNI (70.5%, 96.3%).

ODDS ratio, LR, and accuracy:

The comparison between MMP and AASNI in terms of odds ratio and likelihood ratios is given in **Table 14.**

Table 14

	Odds ratio	**Likelihood ratio (+)**	**Likelihood ratio(-)**	**Accuracy**
MMP	8.86	5.8	0.74	0.89
AASNI	13.20	4.37	0.35	0.83

The odds ratio for MMP is 8.86 and AASNI is 13.20. The positive likelihood ratio is higher for MMP (5.8 for MMP, 4.37 for AASNI) and Negative likelihood ratio is higher for MMP (0.74 for MMP, 0.35 for AASNI). The accuracy for MMP is higher than that of AASNI.

Discussion

DISCUSSION

The terms 'Difficult airway', 'Difficult intubation', 'Difficult laryngoscopy', and 'Difficult visualization of larynx' are often used interchangeably.

Difficult or failed intubation is always a nightmare for any anesthesiologist. The incidence of 'Difficult intubation' or 'Failed intubation' is less and is not a complication by itself. However it may lead to airway compromise and serious complications which can be minimized by forecasting and preparedness.

Difficult intubation can be estimated in terms of Cormack Lehane (CL) grade or percentage of glottic opening (POGO) or intubation difficulty scoring (IDS). According to Cook, the incidence of difficult intubation is 75 % in difficult laryngoscopy and 3% in easy laryngoscopy[38].

CL grading is the commonest way of estimating 'Difficult Laryngoscopy.' This study has used CL grading to define the easiness of laryngoscopy.

The incidence of ‘Difficult visualization of Larynx’ (CL grades 3 and 4) in this study is 10% (17 cases out of 173 cases). The incidence of ‘Difficult laryngoscopy’ or ‘Difficult intubation’ ranges from 1.5% to 13% in various studies[39].

The reasons for the variable incidence of DL or DI are differences in anthropometry among populations, differences in anesthesia protocols, differences in choice of muscle relaxants for intubation, variability in use of ELM (external laryngeal pressure), and choice of laryngoscope blade.[40,41]

Obese patients (BMI >=30) have higher incidence of DL than the non obese (BMI<30) patients. The findings have to be analyzed further and need to be studied in a larger sample to confirm the association.

Modified Mallampati Test (MMP):

A recent Meta analysis by Lee et al (42) showed that sensitivity of MMP ranged from 12% to 100% and specificity varied between 44% and 98% among various studies. A comparison is made between validity of MMP obtained in this study and other ones **(Table 15).**

Table 15

	Sensitivity	**Specificity**	**PPV**	**NPV**
This study	29.4%	95.4%	41.6%	92.5%
Patel B et al[32]	28.6%	93%	18.2%	96%
Lundstorm LH et al[*25]	35%	91%	NA	NA
Adamus M et al[22]	50	99.5	93.3	92.8
Kamranmanesh MR et al [8]	52.4%	85.7%	21.6%	96%
Eberhart LHJ et al[15]	70.2	61	19.5	93.8
Lee A et al*[42]	55%	84%	NA	NA
Arun kr. Gupta et al[23]	77.3	98.2	48.5	99.5

*Meta analysis

PPV – Positive predictive value; NPV – Negative predictive value

Sensitivity:

The sensitivity of MMP in our study is 29.4% which is comparable to the sensitivity obtained in study done by Patel et al, and meta analysis done by Lundstorm LH et al.

The following studies contradict the findings obtained in this study. Adamus M et al, Kamranmanesh MR et al and by Lee A et al showed a sensitivity of 50, 52, 55 % respectively. Arun kr. Gupat et al, and Eberhart LHJ et al showed a higher sensitivity of 77, 70 %.

The sensitivity of MMP is highly variable. The data of meta analysis done by Lee A et al and Lundstorm LH et al proves it all. The variation may be attributed to factors relating to patient population studied, protocols followed in the institution, techniques used for MMP scoring or direct laryngoscopy, and experience of anesthesiologist.

This high variation in sensitivity is a major disadvantage of MMP test, which is again reflected in this study.

Specificity:

The specificity of MMP in this study is 95.4% which is comparable to other studies. The specificity in most of the studies varies from 84% to 99.5% except Eberhart LHJ et al (61%).

Positive Predictive value:

Many studies show lower PPV for MMP. Few examples are 18.2% in Patel et al, 19.5% in Eberhart et al, 21.6% in Kamranmanesh et al. The PPV of MMP derived in this study is 41.6%, which is comparable to Arun kumar Gupta et al (48.5%). Adamaus et al gives a high PPV of 93%, which is higher than the PPV obtained in other studies. The variation in PPV may be due to variation in prevalence of DVL among different study population.

Negative predictive values:

The NPV of MMP derived in our study is 92.5% which is comparable to other studies (92.5 – 99.5%).

Odds ratio:

The odds ratio for MMP is 8.86. Hence MMP class 3 or 4 increases the chance of DVL more than 8 times.

Acromio Axillo Suprasternal Notch Index:

As AASNI is done in supine position, it is of great value in patients who cannot be seated for MMP testing. Hence it can also be used in critically ill patients of ICU who needs intubation. Moreover AASNI is derived from measurements and hence is less subjective when compared to MMP. Patient’s cooperation is also not needed for AASNI estimation. The validity of AASNI obtained in this study is compared to values obtained in the study by Kamranmenesh MR et al in the **Table 16.**

Table 16

AASNI	Sensitivity	Specificity	PPV	NPV
This study	70.5%	84.6%	33.3%	96.3%
Kamranmanesh MR et al	78.9%	89.4%	33.3%	98.4%

In our study AASNI had sensitivity of 70.5% and specificity of 84.6%, which is comparable to 78.9% and 89.4% obtained by Kamranmanesh et al. The positive and negative predictive values obtained by our study are 33.3 and 96.3% which is comparable to the ones obtained by Kamranmanesh MR et al.

An odds ratio of 13.2 for AASNI indicates that an AASNI of 0.5 or more increases the chance of DVL by more than 13 times. Kamranmanesh et al have estimated an odds ratio of 31.5. The differences may be due to differences in population and methodology used between the two studies.

AASNI tested positive more in obese patients than in non obese patients. The finding has to be ascertained by further studies.

AASNI AND MMP:

When comparing AASNI with MMP, AASNI has got more sensitivity and negative predictive value than MMP, but lower specificity and positive predictive value than AASNI **(Table 13).**

A low false negative rate is desirable when selecting a predictive tool for DL or DVL. This will help the anesthesiologist in ‘preparedness’ for a DL or DVL. The test with higher sensitivity will have lower false negatives.

A good predictor (test/index) should have maximum sensitivity (should not miss any DVL case) with reasonable specificity (should not raise false alarms).

AASNI with a higher sensitivity and reasonable specificity can be considered as a predictor tool for difficult visualization of larynx.

The PPV of AASNI obtained in this study is similar to the PPV of AASNI (33.3%) obtained by Kamranmanesh et al. However it is lower than PPV of MMP in this study. The higher PPV of MMP (relative to PPV of MMP obtained by Kamranmanesh MR et al) in this study may be attributed to this difference and the reasons discussed earlier.

The NPV of AASNI (96%) is higher than that of MMP (92%) and AASNI.

Summary

SUMMARY

An ideal predictor to forecast 'Difficult Laryngoscopy' or 'Difficult intubation' is the need of the hour. The reason being - foreseeing 'Difficult laryngoscopy' increases the preparedness, optimizes work force and probably reduce the airway complications. The search for an ideal predictor is still on.

The MMP is put to test for number of times, since the test gives inconsistent results. The low sensitivity is a worrisome factor. This study reflects the same.

AASNI could be tested in patients who can't sit and is more objective. The main advantage of AASNI over MMP is its significantly higher sensitivity and comparable specificity. The PPV of AASNI is relatively lower than MMP in this study, but PPV of MMP can be as low as 18.2%[32].

The validity of AASNI has proved to be consistent. AASNI with higher sensitivity and higher negative predictive value, reasonable specificity can be used to rule out 'Difficult visualization of larynx'.

MMP test have been combined with various other indices to increase its validity. Hence, AASNI may be put to use in conjunction with MMP for better predictive values. However further analysis of the data of this study and study in larger sample size is needed to validate the usefulness of the composite index.

Conclusion

CONCLUSION

This study concludes that AASNI can be used as a predictive tool for 'Difficult visualization of larynx' (DVL). The higher sensitivity of AASNI makes it a better tool than MMP for screening DVL. As no single test predicts DVL precisely, AASNI can be used in conjunction with standard tool like MMP to increase the validity. AASNI may be investigated as a part of multivariate index to predict DVL. However the findings of this study have to be confirmed in large scale multicentric trials in different population, before putting it to regular use.

Bibliography

BIBLIOGRAPHY

1. Ronald D. Miller. Miller's Anesthesia. 8th ed. Elsevier Saunders; 2015.

2. Apfelbaum JL, Hagberg CA, Caplan RA, Blitt CD, Connis RT, Nickinovich DG, et al. Practice Guidelines for Management of the Difficult AirwayAn Updated Report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. J Am Soc Anesthesiol. 2013 Feb 1;118(2):251–70.

3. Divatia JV, Bhowmick K. Complications of endotracheal intubation and other airway management procedures. Indian J Anaesth. 2005 Jul 1;49(4):308.

4. Cook TM, MacDougall-Davis SR. Complications and failure of airway management. Br J Anaesth. 2012 Dec 1;109(suppl 1): i68–85.

5. Caplan RA, Posner KL, Ward RJ, Cheney FW. Adverse Respiratory Events in Anesthesia: A Closed Claims Analysis. J Am Soc Anesthesiol. 1990 May 1;72(5):828–33.

6. Mallampati SR, Gatt SP, Gugino LD, Desai SP, Waraksa B, Freiberger D, et al. A clinical sign to predict difficult tracheal intubation: a prospective study. Can Anaesth Soc J. 1985 Jul;32(4):429–34.

7. Gupta S, Sharma KR, Jain D. Airway assessment : Predictors of difficult airway. Indian J Anaesth. 2005 Jul 1;49(4):257.

8. Kamranmanesh MR, Jafari AR, Gharaei B, Aghamohammadi H, Poor Zamany N.K. M, Kashi AH. Comparison of acromioaxillosuprasternal notch index (a new test) with modified Mallampati test in predicting difficult visualization of larynx. Acta Anaesthesiol Taiwan. 2013 Dec;51(4):141–4.

9. Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. Anaesthesia. 1984 Nov 1;39(11):1105–11.

10. Samsoon GL, Young JR. Difficult tracheal intubation: a retrospective study. Anaesthesia. 1987 May;42(5):487–90.

11. Pilkington S, Carli F, Dakin MJ, Romney M, De Witt KA, Doré CJ, et al. Increase in Mallampati score during pregnancy. Br J Anaesth. 1995 Jun;74(6):638–42.

12. Ezri T, Gewürtz G, Sessler DI, Medalion B, Szmuk P, Hagberg C, et al. Prediction of Difficult Laryngoscopy in Obese Patients by Ultrasound Quantification of Anterior Neck Soft Tissue. Anaesthesia. 2003 Nov;58(11):1111–4.

13. Hillman DR, Platt PR, Eastwood PR. The upper airway during anaesthesia. Br J Anaesth. 2003 Jul;91(1):31–9.

14. Merah NA, Foulkes-Crabbe DJO, Kushimo OT, Ajayi PA. Prediction of difficult laryngoscopy in a population of Nigerian obstetric patients. West Afr J Med. 2004 Mar;23(1):38–41.

15. Eberhart LHJ, Arndt C, Cierpka T, Schwanekamp J, Wulf H, Putzke C. The reliability and validity of the upper lip bite test compared with the Mallampati classification to predict difficult laryngoscopy: an external prospective evaluation. Anesth Analg. 2005 Jul;101(1):284–9, table of contents.

16. Shiga T, Wajima Z, Inoue T, Sakamoto A. Predicting difficult intubation in apparently normal patients: a meta-analysis of bedside screening test performance. Anesthesiology. 2005 Aug;103(2):429–37.

17. Kheterpal S, Han R, Tremper KK, Shanks A, Tait AR, O'Reilly M, et al. Incidence and predictors of difficult and impossible mask ventilation. Anesthesiology. 2006 Nov;105(5):885–91.

18. Khan ZH, Mohammadi M, Rasouli MR, Farrokhnia F, Khan RH. The diagnostic value of the upper lip bite test combined with sternomental distance, thyromental distance, and interincisor distance for prediction of easy laryngoscopy and intubation: a prospective study. Anesth Analg. 2009 Sep;109(3):822–4.

19. Boutonnet M, Faitot V, Katz A, Salomon L, Keita H. Mallampati class changes during pregnancy, labour, and after delivery: can these be predicted? Br J Anaesth. 2010 Jan 1;104(1):67–70.

20. Krage R, van Rijn C, van Groeningen D, Loer SA, Schwarte LA, Schober P. Cormack-Lehane classification revisited. Br J Anaesth. 2010 Aug;105(2):220–7.

21. Bindra A, Prabhakar H, Singh GP, Ali Z, Singhal V. Is the modified Mallampati test performed in supine position a reliable predictor of difficult tracheal intubation? J Anesth. 2010 Jun;24(3):482–5.

22. Adamus M, Fritscherova S, Hrabalek L, Gabrhelik T, Zapletalova J, Janout V. Mallampati test as a predictor of laryngoscopic view. Biomed Pap Med Fac Univ Palacký Olomouc Czechoslov. 2010 Dec;154(4):339–43.

23. Predictors Of Difficult Intubation: Study In Kashmiri Population | British Journal of Medical Practitioners [Internet]. [cited 2015 Sep 8]. Available from: http://bjmp.org/content/predictors-difficult-intubation-study-kashmiri-population

24. Nasir KK, Shahani AS, Maqbool MS. Correlative value of airway assessment by Mallampati classification and Cormack and Lehane grading. Rawal Med J. 2011;36(1):2–6.

25. Lundstrøm LH, Vester-Andersen M, Møller AM, Charuluxananan S, L'Hermite J, Wetterslev J. Poor prognostic value of the modified Mallampati score: a meta-analysis involving 177 088 patients. Br J Anaesth. 2011 Nov 1;107(5):659–67.

26. El-Orbany M, Woehlck H, Salem MR. Head and neck position for direct laryngoscopy. Anesth Analg. 2011 Jul;113(1):103–9.

27. Kim WH, Ahn HJ, Lee CJ, Shin BS, Ko JS, Choi SJ, et al. Neck circumference to thyromental distance ratio: a new predictor of difficult intubation in obese patients. Br J Anaesth. 2011 Feb 24;aer024.

28. Prakash S, Kumar A, Bhandari S, Mullick P, Singh R, Gogia AR. Difficult laryngoscopy and intubation in the Indian population: An assessment of anatomical and clinical risk factors. Indian J Anaesth. 2013 Nov 1;57(6):569.

29. Cattano D, Killoran PV, Iannucci D, Maddukuri V, Altamirano AV, Sridhar S, et al. Anticipation of the difficult airway: preoperative airway assessment, an educational and quality improvement tool. Br J Anaesth. 2013 Aug;111(2):276–85.

30. Sillén A. Cognitive tool for dealing with unexpected difficult airway. Br J Anaesth. 2014 Apr;112(4):773–4.

31. Chara L, Eleftherios V, Maria M, Anastasia T, Chryssoula S. Anatomic features of the neck as predictive markers of difficult direct laryngoscopy in men and women: A prospective study. Indian J Anaesth. 2014 Apr;58(2):176.

32. Patel B, Khandekar R, Diwan R, Shah A. Validation of modified Mallampati test with addition of thyromental distance and sternomental distance to predict difficult endotracheal intubation in adults. Indian J Anaesth. 2014;58(2):171–5.

33. Attia RR, Battit GE, Murphy JD. Transtracheal ventilation. JAMA. 1975;234(11):1152–3.

34. Snow J. On Chloroform and Other Anaesthetics. Richardson Lond UK John Churchill. 1858;

35. Trendelenburg F. Beiträge zu den Operationen an den Luftwegen. Tamponade Trachea Arch Klin Chir. 1871;12:121–33.

36. Magill IW. Endotracheal anesthesia. Am J Surg. 1936;24:450–5.

37. Carin A. Hagberg. Benumof and Hagberg’s Airway management. 3rd ed. Elsevier Saunders; 2013.

38. Cook TM. A new practical classification of laryngeal view. Anaesthesia. 2000 Mar;55(3):274–9.

39. S G, S P, Sc D. Comparison of two methods for predicting difficult intubation in obstetric patients. Middle East J Anaesthesiol. 2003 Jun;17(2):275–85.

40. Bilgin H, Ozyurt O. Screening tests for predicting difficult intubation. A clinical assessment in Turkish patients. Anaesth Intensive Care. 1998;26(4):382.

41. Yildiz TS, Korkmaz F, Solak M, Toker K, Erciyes N, Bayrak F, et al. Prediction of difficult tracheal intubation in Turkish patients: a multi-center methodological study. Eur J Anaesthesiol. 2007 Dec;24(12):1034–40.

42. Lee A, Fan LTY, Gin T, Karmakar MK, Ngan Kee WD. A Systematic Review (Meta-Analysis) of the Accuracy of the Mallampati Tests to Predict the Difficult Airway: Anesth Analg. 2006 Jun;102(6):1867–78.

Annexures

PATIENT CONSENT FORM

Study title:

A prospective study comparing Acromio axillo suprasternal notch index and Modified Mallampati test in predicting the difficulty in visualization of larynx.

Study centre:

ESI – PGIMSR, K.K.NAGAR, CHENNAI -78

Participant name: **Age:** **Sex:**

I confirm that I have understood the purpose of procedure for the above study. I have the opportunity to ask the question and all my questions and doubts have been answered to my satisfaction.

I have been explained about the pitfall in the procedure. I have been explained about the safety, advantage and disadvantage of the technique. I understand that my participation in the study is voluntary and that I am free to withdraw at anytime without giving any reason.

I understand that investigator, regulatory authorities and the ethics committee will not need my permission to look at my health records both in respect to current study and any further research that may be conducted in relation to it, even if I withdraw from the study. I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from the study.

I understand that I will undergo airway examination preoperatively to assess the difficulty in visualization of larynx. I have been explained that the technique is a standard and approved technique. This may help in future research in the field of anesthesia. I consent to undergo this procedure.

Insurance No:
Date:

Signature / thumb impression of patient

<u>ஒப்புதல் படிவம்</u>

1. எனக்கு

____

அறுவை சிகிச்சை செய்யுமாறு இ.எஸ்.ஐ.ஸி.(ESIC) மருத்துவர் மற்றும் குழுவினரை வேண்டிக் கொள்கிறேன்.

2. நோயின் தன்மை :

சிகிச்சை முறை :

3. மேலே குறிப்பிட்டுள்ள சிகிச்சைக்கு முழு மயக்கம் எனும் மயக்க முறைக்கு உட்படவும் முழு சம்மதம் அளிக்கிறேன். மயக்கம் தரும் முன் தேவையான உடல் மற்றும் சுவாசவழி (airway) பரிசோதனைக்கும் முழு சம்மதம் அளிக்கிறேன்.
4. அனைத்து மருத்துவ சிகிச்சை முறைகளின் நிறைகளும் குறைகளும் எனக்கு விளக்கப்பட்டன.
5. மேலே கொடுக்கபட்டுள்ள அனைத்தும் மருத்துவமனை நன்னெறி குழுவின் (Ethical committee) வரைமுரைக்கு உட்பட்டே நடக்கும் என மருத்துவர் விளக்கினார். மேலும் இந்த சிகிச்சை முறைகளுக்கு உடன்பட மறுக்கவும் எனக்கு உரிமை உண்டு என்பதை நான் அறிவேன்.
6. என் பெயர் உட்பட்ட அடையாளங்கள் மற்றும் நோய் / சிகிச்சை முறை பற்றிய தகவல்களை பிறருக்கு தெரிவிக்கபடாது என மருத்துவர் கூறினார்.
7. என் சிகிச்சையின் போது கிடைக்கும் தகவல்களை மருத்துவ ஆராய்சிக்கு பயன்படுத்தவும் சம்மதம் அளிக்கிறேன்.

நான் இந்த ஒப்புதல் படிவத்தை படித்த / படித்து காண்பிக்க பட்ட பின்னரே இதன் சாராம்சத்தை முழுவதுமாக புரிந்து கொண்டு மேற்சொன்ன அறுவை / மயக்க சிகிச்சை முறைகளுக்கு முழுமனதுடன் சம்மதிக்கிறேன்.

சென்னை, ஒப்புதல் அளிப்பவர் :

தேதி : எண் :

சாட்சி:

PATIENT CASE RECORD / PROFORMA

Name of the patient: Age:

Sex: Insurance No:

OT: Date:

Surgeon: Anesthetist:

Diagnosis / indication for surgery:

Plan of surgery:

Consent given for study:

PREOPERATIVE DETAILS

ASA Grade: **Remarks:**

Investigations:

Hemoglobin	
Random blood sugar	
Renal function tests	
Liver function tests	
Electrocardiography	
Chest X-ray	
Others	

Demographic characteristics:

Age	
Sex	
Height	
Weight	
Body Mass Index (BMI)	

<u>PEROPERATIVE DETAILS:</u>

Baseline Vitals:

Blood pressure	Pulse rate	Respiratory rate	SpO2	Temperature

Observed Characteristics:

Line C (cms)	
Line A (cms)	
Acromio axillo suprasternal notch index (AASI)	
Modified Mallampati score (MMP)	
Cormack Lehane grade (CL)	

SIGNATURE OF INVESTIGATOR **SIGNATURE OF THE PARTICIPANT**

WITNESS:

KEY TO THE MASTER CHART

S.No	:	Serial number
INS_No	:	Insurance number
Yr	:	Years
ASA	:	American Society of Anesthesiologists class of physical status
BMI	:	Body mass index
Hb	:	Hemoglobin
RBS	:	Random blood sugar
PR	:	Pulse rate
RR	:	Respiratory rate
MAP	:	Mean arterial pressure
MMP	:	Modified Mallampati class
AASNI	:	Acromio axillo suprasternal notch index
CL	:	Cormack Lehane grade

MASTER CHART

S.No	Ins_NO	Age (Yr)	gender (male=1 female=2)	Diagnosis	Surgery	ASA	BMI	Hb	RBS	PR	RR	MAP	MMP	Line C	LineA	AASNI	CL GRADE
1	17211339	32	1	Cholelithiasis	Lap cholecystectomy	1	24	10.7	96	80	14	102	2	2.6	12	0.21	2
2	17630500	33	2	PUJ obstruction - Right	Right pyeloplasty	2	29	11.8	76	86	18	97	2	10	12	0.83	3
3	22857736	39	1	Chronic sinusitis	FESS	1	25	13.9	64	80	20	91	1	4.5	14	0.32	1
4	23642829	27	1	Right nasal mass	Endoscopic excision	1	25	14.2	86	82	12	92	2	3.5	13	0.26	1
5	20927238	24	2	Right nasal polyp	FESS	1	19	12.8	91	102	16	107	1	4	9	0.44	1
6	15505200	27	1	IVDP L4-5	Discectomy L4-5	1	22	13.9	98	65	14	74	1	4.5	12	0.37	1
7	20058686	39	1	Fracture clavicle - Right	ORIF - TENS nailing	1	22	14.8	101	70	10	83	3	4.5	12	0.37	1
8	22275073	48	2	Appendicitis / ?Ileocecal intus	Laparotomy	2	26	11.7	112	66	12	115	2	7	11	0.63	3
9	22096894	35	2	Tonsillitis	Tonsillectomy	1	21	11	116	90	14	90	2	7.5	11	0.68	3
10	13871804	35	2	Right renal calculi	Right PCNL	2	23	9.3	97	88	14	109	3	3.5	11	0.31	2
11	16831265	35	2	Chronic sinusitis	FESS	1	16	11	101	90	13	75	1	5.2	10	0.52	1
12	15146145	48	1	Gall bladder - ? Growth	Lap cholecystectomy	2	26	13.9	152	62	14	98	1	6.5	12	0.54	3
13	23924792	21	2	Tonsillitis	Tonsillectomy	1	19	11.4	85	72	16	67	1	4.5	9.8	0.45	1
14	21231526	40	2	Multinodular goiter	Subtotal thyroidectomy	1	21	13.1	86	84	14	104	2	5.2	10.5	0.49	1
15	22223203	43	2	IVDP L3-4	Discectomy L3-4	1	19	12	118	76	15	98	2	6.8	11	0.61	2
16	22268358	49	1	Chronic abscess Right thigh	Incision and Drainage	2	22	13.6	112	72	12	109	2	10.5	12	0.87	3
17	14573950	29	2	Keratosis obturans	Excision	1	22	12.6	95	76	14	102	2	5.5	12	0.45	1
18	23291994	22	1	Fracture BB left leg	ORIF - IMIL nailing	1	22	12.7	102	82	12	95	1	3.7	10.5	0.35	1
19	21563828	38	2	Chronic abdominal pain	Diagnostic laparascopy	1	21	11.8	100	88	14	98	2	3.8	9.8	0.38	2
20	22863170	25	1	Appendicitis	Lap appendicectomy	1	22	14.9	91	86	12	99	1	7.5	12.5	0.6	1
21	23020708	21	1	Scaphoid fracture	ORIF + grafting	1	20	14.6	102	68	12	79	1	8.5	13.5	0.62	2
22	14910874	28	2	Cholecystitis	Lap cholecystectomy	1	22	10.5	97	78	13	85	2	3.5	8.5	0.41	1
23	13794012	18	2	Left breast fibroadenoma	Excision biopsy	1	17	11.4	83	80	12	80	1	5.5	10.5	0.52	1
24	15062088	30	1	Vocal cord swelling	MLS + Vocal cord biopsy	2	22	14.5	98.5	76	12	89	1	5.2	12.2	0.42	1
25	22460821	35	1	IVDP L4-5	Discectomy L4-5	1	23	13.2	118	86	12	107	1	5.6	10.8	0.51	1
26	22627209	28	1	Appendicitis	Lap appendicectomy	1	27	14.3	101	86	14	95	1	3.2	12.2	0.26	1
27	12896878	50	2	Lump right breast	Lumpectomy	2	24	9.8	122	88	14	105	2	8	11	0.72	2
28	23316757	35	1	Right ear CSOM	Right Mastoidectomy	1	27	14.6	108	86	12	94	2	5	12	0.41	2
29	23643875	49	1	Left epididymal cyst	Excision	2	27	15	100	84	13	114	2	9	11	0.81	2
30	22440219	40	2	Carcinoma left breast	Left MRM	2	21	11.6	90	82	13	104	2	3.8	9	0.42	2
31	16353605	33	1	IVDP L4-5	Discectomy L4-5	2	22	15.2	94	76	14	89	3	5.5	10.5	0.52	2
32	23413446	27	2	Solitary nodule thyroid Right	Hemithyroidectomy Rt	1	22	11.2	81	82	12	92	2	4.5	8	0.56	1
33	24128114	41	2	Infraorbital schwammoma	Excision - intranasal	2	23	11.4	136	84	12	95	2	4.5	11	0.4	1
34	22062965	35	1	Nasal polyp	FESS	1	24	11.2	98	80	12	96	2	4.5	11.5	0.39	2
35	20077750	43	2	Rt breast chronic abscess	Excision Biopsy	2	17	13.3	99	74	13	79	3	3.5	10	0.35	2
36	16384540	45	2	Chronic parotitis Rt	Rt Total parotidectomy	2	24	11.4	113	68	11	77	3	4.8	9.5	0.5	3
37	13817573	39	2	Cholecystitis	Lap cholecystectomy	2	24	12.4	90	92	15	106	2	2.5	7.5	0.33	1
38	12830966	45	2	Carcinoma Right breast	Right MRM	2	25	10.3	156	80	16	110	2	3.6	8.8	0.4	2
39	60274642	46	1	IVDP L4-5 Discectomy and	Laminectomy L4	2	23	13.4	124	92	14	95	2	3.8	10.5	0.36	3
40	17570347	27	2	Primary infertility	Dlap chromopertubation	2	23	12.9	99	86	12	71	2	4.5	10.2	0.44	2
41	21948888	27	1	Right CSOM attic perforation	Right Mastoidectomy	1	25	15.8	112	76	14	92	1	3.2	11.5	0.27	1
42	N160316	48	2	Cholecystitis	Lap chole + UH repair	1	25	13.6	113	90	12	91	2	5.5	10.5	0.52	2
43	20541269	30	2	IVDP L5-S1 Discectomy L5-S1	Laminectomy L4	1	22	11.3	128	88	14	96	2	3.2	11.2	0.28	1
44	15729791	43	2	Chronic parotitis Rt	Partial parotidectomy	1	27	12.6	122	90	15	103	3	3.6	11.2	0.32	2
45	16248430	40	2	Calculus cholecystitis	Lap cholecystectomy	2	28	12.7	118	78	16	91	1	4.2	12.2	0.34	2
46	15207778	25	1	Right CSOM	Right mastoid expl	1	23	15.1	92	84	14	95	1	5.2	13.2	0.39	1
47	15146618	48	1	Follicular ca thyroid	Total Thyroidectomy	2	22	14.3	108	90	12	93	2	3.5	11.2	0.31	1
48	22550180	37	2	Multinodular goiter	Total Thyroidectomy	2	22	11.7	128	76	12	99	2	3	8.8	0.34	1
49	2100347	42	2	Right renal calculi	Right PCNL	1	22	11.3	97	80	12	108	2	6	8.2	0.73	3
50	24343926	35	1	Tonsillitis	Tonsillectomy	1	21	11.2	127	68	12	89	1	2.8	11	0.25	1
51	23065205	46	1	Bilateral varicocel	Lap varicocelectomy	1	24	13.8	102	72	13	88	1	4	11.5	0.34	1
52	21823695	49	2	Right breast carcinoma	Right MRM	2	20	11.8	72	90	14	93	1	5.5	10	0.55	1
53	16466402	34	2	Cholecystitis	Lap cholecystectomy	2	20	10.4	94	82	10	93	2	4	8.5	0.47	2
54	17065435	37	1	Explored area lumbar spine	Flap cover	2	22	12	90	78	12	95	2	4.5	11	0.4	2
55	23657412	46	2	Cholecystitis	Lap cholecystectomy	2	23	11.5	108	80	10	109	2	4.7	10.5	0.44	2
56	22380247	48	1	Right parotid gland	Rt sup parotidectomy	2	24	15.4	98	82	16	93	2	4.5	9.5	0.47	2

MASTER CHART

57	660017918	37	1	IVDP L4-5	Laminectomy L4	2	30	14.4	96	88	13	107	3	3.5	10.2	0.34	2
58	20998385	28	1	Inverted pappiloma Nose	Rhinotomy	1	28	14.3	87	72	14	94	1	4	9.8	0.4	1
59	15432890	32	1	Chronic sinusitis	Fess	1	24	14.2	90	80	12	97	1	5.5	12.5	0.44	1
60	17341187	33	2	Multinodular goiter	Subtotal thyroidectomy	2	18	13.6	95	67	14	97	1	2	9.2	0.21	2
61	15641415	21	2	FESS done before	Caldwel luc operation	1	16	13.4	86	102	16	87	1	2.5	7.5	0.33	1
62	24152278	25	1	Chronic sinusoidal polyp	FESS	1	24	10.3	94	64	16	93	1	2.5	10.5	0.23	1
63	22411204	40	1	Pleomorphic adenoma	Rt superficial parotidec	2	22	13.3	143	80	14	103	3	3	10.5	0.28	3
64	228185501	32	2	Tonsillitis	Tonsillectomy	2	29	13.5	99	70	14	92	2	2.8	8.5	0.32	1
65	22548834	33	2	Abdominal colic	Dlap and proceed	1	19	12.9	121	82	12	79	1	1.5	8	0.18	2
66	23168808	26	1	Appendicectomy	Lap appendicectomy	1	21	13.9	141	76	12	96	1	3	9	0.33	1
67	13497693	18	2	Rt CSOM	Rt Myringoplasty	1	19	13	98	90	14	93	1	3	7.5	0.4	1
68	16894423	32	1	Lt montegia fracture	ORIF screw osteosyn	2	28	14	87	90	14	108	3	3.7	11.5	0.32	3
69	15619465	35	2	Lt breast chronic abscess	Excision biopsy	1	25	12	94	82	13	96	2	3.8	11.8	0.32	2
70	21071235	45	1	Left volar barton fracture	ORIF screw osteosyn	1	23	13.3	93	79	12	104	2	5.5	10.5	0.52	3
71	20310003	25	2	Solitary nodule thyroid Right	Hemithyroidectomy Rt	1	16	12.3	94	84	12	95	1	3.2	8.2	0.39	1
72	21355368	21	2	BL breast lump	Excisio biopsy	1	20	12.9	91	74	13	85	1	3.2	8	0.4	2
73	23166190	25	2	DNS	Septoplasty	1	20	13.2	99	87	13	96	1	2	7	0.28	1
74	20377805	24	1	CSOM Left	Left Mastoidectomy	1	25	15.4	82	86	14	78	2	3.8	13.5	0.28	1
75	17217697	46	1	D12 fracture	Posterior stabilisation	1	28	12.6	154	76	15	97	2	3.7	13.2	0.28	2
76	23279260	39	1	Lt Rotator cuff tear	Acromioplasty	1	23	16.3	98	82	16	90	1	4.2	12.5	0.33	2
77	22761048	35	2	? Tb abdomen	Diagnostic laparascopy	2	25	12.2	98	80	14	87	1	3.8	8	0.47	1
78	16328836	33	2	Right renal calculi	Right PCNL	1	30	11.2	84	52	16	91	3	8	10.5	0.76	3
79	23612160	35	2	Multinodular goiter	Subtotal thyroidectomy	1	26	12	95	80	14	90	2	3.5	9	0.38	2
80	112271	20	1	Post traumatic injury	Tendon transfer Rt hand	1	21	13.5	111	72	13	80	1	4.2	10.5	0.4	1
81	16684666	40	2	Osteochondroma left humerus	Excision biopsy	2	24	12.9	101	74	13	93	2	3.6	9	0.4	1
82	20083819	29	2	Tonsillitis	Adenotonsillectomy	1	19	13	107	90	15	83	1	3.5	8.5	0.41	1
83	22188481	24	1	Right CSOM	Right Mastoidectomy	1	25	14.8	77	78	14	82	1	4.2	12.5	0.33	1
84	13401298	46	1	IVDP L3-4	Discectomy	1	22	11.2	89	68	15	83	1	3.5	9.5	0.36	1
85	24376207	27	1	Fracture clavicle right	ORIF	1	24	12	112	78	12	93	1	4.5	14	0.32	1
86	21794800	32	1	Calculus cholecystitis	Lap cholecystectomy	2	21	15.1	101	78	15	99	2	3.8	13.2	0.28	2
87	23354537	36	2	Solitary nodule thyroid Right	Hemithyroidectomy Rt	2	21	12	105	96	14	87	2	4	10.5	0.38	2
88	24393195	41	1	Clavicle fracture right	TENS nailing	1	23	10.6	121	82	12	93	1	5	11.5	0.43	1
89	15245603	33	1	IVDP L3-4	Discectomy	2	30	13.7	125	88	13	96	3	8.5	13	0.65	2
90	21008164	28	2	Right PUJ obstr	Rt Nephrectomy	2	20	10.5	105	102	16	82	2	4	8.5	0.47	2
91	22773868	38	2	Solitary nodule thyroid Right	Hemithyroidectomy Rt	2	22	12.9	132	78	14	97	2	3.2	9	0.35	1
92	N112938	50	2	Cholecystitis	Lap cholecystectomy	2	20	10.9	95	74	13	90	1	5	9	0.55	2
93	150113009	18	2	Adenoiditis	Adenoidectomy	1	18	13.9	101	76	12	95	1	3.5	8.5	0.41	1
94	22248395	22	1	D12 fracture, listhesis L5-S1	Posterior stabilisation	1	19	12.9	145	70	14	93	1	5	10.5	0.47	1
95	1560639	45	2	Choledochal cyst	ExcisionLapcholeHjtomy	1	21	11.5	106	74	12	88	2	3	8.8	0.34	1
96	14006725	35	1	Fracture clavicle tibia right	ORIF	1	28	12.9	104	74	15	100	1	2.8	9.8	0.28	1
97	11626672	50	2	Cholelithiasis	Lap cholecystectomy	1	23	12.5	113	84	14	107	2	5.5	9	0.61	2
98	2902773	45	2	Multinodular goiter	Total Thyroidectomy	2	22	11.9	86	78	14	93	2	4.5	9	0.5	2
99	14526657	27	2	Multinodular goiter	Total Thyroidectomy	1	22	13	85	84	13	95	1	3	8.2	0.36	2
100	23348638	36	2	Left renal calculi	Left PCNL	2	23	13.4	98	80	15	97	1	4	8.5	0.47	2
101	16539029	26	1	Chronic sinusitis	FESS	1	22	14	82	70	11	89	1	3.2	10	0.32	1
102	11914446	32	1	IVDP L3-4	Partial laminectomy L3	1	22	14.5	103	82	10	83	1	2.5	10.5	0.23	1
103	16831532	44	2	Cholelithiasis	Lap cholecystectomy	1	24	12.3	102	80	13	103	1	3.8	8.5	0.44	2
104	20906180	41	2	Sphenoidal sinusitis	FESS	1	22	12.3	94	72	12	93	1	2.8	8	0.35	2
105	24179472	21	2	CSOM Left + Node neck	Tympanoplasty + Biopsy	1	20	11.4	103	78	12	83	1	2.8	8.5	0.32	1
106	17143720	18	2		Tympanoplasty left	2	19	13.6	101	118	14	93	2	3.2	7.5	0.42	1
107	11010205	50	1	Fracture right clavicle	ORIF	2	24	14.1	91	96	14	90	2	4.5	9.5	0.47	2
108	20343561	38	1	Cholelithiasis	Lap cholecystectomy	2	24	13.2	116	96	12	106	2	2.5	10.5	0.23	3
109	15730726	35	2	IVDP L4-5	Discectomy	2	28	13.3	92	90	16	93	2	4	9.2	0.43	2
110	21606041	26	2	Cholelithiasis	Lap cholecystectomy	2	25	10.5	85	100	12	93	1	2	7.5	0.26	1
111	22503558	21	1	Left gynacomastia	Websters procedure	2	21	14.5	79	98	14	88	1	5.8	11	0.52	1
112	23623488	28	1	Appendicitis	Lap appendicectomy	1	27	12.2	86	80	13	95	2	5	9.5	0.52	2
113	23308692	28	2	Fibroadenoma left breast	Excision biopsy	2	19	10.2	91	92	14	79	1	3	8	0.37	1
114	22504041	34	1	Volar barton fracture Left wrist	ORIF	1	33	13.2	86	88	12	97	2	3.5	9	0.38	2
115	22340303	45	2	Right axill lipoma	Excision biopsy	1	26	12.2	98	84	12	83	1	3.5	7.5	0.46	1

MASTER CHART

116	22306892	34	2	Calculus cholecystitis	Lap cholecystectomy	1	24	13.8	135	72	14	90	1	4	8	0.5	1
117	23328952	45	2	Right renal calculi	Right PCNL	2	24	11.2	116	80	11	96	2	4	8.2	0.48	1
118	22996837	21	2	Primary infertility	Diagnostic laparascopy	1	19	11.6	90	94	15	83	1	3	7	0.42	1
119	20712143	21	1	Nasal polyp	FESS	1	24	16	97	80	10	100	2	3.8	11.8	0.32	1
120	10559311	49	1	Right BB fracture forearm	ORIF	2	23	12.4	91	86	14	80	2	4	10.5	0.38	1
121	23503599	34	2	Right trigger finger	Release	1	22	13	82	74	12	85	1	3	8	0.37	1
122	23416101	24	2	Multinodular goiter	Total Thyroidectomy	1	19	10	94	78	14	70	1	3.8	9.5	0.4	1
123	233553291	22	2	Chronic sinusitits	FESS	1	21	10.4	80	72	11	83	1	2.5	8	0.31	1
124	235478625	50	2	Recurrent Ca thyroid	Total Thyroidectomy	2	24	10.4	125	65	12	97	2	2.5	8	0.31	2
125	17217485	48	2	Right malunited fracture BB fA	ORIF	2	23	12	125	84	12	83	2	4	8.2	0.48	2
126	20266073	50	2	Multinodular goiter	Total Thyroidectomy	2	22	13.1	95	96	15	105	2	4	8.9	0.44	1
127	o1621496	49	2	Multinodular goiter	Total Thyroidectomy	2	23	13.3	89	80	13	83	2	3	8	0.37	2
128	13213904	32	2	Chronic sinusitis	FESS	1	24	13.2	89	78	14	87	2	2.5	9	0.27	1
129	23234877	24	1	Tonsillitis	Tonsillectomy	1	22	13.9	101	88	14	100	2	3.5	11.5	0.3	1
130	20068638	35	2	Hydatid cyst liver	Excision	1	21	12.7	89	80	13	89	1	3	8.5	0.35	1
131	22018313	48	1	Clavicle left implant	Exit	1	28	15	92	90	14	105	2	4.2	11	0.38	2
132	16495998	44	1	IVDP L4-5	L4 partial laminectomy	2	17	15.2	102	92	14	106	2	3.4	9	0.37	1
133	24315971	31	1	L4-5 spondylolisthesis	Posterior stabilisation	1	22	15	87	84	13	97	1	4	11	0.36	1
134	21297733	18	2	Left malunited BB FA fracture	ORIF	1	18	11.7	91	84	14	97	1	3	9	0.33	1
135	22157348	44	2	Cholelithiasis	Lap cholecystectomy	2	34	10.8	108	52	12	87	2	1.5	9	0.16	2
136	16481509	36	2	Cholecystitis	Lap cholecystectomy	2	25	10.6	106	88	12	83	2	5	10	0.5	2
137	10291315	45	1	Cholecystitis	Lap cholecystectomy	1	26	12.3	89	84	12	73	2	5	9.8	0.51	1
138	22976583	48	1	Cholecystitis	Lap cholecystectomy	1	23	13	137	82	13	87	2	3	10	0.3	1
139	16864833	27	1	Trauma Rt hand	TT right hand	1	24	15.8	89	86	13	83	1	4	12.5	0.32	1
140	24007814	46	1	Left humerus proximal fracture	ORIF	2	23	11.9	97	90	14	99	1	3.8	11.2	0.33	1
141	23409408	29	2	Left breast fibroadenoma	Excision biopsy	1	20	10.9	133	88	18	73	1	2.8	7.5	0.37	1
142	15519474	35	2	Right humerus Fracture	ORIF	2	22	12.5	140	72	14	83	1	3.2	8.2	0.39	2
143	15560942	44	1	Lefort 2 Fr left	ORIF	1	23	13.8	108	94	14	107	2	4.8	9.8	0.48	2
144	21193888	18	2	Tonsillitis	Tonsillectomy	1	17	12.5	100	86	16	69	1	3	7.2	0.41	1
145	14199556	33	2	Left breast fibroadenoma	Excision biopsy	1	20	9.8	120	90	14	85	2	2.8	8.5	0.32	1
146	24017225	46	2	AUB	TAH-BSO	2	23	11.5	103	80	12	97	2	4.5	9	0.5	3
147	24439572	37	1	Chronic calculus cholecystitis	Lap cholecystectomy	2	20	12.1	116	68	14	83	2	5	11.5	0.43	1
148	24602924	25	2	IVDP L3-4	Decompression	2	36	12.1	111	98	16	123	2	1.5	8	0.18	2
149	15368084	25	2	Follicular ca thyroid	Rt hemithyroidectomy	2	22	10.8	122	98	14	87	1	3	8.2	0.36	2
150	161278	23	2	PCOD-ovarian cyst	Lap and proceed	2	24	11	124	86	10	99	2	2.5	8.5	0.29	2
151	12492208	24	2	Left CSOM	Explorative tympano	1	23	13.4	88	74	12	94	1	1.5	7	0.21	1
152	21553681	42	1	IVDP L5-S1	Discectomy	1	28	12.8	90	86	15	109	2	4.5	11	0.4	2
153	21346799	40	2	Right ear swelling	Excision / skin grafting	1	21	10.5	144	70	12	73	1	3.5	8.2	0.42	2
154	16581601	29	2	Right renal calculi	Right PCNL	1	20	11	113	88	18	73	1	2.8	7.5	0.37	1
155	23585788	49	2	Chronic sinusitis	FESS	2	24	12.6	82	89	14	114	2	4.9	9.2	0.53	2
156	2157288	48	2	Fracture clavicle	ORIF/TENS	2	24	12.5	151	90	14	110	2	3.2	8.7	0.36	2
157	14907605	35	2	Nasal polyp	FESS	2	21	12	105	96	14	87	2	4	10.5	0.38	2
158	21704789	32	1	IVDP L4-5	Discectomy	1	23	14	99	78	12	97	1	5	12	0.41	1
159	22806484	35	2	Left CSOM	Left Mastoidectomy	1	20	11.5	101	84	13	96	2	3.5	9.5	0.36	2
160	12295181	45	2	Chronic sinusitis	FESS	2	23	12.3	115	78	12	91	2	4.5	8.8	0.51	3
161	14977003	32	1	Ectropion left lower eyelid	Release	1	24	14	88	76	14	81	1	4.2	12.5	0.33	1
162	12627118	44	1	Fracture right clavicle	ORIF/TENS	2	24	15.2	99	78	14	87	1	3.8	11.5	0.33	2
163	22507280	43	1	Solitary nodule thyroid Right	Subtotal thyroidectomy	2	22	12.3	108	98	14	112	3	5.5	12	0.45	4
164	15085729	44	2	IVDP L3-4	Discectomy/Laminecto	2	24	11.2	124	70	14	95	2	3.2	10	0.32	2
165	23485733	49	1	IVDP L4-5	Discectomy	2	32	11.2	108	75	15	111	2	6.2	11	0.56	3
166	21361761	50	2	IVDP L4-5	Discectomy	2	26	13.3	141	90	16	104	2	4.5	8.2	0.54	1
167	15203749	50	2	Cholelithiasis	Lap cholecystectomy	2	23	11.9	104	86	12	98	2	3.5	9	0.38	1
168	23153827	42	2	Left CSOM	Left Mastoidectomy	1	26	12.2	98	84	12	83	1	3.5	7.5	0.46	1
169	21796612	26	1	Nasal polyp	FESS	1	32	15.3	110	80	13	103	2	5	10	0.5	2
170	2314961	29	1	Ca colon	Laparotomy	2	21	11.8	106	90	12	100	2	3.5	10	0.35	1
171	2881104	21	1	Appendicitis	Lap appendicectomy	1	24	15.2	92	84	14	102	1	5.2	12	0.43	1
172	15584289	31	2	Chronic parotitis Left	Left parotidectomy	1	19	13	108	88	15	85	1	3.5	8.5	0.41	1
173	14471577	28	1	Appendicitis	Lap appendicectomy	1	25	14.1	105	76	14	99	1	3.2	12	0.26	1