COMPARISON OF C-MAC D BLADE AND McCoy BLADE FOR LARYNGOSCOPY IN PATIENTS WITH SIMULATED CERVICAL SPINE INJURY

Dissertation Submitted to the

Tamil Nadu Dr.M.G.R Medical University for MD Degree

examination in Anesthesiology to be held in May 2018

DEPARTMENT OF ANESTHESIOLOGY

PSG INSTITUTE OF MEDICAL SCIENCE & RESEARCH

PEELAMEDU, COIMBATORE- 641 004

TAMILNADU, INDIA

CERTIFICATE

This is to certify that this dissertation entitled "**COMPARISON OF C-MAC D BLADE AND McCoy BLADE FOR LARYNGOSCOPY IN PATIENTS WITH SIMULATED CERVICAL SPINE INJURY**" done by **Dr.Rohini Sagadhevan** a post graduate student (2015-2018) in the Department of Anesthesiology, PSG Institute of Medical Sciences & Research, Coimbatore, under the direct guidance and supervision of guide **Prof. Dr. G. DHANABAGYAM** in partial fulfillment of the regulations laid down by the Tamilnadu Dr.M.G.R. Medical University, Chennai, for MD, Anesthesiology degree examination.

Dr. C. GANESAN
Professor & HOD
Department of Anesthesiology
Coimbatore – 04

Dr.S.RAMALINGAM
Dean
PSG IMS & R
Coimbatore – 04

CERTIFICATE

This is to certify that this dissertation entitled "**COMPARISON OF C-MAC D BLADE AND McCoy BLADE FOR LARYNGOSCOPY IN PATIENTS WITH SIMULATED CERVICAL SPINE INJURY**" done by **Dr.Rohini Sagadhevan** a post graduate student (2015-2018) in the Department of Anesthesiology, PSG Institute of Medical Sciences & Research, Coimbatore, under the direct guidance and supervision of guide Prof. Dr. G. DHANABAGYAM in partial fulfillment of the regulations laid down by the Tamilnadu Dr.M.G.R. Medical University, Chennai, for MD, Anesthesiology degree examination.

Dr. G. DHANABAGYAM
Professor
Department of
Anesthesiology
PSG IMS & R.

DECLARATION

I, **Dr.Rohini Sagadhevan,** hereby declare that this dissertation entitled "**COMPARISON OF C-MAC D BLADE AND McCoy BLADE FOR LARYNGOSCOPY IN PATIENTS WITH SIMULATED CERVICAL SPINE INJURY**" done by me is being submitted in partial fulfilment for the award of M.D. degree in Anesthesiology by the Tamil Nadu MGR Medical University in the examination to be held in May 2018.

Place : Coimbatore

Date :

Dr. Rohini Sagadhevan
MD (Pathology) postgraduate
Department of Pathology
PSGIMS&R
Coimbatore-641004

PSG Institute of Medical Sciences & Research
Institutional Human Ethics Committee
Recognized by The Strategic Initiative for Developing Capacity in Ethical Review (SIDCER)
POST BOX NO. 1674, PEELAMEDU, COIMBATORE 641 004, TAMIL NADU, INDIA
Phone : 91 422 - 2598822, 2570170, Fax : 91 422 - 2594400, Email : ihec@psgimsr.ac.in

To
Dr Rohini Sagadhevan
Postgraduate
Department of Anaesthesiology
Guides: Dr G Dhanabagyam
PSG IMS & R
Coimbatore

Ref: Project No.15/385

Date: December 30, 2015

Dear Dr Rohini,

Institutional Human Ethics Committee, PSG IMS&R reviewed and discussed your application dated 17.12.2015 to conduct the research study entitled *"Comparison of C-Mac D-Blade and McCoy blade for laryngoscopy in patients with simulated cervical spine injury"* during the IHEC meeting held on 29.12.2015.

The following documents were reviewed and approved:

1. Project Submission form
2. Study protocol (Version 1 dated 17.12.2015)
3. Informed consent forms (Version 1 dated 17.12.2015)
4. Data collection tool (Version 1 dated 17.12.2015)
5. Current CVs of Principal investigator, Co-investigators
6. Budget

The following members of the Institutional Human Ethics Committee (IHEC) were present at the meeting held on 29.12.2015 at IHEC Secretariat, PSG IMS & R between 10.00 am and 11.00 am:

Sl. No.	Name of the Member of IHEC	Qualification	Area of Expertise	Gender	Affiliation to the Institution Yes/No	Present at the meeting Yes/No
1	Mr. R. Nandakumar	BA., BL	Legal Expert, Chairperson	Male	No	Yes
2	Dr. S. Shanthakumari	MD	Pathology, Ethicist	Female	Yes	Yes
3	Dr Sudha Ramalingam (Alternate Member-Secretary	MD	Ethicist, Epidemiologist	Female	Yes	Yes
4	Mrs P Rama	M Pharm	Member	Female	Yes	Yes

The study is approved in its presented form. The decision was arrived at through consensus. Neither PI nor any of proposed study team members were present during the decision making of the IHEC. The IHEC functions in accordance with the ICH-GCP/ICMR/Schedule Y guidelines. The approval is valid until one year from the date of sanction. You may make a written request for renewal / extension of the validity, along with the submission of status report as decided by the IHEC.

PSG Institute of Medical Sciences & Research
Institutional Human Ethics Committee
Recognized by The Strategic Initiative for Developing Capacity in Ethical Review (SIDCER)
POST BOX NO. 1674, PEELAMEDU, COIMBATORE 641 004, TAMIL NADU, INDIA
Phone : 91 422 - 2598822, 2570170, Fax : 91 422 - 2594400, Email : ihec@psgimsr.ac.in

Following points must be noted:

1. IHEC should be informed of the date of initiation of the study
2. Status report of the study should be submitted to the IHEC every 12 months
3. PI and other investigators should co-operate fully with IHEC, who will monitor the trial from time to time
4. At the time of PI's retirement/intention to leave the institute, study responsibility should be transferred to a colleague after obtaining clearance from HOD, Status report, including accounts details should be submitted to IHEC and extramural sponsors
5. In case of any new information or any SAE, which could affect any study, must be informed to IHEC and sponsors. The PI should report SAEs occurred for IHEC approved studies within 7 days of the occurrence of the SAE. If the SAE is 'Death', the IHEC Secretariat will receive the SAE reporting form within 24 hours of the occurrence
6. In the event of any protocol amendments, IHEC must be informed and the amendments should be highlighted in clear terms as follows:
   a. The exact alteration/amendment should be specified and indicated where the amendment occurred in the original project. (Page no. Clause no. etc.)
   b. Alteration in the budgetary status should be clearly indicated and the revised budget form should be submitted
   c. If the amendments require a change in the consent form, the copy of revised Consent Form should be submitted to Ethics Committee for approval
   d. If the amendment demands a re-look at the toxicity or side effects to patients, the same should be documented
   e. If there are any amendments in the trial design, these must be incorporated in the protocol, and other study documents. These revised documents should be submitted for approval of the IHEC and only then can they be implemented
   f. Any deviation-Violation/waiver in the protocol must be informed to the IHEC within the stipulated period for review
7. Final report along with summary of findings and presentations/publications if any on closure of the study should be submitted to IHEC

Kindly note this approval is subject to ratification in the forthcoming full board review meeting of the IHEC.

Thanking You,

Yours Sincerely,

SECRETARY
PSG IMS&R
COIMBATORE-641004
INSTITUTIONAL HUMAN ETHICS COMMITTEE

Dr S Bhuvaneshwari
Member -Secretary
Institutional Human Ethics Committee

URKUND

Urkund Analysis Result

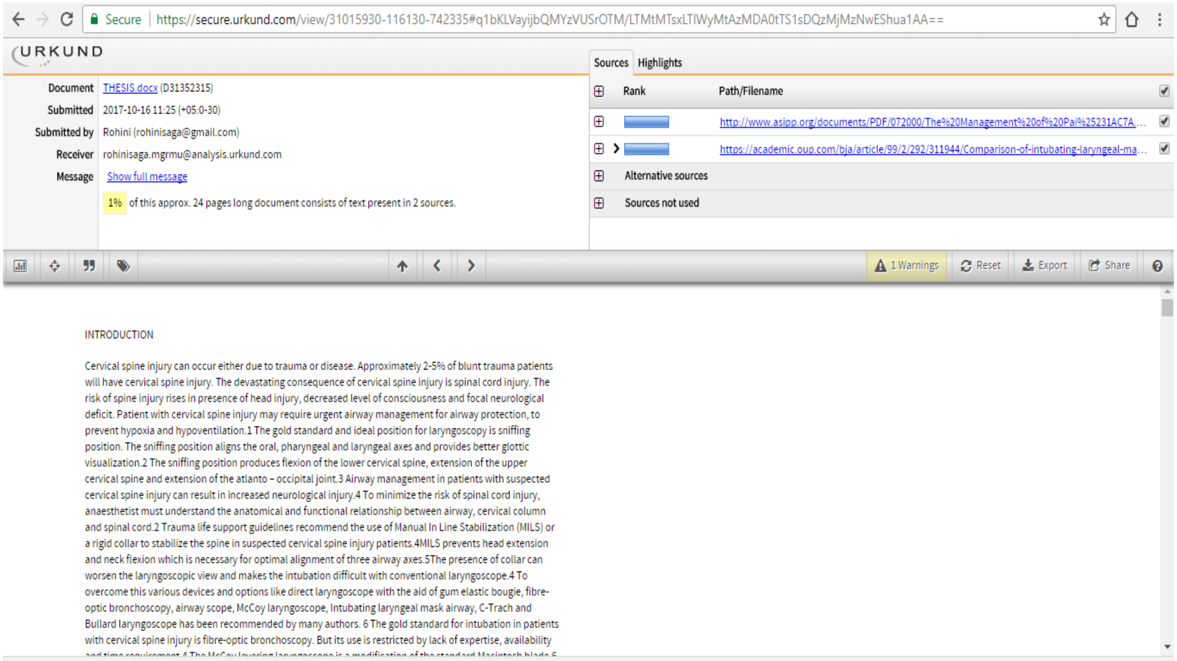
Analysed Document: THESIS.docx (D31352315)
Submitted: 10/16/2017 7:55:00 AM
Submitted By: rohinisaga@gmail.com
Significance: 1 %

Sources included in the report:

http://www.asipp.org/documents/PDF/072000/The%20Management%20of%20Pai%25231AC7A.PDF
https://academic.oup.com/bja/article/99/2/292/311944/Comparison-of-intubating-laryngeal-mask-airway-and

Instances where selected sources appear:

2



https://secure.urkund.com/view/31015930-116130-742335#q1bKLVayijbQMYzVUSrOTM/LTMtMTsxLTIWyMtAzMDA0tTS1sDQzMjMzNwEShua1AA==

URKUND

Document	THESIS.docx (D31352315)
Submitted	2017-10-16 11:25 (+05:0-30)
Submitted by	Rohini (rohinisaga@gmail.com)
Receiver	rohinisaga.mgrmu@analysis.urkund.com
Message	Show full message
	1% of this approx. 24 pages long document consists of text present in 2 sources.

Sources Highlights

Rank	Path/Filename
	http://www.asipp.org/documents/PDF/072000/The%20Management%20of%20Pai%25231AC7A....
	https://academic.oup.com/bja/article/99/2/292/311944/Comparison-of-intubating-laryngeal-ma...
Alternative sources	
Sources not used	

1 Warnings Reset Export Share

INTRODUCTION

Cervical spine injury can occur either due to trauma or disease. Approximately 2-5% of blunt trauma patients will have cervical spine injury. The devastating consequence of cervical spine injury is spinal cord injury. The risk of spine injury rises in presence of head injury, decreased level of consciousness and focal neurological deficit. Patient with cervical spine injury may require urgent airway management for airway protection, to prevent hypoxia and hypoventilation.1 The gold standard and ideal position for laryngoscopy is sniffing position. The sniffing position aligns the oral, pharyngeal and laryngeal axes and provides better glottic visualization.2 The sniffing position produces flexion of the lower cervical spine, extension of the upper cervical spine and extension of the atlanto – occipital joint.3 Airway management in patients with suspected cervical spine injury can result in increased neurological injury.4 To minimize the risk of spinal cord injury, anaesthetist must understand the anatomical and functional relationship between airway, cervical column and spinal cord.2 Trauma life support guidelines recommend the use of Manual In Line Stabilization (MILS) or a rigid collar to stabilize the spine in suspected cervical spine injury patients.4MILS prevents head extension and neck flexion which is necessary for optimal alignment of three airway axes.5The presence of collar can worsen the laryngoscopic view and makes the intubation difficult with conventional laryngoscope.4 To overcome this various devices and options like direct laryngoscope with the aid of gum elastic bougie, fibre-optic bronchoscopy, airway scope, McCoy laryngoscope, Intubating laryngeal mask airway, C-Trach and Bullard laryngoscope has been recommended by many authors. 6 The gold standard for intubation in patients with cervical spine injury is fibre-optic bronchoscopy. But its use is restricted by lack of expertise, availability

CERTIFICATE - II

This is to certify that this dissertation work titled **"COMPARISON OF C-MAC D BLADE AND McCoy BLADE FOR LARYNGOSCOPY IN PATIENTS WITH SIMULATED CERVICAL SPINE INJURY"** of the candidate **Dr. Rohini Sagadhevan** with registration Number **201520402** for the award of M.D in the branch of Anesthesiology I personally verified the urkund.com website for the purpose of plagiarism Check. I found that the uploaded thesis file contains from introduction to conclusion pages and result shows 1 percentage of plagiarism in the dissertation.

Guide & Supervisor sign with Seal

ACKNOWLEDGEMENT

I would like to place on records my sincere and heartfelt thanks to my guide **Dr. G. DHANABAGYAM**, Professor, Department of Anaesthesiology for her continuous support, guidance and encouragement. Her motivation has enabled me to complete the thesis in a good shaped.

I whole heartedly thank HOD **Dr.C.GANESAN** for his constant support and motivation.

My special thanks to all the faculty members in the Department of Anaesthesia for their consistent support and help.

I sincerely thank **Dr.S.MUSHAHIDA** for her support and **Dr.V.PREMCHANDAR** for his guidance in the statistical calculations.

I am grateful to DEAN **Dr.S.RAMALINGAM** for allowing me to utilize the hospital resources.

I thank the patients from the bottom of my heart for their co-operation to make this study possible and for the training I receive during this course.

My special thanks to my CO PGs and friends.

Finally I thank my family members for their love and encouragement.

TABLE OF CONTENTS

INTRODUCTION

Cervical spine injury can occur either due to trauma or disease. Approximately 2-5% of blunt trauma patients will have cervical spine injury. The devastating consequence of cervical spine injury is spinal cord injury. The risk of spine injury rises in presence of head injury, decreased level of consciousness and focal neurological deficit. Patient with cervical spine injury may require urgent airway management for airway protection, to prevent hypoxia and hypoventilation.[1]

The gold standard and ideal position for laryngoscopy is sniffing position. The sniffing position aligns the oral, pharyngeal and laryngeal axes and provides better glottic visualization.[2] The sniffing position produces flexion of the lower cervical spine, extension of the upper cervical spine and extension of the atlanto – occipital joint.[3]Airway management in patients with suspected cervical spine injury can result in increased neurological injury.[4] To minimize the risk of spinal cord injury, anaesthetist must understand the anatomical and functional relationship between airway, cervical column and spinal cord.[2]

Trauma life support guidelines recommend the use of Manual In Line Stabilization (MILS) or a rigid collar to stabilize the spine in suspected cervical spine injury patients.[4]MILS prevents head extension and neck flexion which is necessary for optimal alignment of three airway axes.[5]The presence of collar can worsen the laryngoscopic view and makes the intubation difficult with conventional laryngoscope.[4] To overcome this various devices and options like direct laryngoscope with the aid of gum elastic bougie, fibre-optic bronchoscopy, airway scope, McCoy laryngoscope, Intubating laryngeal mask airway, C-Trach and Bullard laryngoscope has been recommended by many authors. [6]

The gold standard for intubation in patients with cervical spine injury is fibre-optic bronchoscopy. But its use is restricted by lack of expertise, availability and time requirement.[4]

The McCoy levering laryngoscope is a modification of the standard Macintosh blade.[6] It has a hinged tip and the angle of the hinged portion can be altered by a lever attached to the handle.[7,8]Depression of the lever towards the handle elevates the tip.[8] The hinged tip aids in improving the Cormac and Lehane laryngoscopic view by 1 grade in comparison to Macintosh blade in patient with cervical spine injury. The blade is available in size 3 and 4.[4]

The latest generation C-MAC video laryngoscope has several distinct improvements.[8] It has external light source and small digital camera at the distal third of the blade, which extends to a video display monitor.[9] It provides optimum view of the glottis by direct and indirect view.[9] C-MAC laryngoscope can accommodate Macintosh blade 2, 3 & 4. A special D blade with greater curvature is designed to facilitate intubation of the difficult airways.[8]

Both the devices have been independently compared with Macintosh laryngoscope in simulated difficult airway. Only a few studies are available comparing C-MAC and McCoy laryngoscope.[4]

This study was carried out to compare the efficacy of C-MAC D blade and McCoy blade laryngoscope in simulated cervical spine injury by comparing duration of laryngoscopy, duration of intubation, total duration of intubation, ease of intubation and haemodynamic responses.

AIM OF THE STUDY

To compare C-MAC D blade and McCoy blade laryngoscope in simulated cervical spine injury using Manual In Line Stabilisation (MILS) with the following parameters

PRIMARY AIM:

Duration of laryngoscopy

Duration of intubation

Total duration of intubation

Ease of intubation - Intubation Difficulty Scale (IDS score)

SECONDARY AIM:

Haemodynamic responses.

REVIEW OF LITERATURE

Laurent et al., did a study on the use of McCoy laryngoscope in patients with simulated cervical spine injuries. 167 patients of ASA grades 1-3, scheduled for elective surgery under general anaesthesia who required tracheal intubation were included. Laryngoscopy was done with their head and necks held in the neutral position using manual in-line stabilisation and cricoid pressure to simulate the patient with a suspected cervical spine injury. Each patient underwent laryngoscopy using both Macintosh and McCoy laryngoscope and the best view obtained by each scope was graded. The results showed that the McCoy was better than the Macintosh. It improved the Macintosh grade by 1 grade in 41% and by 2 grades in 8% .They concluded that patients with a suspected cervical spine injury should be intubated using a McCoy in preference to a Macintosh laryngoscope.[7]

Jain et al., did a randomised study and compared the effectiveness of McCoy laryngoscope and CMAC video laryngoscope in simulated cervical spine injury. They randomly divided 60 ASA 1 and 2 patients into two equal groups. To immobilize the cervical spine a rigid collar was applied. They Compared data on the IDS scale, Cormack-Lehane (CL) laryngoscopic view, time taken for glottis visualization, time taken to pass endotracheal tube, total time to intubate, number of optimizing maneuvers and hemodynamic variables among two groups.IDS score was significantly less in the C-MAC group compared to the McCoy group. The hemodynamic variables, number of optimizing maneuvers and side effects were comparable in the two groups. They concluded that CMAC video laryngoscope forms an effective tool for the airway management of cervical spine patients with a cervical collar.[4]

Jain et al., compared the conventional C-MAC and the D-blade C-MAC with the direct laryngoscopes in simulated cervical spine injury (manikin study). Forty resident doctors with minimum 6 months training were enrolled. The airway manikin with cervical collar was used. The outcomes measured were vocal cord visualization (Cormack–Lehane grading), time taken to intubate, number of attempts for successful intubation and optimizing maneuvers required The results showed that the use of video laryngoscopes resulted in better glottic visualization in comparison to the direct laryngoscopes, the time taken to intubate was less in Macintosh group and the 1st attempt intubation success rate was high in C-MAC group. They concluded that he overall performance of the conventional C-MAC blade proved to be the best when compared with the D-blade C-MAC, Macintosh blade and the McCoy blade.[10]

Sabrya et al., did a randomised control study and compared C-MAC D-blade and McCoy laryngoscopes in intubating patients during cervical immobilization. 60 adult ASA I and II patients were randomly categorized into two equal groups. After MILS group I patients were intubated usingC-MAC D-blade laryngoscope and group II patients intubated using McCoy laryngoscope. Haemodynamic measurements and oxygen saturation, laryngeal view according to modified Cormack and Lehane grade at laryngoscopy, duration of the intubation procedure, number of intubation attempts and complications were compared. Haemodynamic parameters were significantly lower in the C-MAC D-blade group compared to McCoy group until 4min after intubation. Duration of intubation was significantly longer in C-MACD-blade group than in McCoy group. C-MAC D-blade results in more successful intubation in the first attempt than the McCoy laryngoscope. They concluded that C-MAC D-blade laryngoscope offers a new approach for the management of patients in need for cervical immobilization. It causes less haemodynamic stress, gives a better view of the larynx without moving the cervical spine, but it may be more time-consuming.[8]

Ali et al., compared King Vision video laryngoscope, McCoy, and Macintosh laryngoscopes in patients with immobilized cervical spine. Ninety adult patients of ASA grade I-II with immobilized cervical spine using manual inline stabilization technique, undergoing elective cervical surgery were included in the study. Intubation was carried out depending on the group to which the patient was assigned. After obtaining the best possible view of the glottis, the Cormack-Lehane laryngoscopy grade and the percentage of glottic opening (POGO) score were assessed. The intubation time, the intubation difficulty score, the intubation success rate, haemodynamic parameters and airway complications were recorded. King Vision video laryngoscope reduced the intubation difficulty score, improved the Cormack and Lehane glottic view, and the POGO score when compared with the McCoy and Macintosh laryngoscopes. They concluded that the use of a King Vision video laryngoscope resulted in better glottis visualization, easier tracheal intubation, and higher first attempt success rate as compared to Macintosh and McCoy laryngoscopes in immobilized cervical spine patients.[11]

Moningi et al., did a prospective randomized study and compared Airtraq and McCoy laryngoscope in patients undergoing anterior cervical discectomy and fusion (ACDF) surgery. Forty ASA I and II patients involving single level ACDF surgery were selected. Cervical immobilization was achieved in all the patients either with pin traction or with a rigid cervical collar along with Manual in-line stabilization (MILS) to all the patients by an experienced neurosurgeon who was not involved in the study. Patients were randomized in to two groups either Airtraq intubation (Group A) or intubation with McCoy (Group M). The time taken for intubation, intubation difficulty score (IDS), hemodynamic parameters and comfort grading were noted following intubation. They finally concluded that Airtraq improves the grade of glottic visualization with minimal assistance and also minimized the time taken for intubation with stable haemodynamics.[12]

Kilicaslan et al., did a randomized trial and compared the C-MAC D-Blade, Conventional C-MAC and Macintosh Laryngoscopes (ML) in simulated easy and difficult airways. 26 experienced anaesthesia providers performed tracheal intubation of a Laerdal SimMan manikin with each laryngoscope in the following scenarios: (1) normal airway, (2) cervical spine immobilization, and (3) tongue edema. The intubation times, number of intubation attempts, laryngoscopic views, success rates and severity of dental compression were noted. They concluded that in the cervical immobilization scenario C-MAC D-Blade caused less dental pressure than the conventional C-MAC and ML. In the tongue edema scenario the conventional C-MAC performed better than the D-Blade and ML. [13]

Bharti et al., did a randomised prosoective study and compared McCoy, TruView, and Macintosh laryngoscopes for tracheal intubation in patients with immobilized cervical spine. 60 adult patients of ASA grade I-II with immobilized cervical spine undergoing elective cervical spine surgery were included. The patients were randomly allocated into three groups. When the best possible view of the glottis was obtained, the Cormack-Lehane laryngoscopy grade and the percentage of glottic opening (POGO) score were assessed. The intubation time, the intubation difficulty score, and the intubation success rate, hemodynamic parameters and any airway complications were recorded. They concluded that the use of a TruView laryngoscope resulted in better glottis visualization, easier tracheal intubation, and higher first attempt success rate as compared to Macintosh and McCoy laryngoscopes in immobilized cervical spine patients.[14]

ANATOMY[15]

General Characteristics of Vertebrae

A typical vertebra consists of an anterior segment, the body, a posterior part and the vertebral or neural arch. These enclose the vertebral foramen, which constitute a canal for the protection of spinal cord. The vertebral arch consists of a pair of pedicles, a pair of laminae, and supports seven processes – four articular, two transverse, and one spinous process. When the vertebrae are articulated with each other, the bodies form a strong pillar for the support of the head and trunk. Between every pair of vertebrae are two apertures named the intervertebral foramina, one on either side, for the transmission of the spinal nerves and vessels.

THE CERVICAL VERTEBRAE (VERTEBRAE CERVICALES)

Cervical vertebrae are the smallest of the vertebrae, and can be readily distinguished by the presence of a foramen in each transverse process. The first, second, and seventh vertebrae presents exceptional features and are separately described. The following characteristics are common to the remaining four.

The body is small and broader from side to side. The anterior and posterior surfaces are flattened. Its inferior border is prolonged downward, so as to overlap the upper and forepart of the vertebra below. The upper surface is concave transversely, and has a projecting lip on either side. The lower surface is convex from side to side and concave from before backward, and has shallow concavities laterally which receive the corresponding projecting lips of the subjacent vertebra.

The pedicles are directed lateral and backward. They are attached to the body midway between its upper and lower borders, so that the superior vertebral notch is as deep as the inferior and narrower. The laminae are narrow and thinner above. The vertebral foramen is large and triangular. The spinous process is short and bifid and the two divisions are of unequal size. On either side the superior and inferior articular processes are fused to form an articular pillar. It projects lateralward from the junction of the pedicle and lamina. The articular facets are flat and oval. The superior looks backward, upward and slightly medial and the inferior looks forward, downward and slightly lateral.

Each transverse process is pierced by the foramen transversarium, which in the upper six vertebrae, gives passage to the vertebral artery and vein and a plexus of sympathetic nerves. Each process has an anterior and a posterior part. The anterior portion is the homologue of the rib in the thoracic region, and therefore it is named the costal process or costal element. The costal process arises from the side of the body and is directed laterally in front of the foramen and ends in a tubercle namely the anterior tubercle. The posterior part is the true transverse process, springs from the vertebral arch behind the foramen and is directed forward and laterally. It ends in a flattened vertical tubercle known as the posterior tubercle. These two parts are joined outside the foramen by a bar of bone which has a deep sulcus on its upper surface for the passage of the corresponding spinal nerve.

FIRST CERVICAL VERTEBRA

The first cervical vertebra(figure 1)is named as the atlas because it supports the globe of the head. Its peculiarities are - it has no body, no spinous process. It is ring-like, and has an anterior and a posterior arch and two lateral masses. The anterior arch forms about one-fifth of the ring circumference. The posterior arch forms about two-fifths of the ring circumference and it ends behind in the posterior tubercle, which is the rudiment of a spinous process. The small size of this process prevents any interference with the movements between the atlas and the skull.

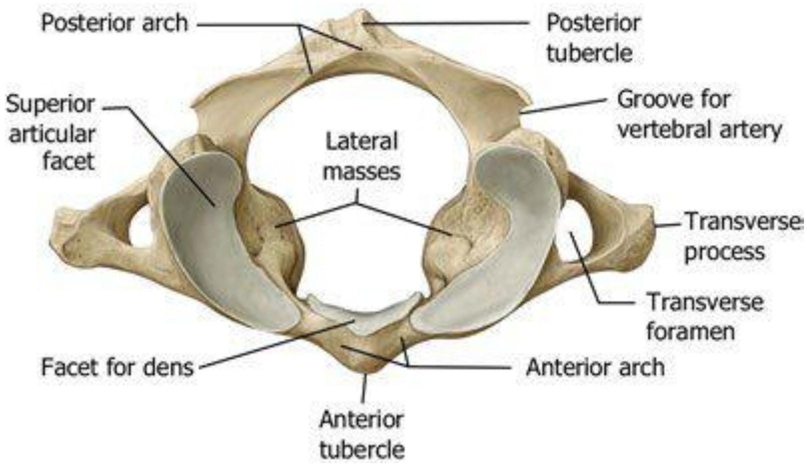


Figure1: First cervical vertebra

SECOND CERVICAL VERTEBRA

The second cervical vertebra (figure 2) is named the epistropheus or axis because it forms the pivot upon which the first vertebra which carries the head rotates. The most distinctive characteristic of this bone is the strong odontoid process. The process rises perpendicularly from the upper surface of the body. The odontoid process exhibits a slight constriction, the neck, where it joins the body. The internal structure of the odontoid process is more compact than the body. The vertebral foramen is large, but smaller than that of the atlas.

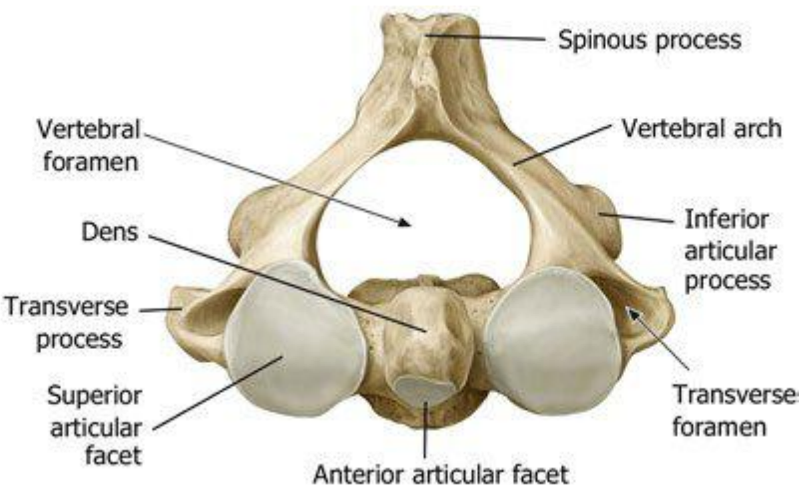


Figure 2 : Second cervical vertebra

THE SEVENTH CERVICAL VERTEBRA

The most distinctive characteristic of seventh cervical vertebra (figure 3) is the presence of a long and prominent spinous process and hence named as vertebra prominens. The spinous process is thick and nearly horizontal in direction. It does not bifurcate but terminate in a tubercle to which the lower end of the ligamentum nuchae is attached.

The transverse processes are of considerable size. Sometimes the anterior root of the transverse process has a large size and exists as a separate bone and is known as a cervical rib.

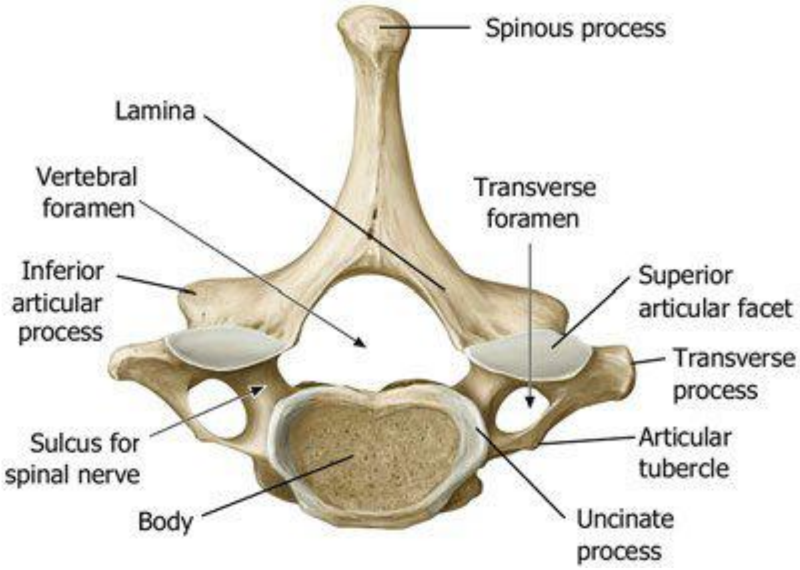


Figure 3: Seventh cervical vertebra

THE ADULT CERVICAL SPINE: STABILITY, INJURY, AND INSTABILITY[16]

Movement and Stability of the Upper Cervical Spine:

Flexion and extension occurs in the upper cervical spine at both the atlanto-occipital and atlanto-axial joints. Flexion is limited by contact between the odontoid process and the anterior border of the foramen magnum at the atlanto-occipital joint and by the tectorial membrane and posterior elements at the C1–C2 level. Extension is limited by the contact between the posterior arch of the atlas with the occiput superiorly and with the arch of the axis inferiorly.

The ligaments contributing to the stability of the upper complex are the transverse, apical, alar ligaments and also the superior terminations of the anterior and posterior longitudinal ligaments. Normally the transverse ligament allows not more than 3 mm of antero-posterior translation between the dens and the anterior arch of the atlas. Posterior displacement of the dens to a significant level reduces the space available for the spinal cord (SAC) in the vertebral column. When this space is reduced, compression of neural elements will occur. Persistant compression will eventually lead to myelopathy and neurological deficit.

Movement and Stability of the Lower Cervical Spine

Flexion and extension occurs in the lower cervical spine, with the C5–C7 segments contributing the largest component. In the lower cervical spine, the structures contributing to stability include, the anterior longitudinal ligament, the intervertebral discs, the posterior longitudinal ligament, the facet joints with their capsular ligaments and the intertransverse ligaments, the interspinous ligament, and the supraspinous ligaments. The posterior longitudinal ligament and the structures anterior to it are known as the anterior elements or anterior column. The posterior elements or posterior column are those behind the posterior ligament.

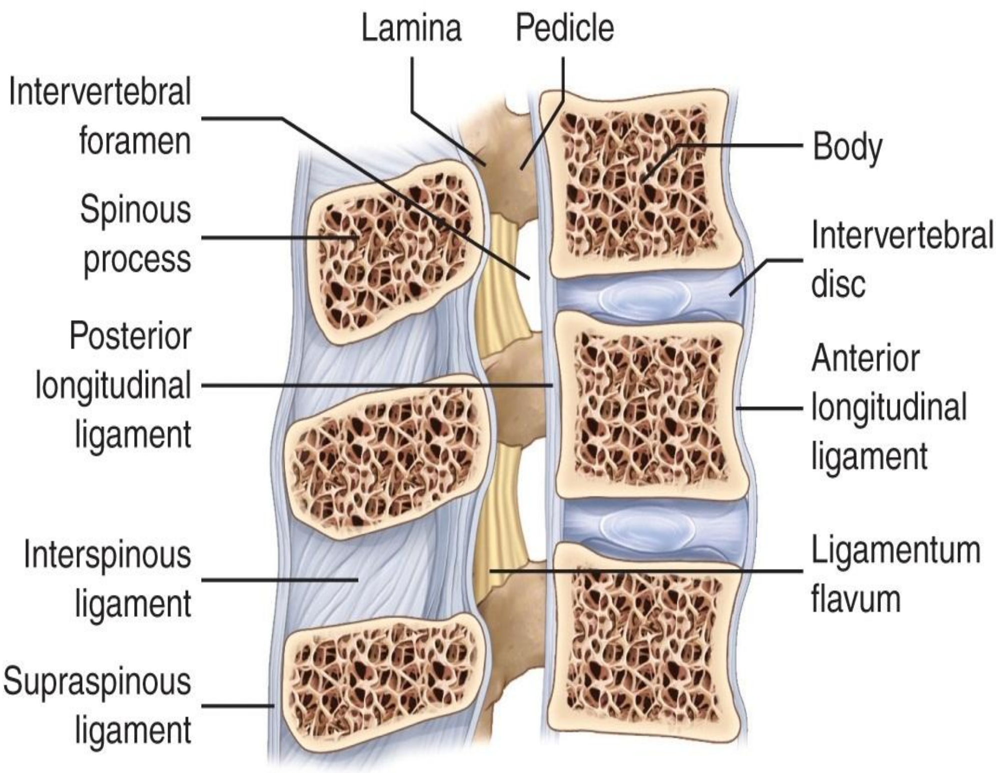


Figure 4 :The ligaments of the lower cervical spine, sagittal section.

Cervical Spinal Instability after Injury:

Mechanisms and Consequences

White AA et al.,[17] have defined stability as "the ability of the spine to limit its pattern of displacement under physiologic loads so as not to allow damage or irritation of the spinal cord or nerve roots."

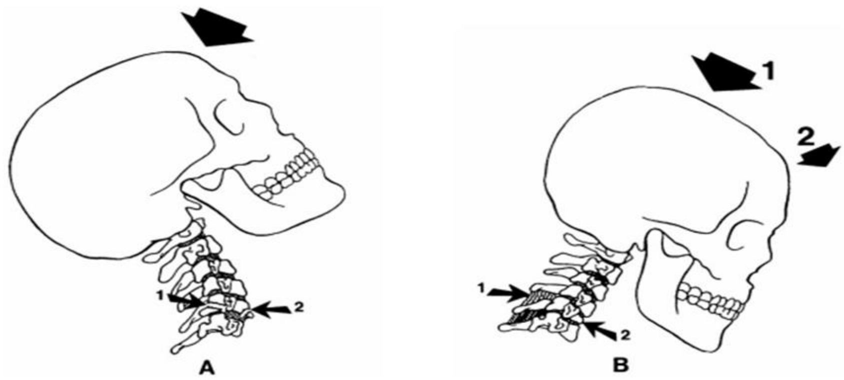


Figure 5: **Injuring force mechanisms and resulting lesions. A) A compression hyperextension force has resulted in distraction of elements of the anterior column and compression of posterior column. B) A flexion (large arrow 2), compression (large arrow 1) force has produced a wedge fracture of the vertebral body (small arrow 2) and an incomplete disruption of inter and supraspinous ligaments (small arrow 1)**

The anterior column contributes more to the stability of the spine in extension, and the posterior column contributes its major forces in flexion. Hence, the anterior elements tend to be disrupted in hyperextension injuries, and the posterior elements tend to be disrupted in hyperflexion injuries. With extreme flexion or extension both columns may be disrupted (figure).

Cervical Spinal Movement during Direct Laryngoscopy in Normal Patients

Sawin PD et al.,[18] determined the nature, extent and distribution of segmental cervical motion produced by direct laryngoscopy and orotracheal intubation in normal human subjects. This study included ten patients who underwent laryngoscopy during general anesthesia. The intubation sequence was divided into distinct stages and fluoroscopic images were recorded. Minimal displacement of the skull base and cervical vertebral bodies was observed during laryngoscope blade insertion. Elevation of the laryngoscope blade to achieve laryngeal visualization caused superior rotation of the occiput and C1 in the sagittal plane and mild inferior rotation of C3–C5. This pattern of displacement resulted in extension at each motion segment with the most significant motion being produced at the atlanto-occipital and atlanto-axial joints. Tracheal intubation created slight additional superior rotation at the cranio-cervical junction but caused little alteration of C3–C5 segments.

Horton WA et al.,[19] conducted a similar experiment in volunteers during topical anesthesia only. Subjects underwent laryngoscopy in a supine, sniffing position, at full glottic exposure, and a lateral radiograph of the head and neck was performed. The radiographs indicated that extension at the cranio-cervical junction was near maximal and that there was progressively increasing extension from C4 to the base of the skull during laryngoscopy.

Determining Stability of the Cervical Spine after Injury

Spinal instability usually results in vertebral displacement and it may be detected in many instances by radiography. **White and Panjabi**[20] identified the upper limit of vertebral displacement and that which is beyond the physiologic range. They concluded that a normal adult spine will permit horizontal motion not greater than 2.7 mm between vertebrae. Hence, if horizontal displacement exceeding 3.5 mm or 20% of the vertebral body width was found on lateral radiographs of the neck, the spine was considered unstable. With respect to angular displacement, the upper limit of physiologic angular displacement of a vertebral body was 11°. If there is greater angulation of the vertebra in, the spine is deemed unstable at the site of the excessively rotated vertebra.

The National Emergency X-Radiography Utilization Study (NEXUS) group identified the following injuries as not clinically significant: spinous process fractures, wedge compression fractures with loss of 25% or less of body height, isolated avulsion fractures without ligament injury, type 1 odontoid fractures, end-plate fractures, trabecular fractures, and isolated transverse process and osteophyte fractures.[21]

The Canadian CT Head and Cervical Spine Study group identified the following injuries as not significant: simple osteophyte fractures, spinous process fractures, transverse process fractures and compression fractures with loss of less than 25% of body height.[22]

Mechanisms of Spinal Cord Injury

Spinal cord injury may be primary or secondary. Primary injury may result from shear, compressive or distracting forces, which primarily avulse and devitalize tissues. Persistent cord compression from fracture and dislocation may lead to ischemia. The cord may be injured by bone fragment or missile injury with resultant laceration or contusion.[23] Secondary and progressive injury may result from local perfusion deficits due to vascular compression by deranged anatomy like edema or from global perfusion compromise caused by systemic hypotension. In addition, tissue hypoxemia as a result of hypoventilation caused by head or cord injury or by primary lung trauma can also lead to secondary injury. Finally, at the cellular and subcellular level there are multiple mechanisms that may result in exacerbation of the injury resulting in an extension of the clinical deficit.[24]

Biomechanics of the Spinal Cord and Canal

For proper functioning of the spinal cord, a minimum canal lumen is required at rest and during movement. Cord compromise will result if the canal space is less than that required for normal cord function. Neurologic injury will occur if the reduction in canal space is persistent. The neurologic injury occurs from sustained mechanical pressure on the cord leading to anatomical deformation and ischemia. The functional size of the spinal canal can be further reduced with movement. The spinal canal is relatively a column of fixed volume.[25]As the canal lengthens, its cross-sectional area will be reduced, and as it is shortened, its area will be increased; this behaviour is termed the Poisson effect. With flexion, the canal length is increased and its area is reduced; the cord is stretched. The Poisson effect states that both the lumen of the canal and the spinal cord will narrow as they lengthen. The cord can tolerate a degree of elastic deformation while maintaining normal neurologic function. With extension, the canal length decreases and its area increases; the cord is shortened. The Poisson effect will dictate canal widening.

Methods of cervical spine immobilisation

PodolskySet al.,[26] evaluated the efficacy of cervical spine immobilization techniques. Hard foam and hard plastic collars were better than soft foam collars in limiting cervical spine motion. The use of collars alone did not effectively restrict spinal motion. The use of sandbag-tape immobilization was more effective at reducing spinal movement than any other method. Adding a Philadelphia collar to the sandbag–tape reduced neck extension and was found to be the most effective technique of immobilisation.

Bednar DA[27] assessed the efficacy of immobilisation with soft, semi rigid and hard collars in a destabilized elderly cadaver model. Soft, semirigid and rigid collars were used to restrict neck movements and then the spines were subjected to unrestrained gravitational forces with flexion, lateral side-bending and extension. The collars were not effective in reducing spinal movement.

Goutcher and Lochhead[28] measured the maximal mouth opening (inter incisor distance) in 52 volunteers, before and after the application of a semirigid cervical collar. Three collars were assessed namely the Stifneck (Laerdal Medical Corp., Wappinger's Falls, NY), the Miami J (Jerome Medical, Moorestown, NJ) and the Philadelphia (Philadelphia Cervical Collar Co., Thorofare, NJ). There was a wide variation and a significant proportion of people had an interincisor distance reduced to less than 20 mm after application of the collar. The reduction was with Stifneck 25%, Miami J 21% and Philadelphia 21%. They concluded that the presence of a semirigid collar significantly reduced mouth opening and would interfere with airway management. They suggest removal the anterior portion of the collar before attempts at tracheal intubation.

Manual In-line Stabilisation (MILS)

The goal of Manual In-Line Stabilisation is to apply sufficient forces to the head and neck to limit the movement which might result during medical interventions, mainly during airway management. MILS is typically provided by an assistant positioned either at the headend of the bed or at the side of the stretcher facing the head of the bed. The patient should be in supine with the head and the neck in neutral position. Assistants will either grasp the mastoid process with their fingertips and cradle the occiput in the palms of their hands (head-of-bed assistant) or cradle the mastoids and grasp the occiput (side-of-bed assistant). When MILS is applied, the anterior portion of the cervical collar can be removed to allow for greater mouth opening, facilitating airway interventions. During laryngoscopy, the assistant should apply forces that are equal in force and opposite in direction to those being generated by the laryngoscopist to keep the head and neck in the neutral position. Avoiding traction forces during the application of MILS may be particularly important when there is a serious ligamentous injury resulting in gross spinal instability.

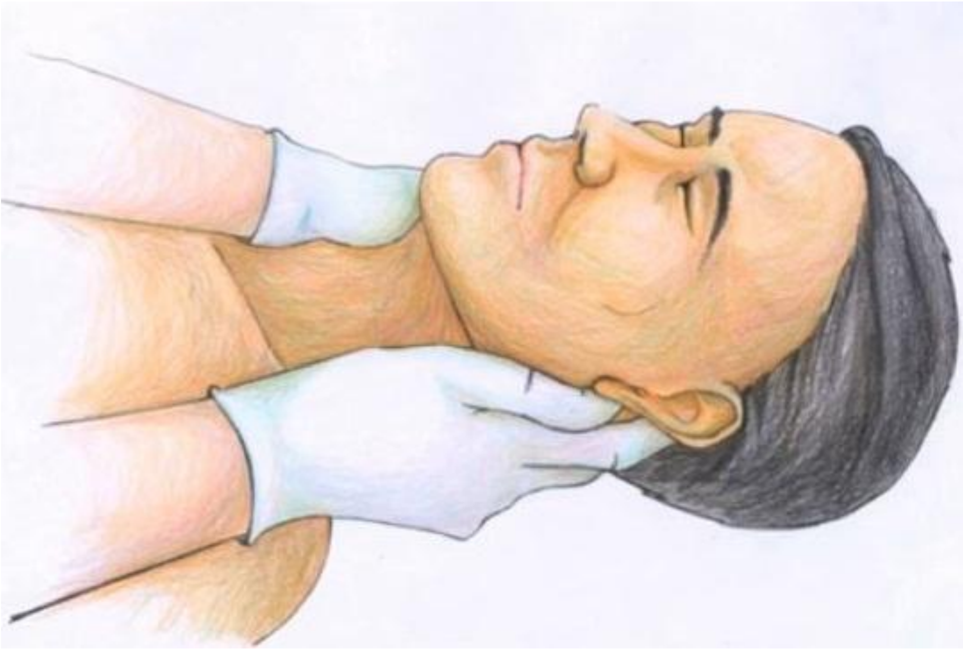


Figure 6 : Manual In Line Stabilisation (MILS)

Majernick et al.,[29] did a study on cervical spine movment during orotracheal intubation with direct laryngoscopy in normal patients. They demonstrated that MILS reduced total movement of spine during the process of laryngoscopy and tracheal intubation. However movement was not reduced to a similar degree by collars.

Watts AD J et al.,[30] measured a reduction in spinal movement with the application of MILS during tracheal intubation in patients with normal spines during general anesthesia.

Lennarson PJ et al.,[31] also assessed the efficacy of MILS and Gardner-Wells traction in a model of complete C4-C5 segmental instability. They studied the segmental angular rotation, subluxation and distraction at the injured C4-C5 level. Movements were measured from recorded video fluoroscopy. Traction significantly increased distraction but reduced angular rotation and effectively eliminated subluxation. MILS effectively eliminated distraction and diminished angulation but increased subluxation. Orotracheal intubation without MILS or Gardner-Wells traction had intermediate results causing less distraction than traction, less subluxation than immobilisation, but increased angulation compared with either intervention.

Gerling MC et al.,[32] evaluated the effect of MILS and cervical collar immobilisation on spinal movement study during direct laryngoscopy in an unstable C5-C6 cadaver model. MILS allowed less displacement (2mm) when compared to cervical collar immobilisation. The magnitude of movement was small and within physiological limits. MILS was also associated with improved laryngeal visualisation.

Impact of MILS on the View Obtained at Laryngoscopy

The use of MILS during airway maneuvers have less impact on the view obtained during direct laryngoscopy than other immobilization techniques like axial traction or a cervical collar, tape and sandbags. **Heath KJ et al**.,[33] examined the effect on laryngoscopy of two different immobilization techniques in 50 patients. The cervical spine was immobilised in a rigid collar with tape across the forehead and sand bags on either side of the neck. A CL grade 3 or 4 laryngoscopic view was obtained in 64% of patients immobilized with a collar, tape and sandbags compared with 22% of patients stabilized with MILS. The laryngeal view improved by one grade in 56% of patients and by two grades in 10% when MILS was substituted for the collar, tape and sandbags. The main factor contributing to the increased difficulty of laryngoscopy with patients wearing cervical collars was reduced mouth opening.

Hastings RH and Wood PR[34] measured the degree of head extension required to expose the arytenoid cartilages and glottis and determined the impact of MILS applied. 31 anesthetized patients with normal cervical spines and Mallampati 1 views were involved in the study. Two methods of immobilization were used. Either axial traction was applied, wherein the assistant pulled the head in a caudal to cephalad direction strongly or force was applied to the head in a downward direction to hold the head onto the table. Without stabilization, the best glottis view was achieved with 10°–15° of head extension. Head immobilization reduced extension angles of 4°–5° when compared with no stabilization, and it was more effective than axial traction immobilization in limiting extension. Therefore, the use of MILS reduced the amount of head extension that was necessary for laryngoscopy but resulted in a poorer view in a portion of the patients studied

Wood et al.,[35] studied the effect of cervical stabilization maneuvers on the view obtained at laryngoscopy in 78 elective surgical patients and concluded that cervical immobilization commonly worsened laryngoscopic view. The effects of MILS on laryngeal view were in a similar direction to those reported by Hastings but occurred more commonly in Wood's study. Anterior laryngeal or cricoid pressure often improved the view of the larynx when the neck was immobilized.

Laryngeal view

In 1984 **Cormack and Lehane**[36]described the four graded scoring system to describe the laryngeal view obtained during the Macintosh laryngoscope.

Grading is as follows:

- Grade I : Full view of glottis
- Grade II : Partial view of glottis or arytenoids
- Grade III : Only epiglottis visible
- Grade IV : Neither glottis nor epiglottis visible

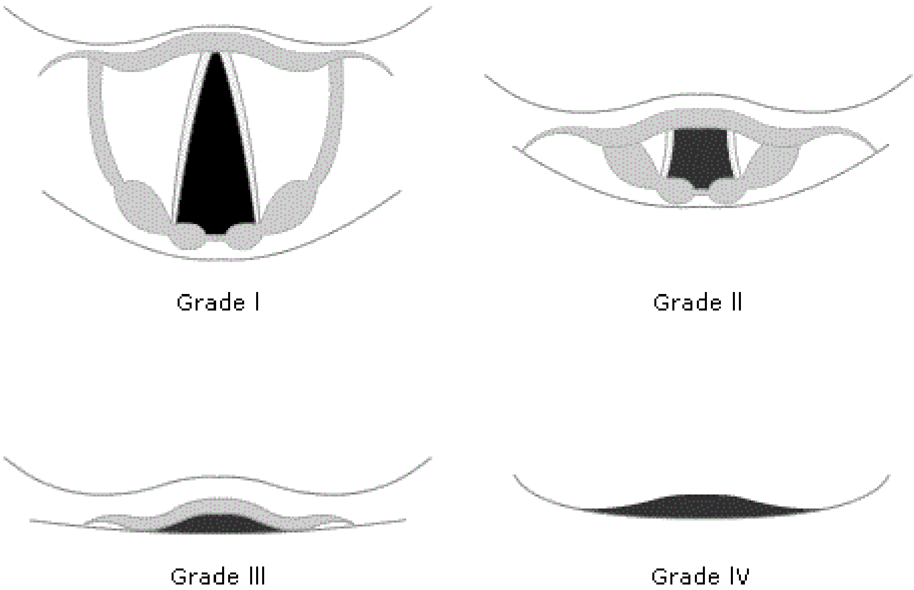


Figure 7: Cormack and Lehane classification of laryngoscopic view

Though the Cormack and Lehane grading was originally described to grade laryngeal view using conventional laryngoscopy, now with the introduction of indirect video laryngoscopes, it is still used to compare the laryngeal views obtained by different laryngoscope.

THE INTUBATION DIFFICULTY SCALE (IDS)[37]

In 1997 **Frederic Adnet et al.,** evaluated and proposed an Intubation Difficulty Scale (IDS) score characterising the complexity of endotracheal intubation in both the prehospital and operating room settings. The IDS score has been used to assess the degree of difficulty.

The Intubation Difficulty Scale (IDS) score is a function of seven parameters, resulting in a progressive, quantitative determination of intubation complexity.

The seven variables are as follows:

N^1-The number of intubation attempts.

An attempt is defined as one advancement of the tube in the direction of the glottis during direct laryngoscopy.

$N^1 = 0$ if only one attempt.

Every additional attempt adds one point.

N^2-The number of supplementary operators.

It represents the number of additional persons directly attempting intubation.

$N^2 = 0$ if only one operator.

Every additional operator adds one point.

N^3-The number of alternative techniques used.

Change in approach - oral intubation to blind nasotracheal intubation, change in material – blade, endotracheal tube, addition of stylette. Each alternative technique adds one point.

N^4-Glottic exposure as defined by the Cormack grade minus one.

Grade I ($N^4 = 0$)

Grade II (N^4 = 1)

Grade III (N^4 = 2)

Grade IV (N^4 = 3)

Glottic exposure is evaluated during the first attempt by the first operator.

N^5- Lifting force applied during laryngoscopy.

N^5= 0 if little effort is necessary

N^5= 1 if subjectively increased lifting force is necessary.

N^6- Necessity for external laryngeal pressure for optimized glottic exposure.

N^6= 0 if no external pressure is applied.

N^6= 1 if external laryngeal pressure is necessary.

N^7- Position of vocal cords during intubation.

N^7= 0 if vocal cords are in abduction.

N^7= 1 if the vocal cords are in adduction.

The degree of difficulty is described according to IDS score as follows

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

LARYNGOSCOPE

In 1940 Sir Robert Macintosh and Sir Ivan Magill popularised the visualization of vocal cords for intubation using laryngoscope. Laryngoscopes are broadly categorised into two categories:

1. Direct line of sight devices – rigid lighted retractors are used to retract tissue to create direct visualisation. It is termed as Direct laryngoscope.
2. Indirect line of sight devices – optical laryngoscopes in which fibreoptic bundle, prism, lens or miniature camera transmits image. It is termed Indirect laryngoscope. It is subdivided as follows :
   a. Rigid optical laryngoscopes – The image conveying system is encased in a rigid structure
   b. Flexible endoscopes – The viewing bundle, light transmitting bundle and an optical instrument channel are wrapped in a flexible casing.[38]

Rigid laryngoscope has a separate detachable handle and blade. The light source is either a lamp in the handle with a light guide in the blade or a lamp attached to the blade. A hook on hinged connection between the handle and the blade is commonly used. A single piece laryngoscope has a switch on the handle to control the power to lamp.

Handle

Handle is the part held in hand during laryngoscopy. The power for light is provided by the handle. The power source is either disposable or rechargeable batteries. Fibreoptic-illuminated laryngoscopes use a remote electrically operated light source. Most of the handles are designed to accept either fibreoptic-illuminated or lamp-in-bulb blades, but some can accept both. Handles designed to accept blades which have a light bulb will have a metallic contact, which completes an electrical circuit when the handle and blade are in the working position. Handles containing batteries and using fibreoptic illumination has a halogen lamp bulb. When the handle and blade are locked in the working position, an activator switch will be depressed. This will provide a connection between the bulb and the batteries. Handles are available in various sizes. The surface is usually rough for better grip.

Short handles may be advantageous for patients in whom the chest or breasts contact the handle during use, when applying cricoid pressure or when the patient is in a body cast. Another technique is to insert the blade laterally into the mouth, then to advance and rotate it until it is in a midline position. The blade can be detached from the handle before it is inserted into the mouth and then can be attached to the handle after it is placed. Most blades form a right angle with the handle when ready for use, acute or obtuse is also possible. An adapter may be fitted between the handle and the blade to allow the angle to be altered.

Blade

The blade is the part that is inserted into the mouth. When blades are available in many sizes, the blades are numbered, with the number increasing with size. The blade is composed of several parts, which includes the base, heel, tongue, flange, web, tip, and light source. The base is the part that is attached to the handle. It has a slot for engaging the hinge pin of the handle. The end of the base is called the heel.

The tongue (spatula) is the main shaft and it serves to compress and manipulate the soft tissues like tongue and lower jaw. The long axis of the tongue may be straight or curved in part or throughout its length. Blades are commonly referred to as straight or curved, depending on the predominant shape of the tongue.

The flange projects off the side of the tongue. It is connected to the tongue by the web. It serves to guide instrumentation and also deflect tissues from the line of vision. The flange usually determines the cross-sectional shape of the blade. The vertical height of the cross-sectional shape of a blade is so referred to as the step.

The tip contacts either the epiglottis or the vallecula and directly or indirectly elevates the epiglottis. It is usually blunt and thickened to decrease trauma. The blade may have a fibreoptic bundle or a lamp that transmits light from a source in the handle. The lamp screws into a socket which has a metallic contact.[39]

McCoy blade[40]

The McCoy blade differs from the usual curved blade in four features. It has a hinged tip, a lever at the proximal end, a spring loaded drum and a connecting shaft.

The hinged tip - The normal blade is cut 25 mm proximal to the tip and a hinge placed between the two parts. The flange is in a curved manner so the adjustable tip locks with the rest of the blade in the resting position. Hence the pressure exerted on the tip will be transmitted down the long axis of the flange and not exerted on the hinge.

The proximal lever – It is 15.5 cm in length and 1 cm wide and is attached to the proximal end of the blade. It is connected to a spring loaded drum by a pin through the flange.

The spring loaded drum lies enclosed on the left side of the flange. The spring acts in a clockwise manner when viewed from the left side.

The connecting shaft - The shaft links the spring loaded drum to the hinged tip. It is 10 cm long. It is concave upwards and cut so as not to impinge on the bulb. At the distal end it is linked to the hinged tip with a 1.5 cm wire, soldered to the connecting shaft proximally, bent to 90" distally and inserted through a hole in the flange of the hinge. Proximally the connecting shaft joins the spring loaded drum via a second hinge. The modified blade weighs I70 g. The blade can be fitted to a standard Penlon handle.

Figure 8: McCoy blade Laryngoscope

Use - The blade is attached to a standard laryngoscope handle. The handle is grasped normally with the lever lying posterior to the thumb and the thumb may be moved posterior to the lever to lie along its long axis. Compression of the lever towards the handle will cause the spring-loaded drum to rotate anticlockwise direction. The rotational movement causes the connecting shaft to move forwards along the blade. At the tip, the forward motion of the connecting shaft will push the wire forwards resulting in elevation of the hinged tip. Release of the lever allows the spring loaded drum to return the connecting shaft and therefore the hinged tip to the resting position.

VIDEO LARYNGOSCOPES

A video laryngoscope is created by attaching a video system to a flexible fiberscope or an optical stylet.

The advantages are

- Displayed anatomy is magnified and a large viewing angle is available.
- The operator and assistant can coordinate their movements easily.
- The ability of projecting the laryngoscopic view obtained, makes it a good teaching tool and also allows the supervisor to monitor the intubation process.
- The intubation process can be recorded.
- It is used to observe bougie placement, movement of vocal cord post thyroid surgery, verify tracheal tube position.[39]

C MAC VIDEO LARYNGOSCOPE[41]

C-MAC video laryngoscope was developed and manufactured by the Karl Storz (Tuttlingen, Germany) in 1999. In the original model the video Macintosh system operates with a small colour video camera housed to a conventional laryngoscope handle. A Macintosh blade is attached to the handle and a combined image/light bundle is threaded into a small metal guide tube which is recessed 40 mm from the blade tip. The light cable is attached to the light source and the camera cable to a control unit. The system is installed on a small cart so that the device is easily moved (figure 9).[42,43]

Figure 9 : C-MAC laryngoscope with monitor

The modified version of video Macintosh system is the Storz direct-coupled interface, Berci-Kaplan or V-MAC video laryngoscope. It consists of a laryngoscope, a light source, a bulk 8-inch monitor and a camera control unit.[44] A fibre light cord and a camera cable emerge from the top of the handle, which connect to the light source and the camera control unit.

The C-MAC video laryngoscope is a modification of the V-MAC device. It has an electronic module utilizing semiconductor chip technology and consists of only 3 parts, a laryngoscope, electronic module and separate 7-inch (18 cm) monitor. The monitor is connected to the electronic module that plugs into a laryngoscope. The weight of monitor with battery is around 1 kg. The key innovation of C-MAC device is to have a completely portable setup that features an improved image quality. The main differences between C-MAC and V-MAC devices are that the C-MAC video laryngoscope includes improved field of view, optics, interface for adjusting video quality and easy recording of imaging. The manufacturer also provides the C-MAC device with a 2-inch pocket monitor attached to the handle. This portable device is specially designed for pre-hospital and in-hospital first aid. The device has lithium-ion battery technology with at least 2 hours capacity.[42,43,45]

The C-MAC device can create continuous video recording or static pictures onto a removable digital card.[43]The electronic module has 2 buttons for photo and video capture. In addition the images can also be displayed on other devices or recorded by a standard video output port.

Three C-MAC reusable metal Macintosh blades (sizes 2–4) is available for adult patients.[45] The reusable blades have slanted edges to avoid tissue damage, a closed design without gaps for hygienic traps.[46] The proximal flange of C-MAC reusable blade is about 2.5 cm high at its base versus Glidescope video laryngoscope, which is 1.5 cm and McGrath video laryngoscope, which is 1.25 cm. This extra height provides more space for manipulating the tracheal tube with the C-MAC device. Also the proximal shape and size of the C-MAC reusable blade make tube passage to the glottis more straightforward compared with other video laryngoscope. Compared with others, a disadvantage of the larger proximal flange of C-MAC video-laryngoscope may be the need of a greater mouth opening.[47]

The tip of the C-MAC blade contains a 320×240 pixel complementary metal oxide semiconductor video chip and fog-resistant lens. The camera with the light source is located close to the tip of the blade and has an 80° view angle. It allows a wide angle of viewing at the blade tip and a high-resolution colour image on the monitor.[43]Since the view obtained by C-MAC device includes the blade tip, it allows for guiding the blade tip into the epiglottic vallecula under vision.[46] The reusable blades should be sterilized for each patient.

The recent handles are truncated and thinned with a light weight and multifunction C-MAC system interface. A disposable C-MAC device is available, with 2 adult blades (sizes 3 and 4).[48]The disposable device contains a disposable Macintosh plastic blade, an image tube with a camera and a monitor. The disposable plastic blade differs from the reusable metal blade. Both the flange and the web sections of the disposable plastic blades are significantly thickened to avoid breakage during use. This additional bulk can reduce the pharyngeal view and limit space for manipulating the tracheal tube.[49]

The larynx can be visualized under direct vision or on a monitor as the C-MAC video laryngoscope uses a Macintosh blade. Hence, this device is unique among video laryngoscopes as it allows for use as a video laryngoscope and simultaneously functioning as a direct laryngoscope.

Intubation procedure with C-MAC video laryngoscope

When used as direct laryngoscopy, the intubation procedure with C-MAC video laryngoscope is same as conventional Macintosh laryngoscope. The laryngoscope is inserted into the right side of the mouth, the tongue is moved to the left by the blade flange, the blade tip is advanced into the valecula, and then the device is lifted to obtain the laryngeal view.[47]If a poor laryngeal view is obtained, optimization maneuver like external laryngeal pressure and blade position adjustment can be used. According to intubator's preference for direct laryngoscopy tracheal tube is inserted and when required to use a stylet and the bend angles of the styletted tube.[43]

A midline insertion technique without tongue sweeping can achieve an unobstructed view of the larynx.[42]Astylet is not always required but it can be very helpful for bringing the tube tip up to the glottis, especially in difficult airway.

VanZundert A et al.,[50] compared Macintosh laryngoscope blade for different video laryngoscopy in patients with normal airway. The study shows that a stylet is required in 10%, 76% and 60% of cases with C-MAC, McGrath and Glidescope video laryngoscopes respectively.

Gupta N et al., evaluated C-MAC video-laryngoscope, with or without use of stylet for endotracheal intubation in patients with cervical spine immobilization. They concluded that in patients undergoing elective cervical spine surgery with head and neck stabilized by manual in-line stabilization, the use of stylet significantly reduces the intubation difficulty scale score, intubation time and the use of gum-elastic bougie with C-MAC video laryngoscope.[51]

Performance of C-MAC video laryngoscope versus direct laryngoscopy

Normal airways

The video laryngoscope was originally designed to manage difficult intubation with direct laryngoscopy.[45] If video laryngoscopy is used for all patients, experience and skill would increase, the number of intubation attempts and complications of multiple attempts would decrease and patient care would improve.[52,53] Combining the benefits of direct and video laryngoscopy in one device also make C-MAC suitable to serve as a standard intubation tool for routine airway management.[42]

3 observational trials are available comparing direct and indirect (video monitor) laryngeal views using a V-MAC or C-MAC video laryngoscope in adult patients with a normal airway. These studies showed that compared with direct visualization, video-assisted laryngoscopy provided an improved laryngeal view.[50,54,55]

Cavus E et al.,[46] did a randomized, controlled study and compared the C-MAC video laryngoscope with direct laryngoscopy in 150 patients during routine induction of anaesthesia. They found that C-MAC video laryngoscope provided better laryngeal views than direct laryngoscopy and the intubation time was comparable between direct and video laryngoscopy.

Sarkılar G et al.,[56] compared hemodynamic responses to endotracheal intubation performed with video and direct laryngoscopy in patients scheduled for major cardiac surgery. They compared Macintosh laryngoscope and C-MAC video laryngoscope and demonstrated that C-MAC device offered a better laryngeal view and a longer intubation time, but the number of intubation attempts, the use of external laryngeal pressure or stylet and hemodynamic response to orotracheal intubation were comparable between 2 devices.

Purugganan RV et al.,[57] did a retrospective analysis comparing video laryngoscopy versus direct laryngoscopy for double-lumen endotracheal tube intubation. They compared using Macintosh laryngoscope and C-MAC video laryngoscope in patients without predictors of difficult intubation and showed that C-MAC device provided an improved laryngeal view and increased the ease of procedure.

Difficult airways

Video laryngoscopy has rapidly become a first-line strategy for potential and/or encountered difficult intubation.[45] Most of the current algorithms for difficult airway management recommend video laryngoscopy as a rescue strategy for difficult or failed intubation with direct laryngoscopy.[58 - 60]

Two randomized control study compared the effectiveness of V-MAC and C-MAC video laryngoscopes versus direct laryngoscope for orotracheal intubation in patients with predicted difficult airways. They demonstrate that video laryngoscopy provides improved laryngeal views, more successful intubations on the first attempt, shorter laryngoscopy and intubation times and decreased need of adjuncts.[61,62]

The patients with cervical spine injury require the use of semi-rigid cervical collar or manual in-line stabilization to prevent neck movements and it may lead to poor laryngeal view on direct laryngoscopy and difficulty with intubation.[63]

Byhahn C et al.,[64] compared tracheal intubation using C-MAC video laryngoscope and direct laryngoscopy for patients with a simulated difficult airway and concluded that C-MAC video laryngoscope offeres an improved laryngeal view, but no conclusive benefits with regard to intubation time, number of intubation attempts, intubation success and incidence of complications.

Piepho T et al.,[65] studied the performance of the C-MAC video laryngoscope in 51 patients after a limited glottic view using Macintosh laryngoscopy. In patients with an unexpected Cormack and Lehane grade 3 or 4 view with Macintosh laryngoscope, the laryngeal views were improved and successful intubation was achieved with C-MAC video laryngoscope in 49 patients (94%).

Performance of C-MAC video laryngoscope versus other devices

Lee AH et al.,[66] did a randomised single blinded study and compared the Bonfils intubation fiberscope and C-MAC video laryngoscope in patients with normal airways requiring orotracheal intubation and showed.44 ASA I patients aged between 18 and 60 years scheduled for elective surgery requiring endotracheal intubation were included. Hemodynamic changes, laryngeal view, duration of intubation and post intubation complications were recorded. They concluded that intubation success rate at the first attempt was not different between the 2 devices, but intubation with C-MAC device required a shorter time, and resulted in significantly attenuated hemodynamic responses.

Ng I et al.,[67] compared the McGrath video laryngoscope with the C-MAC video laryngoscope in intubating adult patients with potential difficult airways.130 patients with the Mallampati grade of ≥3 requiring orotracheal intubation, were randomized into two groups. Time to intubation, the laryngoscopic view, the number of intubation attempts, the proportion of intubation success, the ease of intubation, the haemodynamic responses, and the incidence of any complications were recorded. They concluded that the C-MAC device allowed a quicker intubation time, a fewer number of intubation attempts and a greater ease of intubation compared with the McGrath device.

Brück S et al.,[68] compared C-MAC and GlideScope video laryngoscopes in patients with cervical spine disorders and immobilization. 56 patients of ASA 1- 3 scheduled for elective cervical spine surgery were included. Laryngeal view, time for successful intubation, number of intubation attempts were recorded. They concluded that Glidescope and C-MAC video laryngoscopes provide comparable laryngeal views, but the C-MAC device has a higher first-attempt failure rate and requires significantly more intubation attempts and optimizing maneuvers.

Yumul R et al.,[69] did a randomised single blinded study and compared the C-MAC video laryngoscope to a flexible fibreoptic scope for intubation with cervical spine immobilization. 140 adult patients of ASA 1- 3 undergoing elective spinal surgery were included. Cormack-Lehane grade, percentage of glottic opening scoring, the time required for successful intubation, number of intubation attempts, the need for adjuvant airway devices, hemodynamic changes, adverse events, and any airway-related trauma were recorded. They concluded that the C-MAC device significantly decreased the times required to obtain laryngeal view and successful intubation.

METHODOLOGY

A study titled "Comparison of C-MAC D blade and McCoy blade for laryngoscopy in patients with simulated cervical spine injury" was done in PSG Institute of Medical Sciences & Research, Coimbatore during the period of 1.8.16 to 31.5.17. This study was done after getting ethical committee clearance and informed written consent from all the patients participated in this study. It was a prospective and randomised study

Based on the previous studies, the sample size for our study was determined as below.

Mean intubation time is taken as primary outcome from previous study

$Z\alpha$ (5%) = 1.96 $Z\beta$ (90%) = 1.282

$$\text{Sample size (N)} = \frac{2(Z\alpha+Z\beta)^2 \times SD^2}{(mc - mt)^2}$$

$$= \frac{2\times10.51\times4.47\times4.47}{(15.54 - 18.90)^2}$$

N = 37

100 patients of age group between 18 – 65 years belonging to ASA 1 & 2 posted for elective surgeries under general anaesthesia with endotracheal intubation participated in this study.

INCLUSION CRITERIA

- Patient's acceptance

- Patients aged between 18 – 65 years
- ASA 1 and ASA 2 patients
- Patients undergoing elective surgery under GA with endotracheal intubation

EXCLUSION CRITERIA

- Anticipated difficult airway
- Risk of aspiration
- Hypertensive patients
- Patients on β-blockers, Clonidine.
- Duration of intubation exceeding 120 sec
- Change in laryngoscopy during intubation
- Emergency surgeries

Preoperative evaluation

Routine pre-operative assessment was done on the previous day of surgery. Patients were kept nil per oral from 10 pm the day prior to surgery. Informed written consent was obtained.

Premedication

All the patients were pre-medicated with tablet Ranitidine 150mg orally at night the day prior to surgery and at 6 am on the morning of surgery.

Randomisation

Patients were randomly allocated to one of the two groups by computer generated random table number.

Group C: Endotracheal intubation done using C-MAC D blade video laryngoscope

Group M: Endotracheal intubation done using McCoy blade laryngoscope

Parameters recorded

- **Duration of laryngoscopy -** defined as the time taken from insertion of the blade between the teeth until the anaesthetist obtained the best possible view of the vocal cords
- **Duration of intubation -** defined as the time taken from when the anaesthetist indicate the best view at laryngoscopy until the tracheal tube was placed through the vocal cords, as evidenced by visual confirmation by the anaesthetist.
- **Total duration of intubation -** It is the sum of the duration of laryngoscopy and the duration of intubation
- **Ease of intubation -** Intubation Difficulty Scale (IDS score). It includes the following:

1. Number of intubation attempts
2. Number of operators
3. Number of alternative technique used

4. Glottis exposure – CL grading
5. Lifting force required
6. Necessity for laryngeal pressure
7. Vocal cord mobility

- **Haemodynamic responses -** Heart rate, systolic BP, diastolic BP, mean arterial BP after 1st min, 3rd min and 5th min of intubation.

Anaesthesia

- The patients were shifted to operative room after checking for consent and nil per oral status.
- The patients were connected to ASA standard monitors – ECG, Non invasive blood pressure (NIBP) and pulse oximeter (SpO_2).
- Intravenous line started /patency checked.
- Baseline vital parameters - heart rate, blood pressure and SpO_2were noted.
- Patients were pre – oxygenated with 100% Oxygen for 3 minutes.
- Induced with intravenous Inj. Fentanyl 2mcg/kg, Inj. Lignocaine (preservative free) 20mg and Inj. Propofol 2mg/kg.
- After ensuring adequate mask ventilation,patients were paralysed with intravenous Inj. Succinylcholine 1.5mg/kg.
- Pre intubation heart rate, systolic BP, diastolic BP, mean arterial BP were recorded.

- After 1 minute MILS was achieved by an anaesthetist, standing to the side of the patient and using fingers and palms of both hands to stabilize the patient's occiput and mastoid process and gently counteract the forces created by the intubator.
- Laryngoscopy was done by another anaesthetist who is experienced with both the techniques. Laryngoscopy was done with C-MAC D blade laryngoscope in group C and McCoy blade laryngoscope in group M.
- After visualization of the cords, patients were intubated with appropriate sized endotracheal tube with stylet bent to hockey stick shape.
- During intubation the duration of laryngoscopy, the duration of intubation and the ease of intubation (IDS scoring) were recorded.
- After checking for position and securing endotracheal tube, anaesthesia maintained with Oxygen & Nitrous oxide 40:60 with 6 litres fresh gas flow, Sevoflurane 2% and Inj. Vecuronium (loading dose 0.1mg/kg).
- Heart rate, systolic BP, diastolic BP, mean arterial BP were recorded after 1st min, 3rd min and 5th min of intubation.

.

STATISTICAL ANALYSIS

Data were statistically analysed with the SPSS version 17.0 software. Baseline characteristics were presented as mean ± S.D. Two-sided unpaired t-test and chi-square test was applied to analyze the data and p value less than 0.05 were considered as significant. A repeated measure of ANOVA was applied for the two groups to know the with-in subject variability in Ease of intubation and $P < 0.05$ was considered to be significant.

OBSERVATION AND RESULTS

Table 1: Age distribution between two groups

Age in years	Group C		Group M	
	No of patients	Percentage	No of patients	Percentage
20 – 29	11	22	12	24
30 – 39	16	32	14	28
40 – 49	11	22	10	20
>=50	12	24	14	28
Total	50	100	50	100
Mean (in years) ± S.D	40 ± 11.9		40.6 ± 12.601	
p- value	0.808			

The mean age distribution is 40 ± 11.9 and 40.6 ± 12.6 in years for group C and group M respectively. Age distribution was similar in both the groups.

Graph 1: Age distribution between two groups

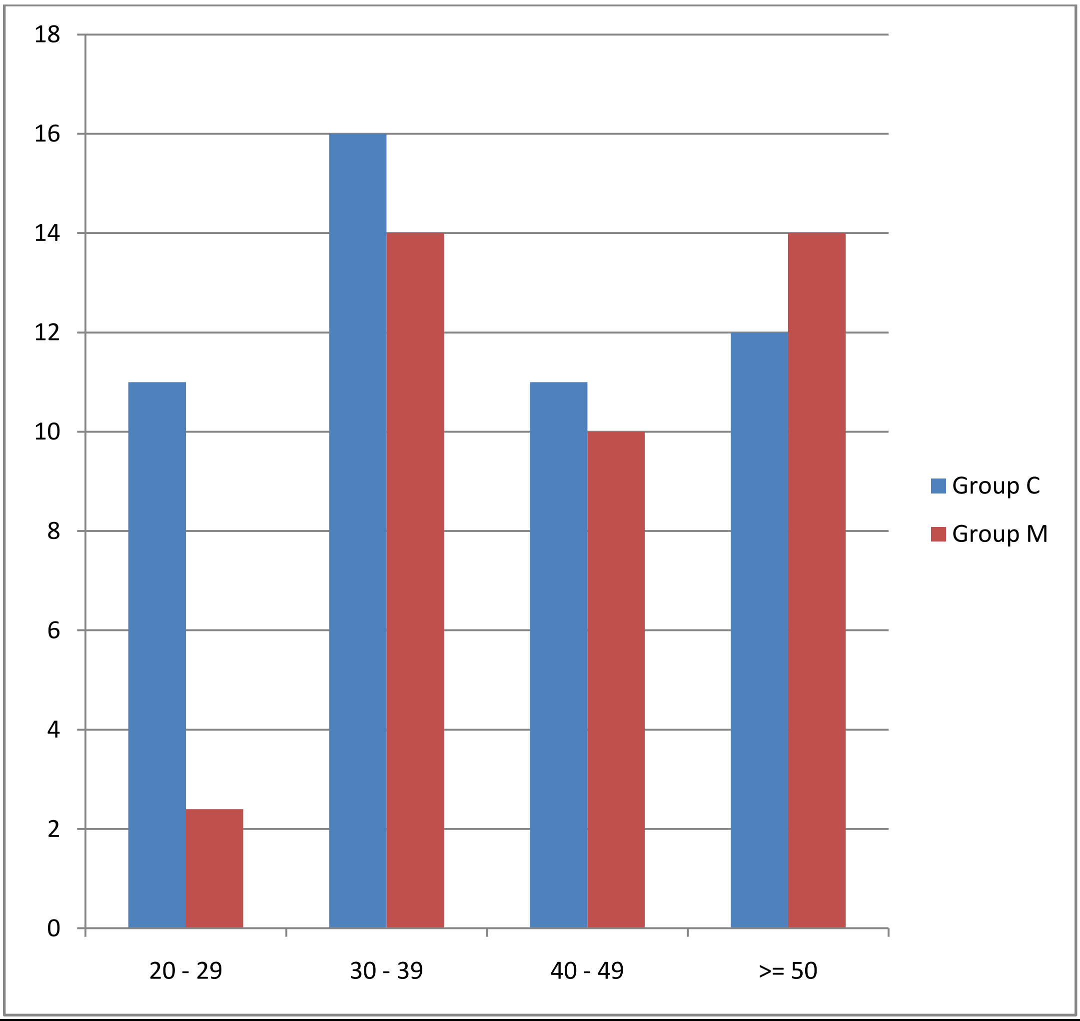


Table 2: Sex distribution between two groups

Sex	Group C		Group M	
	No of patients	**Percentage**	**No of patients**	**Percentage**
Female	24	48	25	50
Male	26	52	25	50
Total	50	100	50	100
p- value	0.843			

Sex distribution between the two groups were comparable.

Graph 2: Sex distribution between two groups

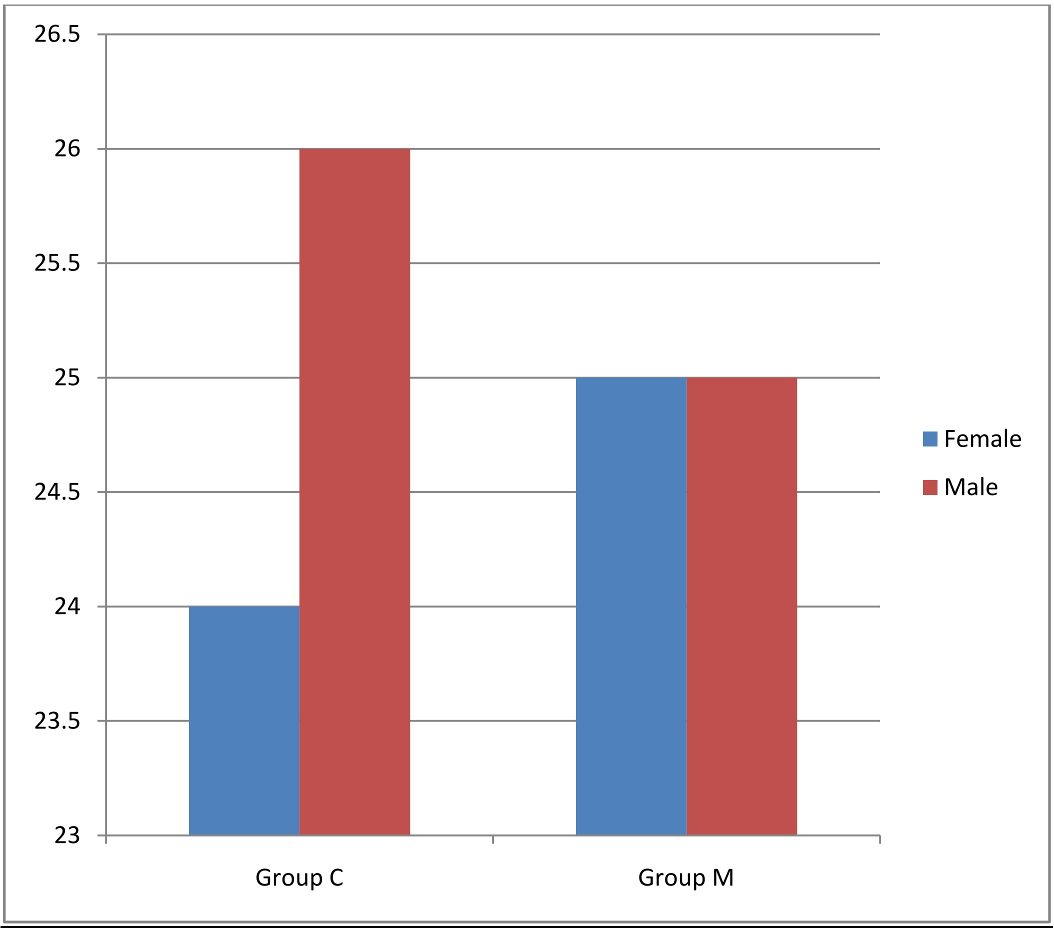


Table3: B.M.I distribution between two groups

B.M.I	Group C		Group M	
	No of patients	**Percentage**	**No of patients**	**Percentage**
>= 30 - Obese	0	0	1	2
25 – 29.99 - Over Weight	26	52	28	56
18.50 – 24.9 - Normal	21	42	19	38
< 18.5 – Under Weight	03	6	02	4
Total	50	100	50	100
Mean (in years) ± S.D	24.36 ± 3.26		24.9 ± 3.12	
p- value	0.337			

Mean BMI for Group C is 24.36 ± 3.26 and Group M is 24.9 ± 3.12. BMI in both the groups were comparable.

Graph 3: B.M.I distribution between two groups

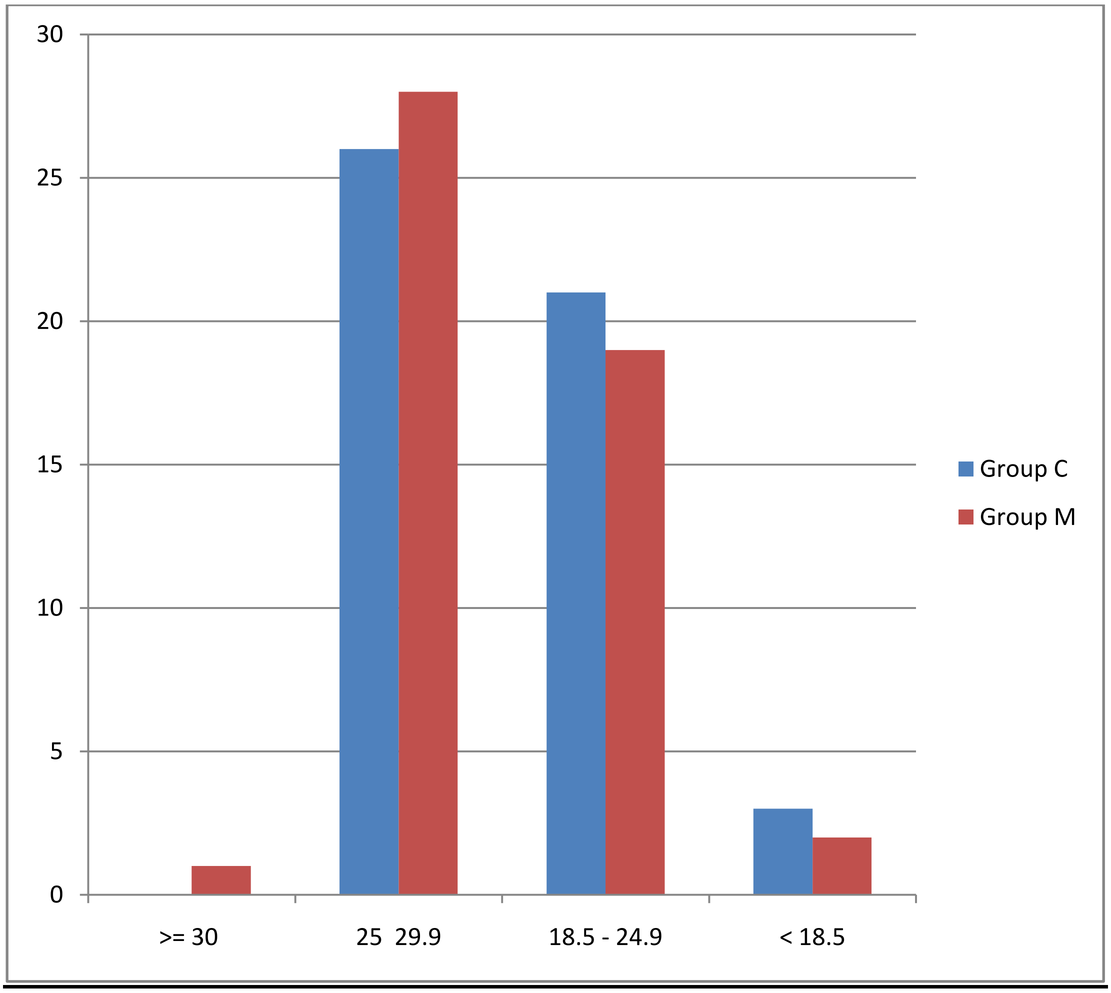


Table 4: Duration of Laryngoscopy - Comparison between Group C and Group M

Parameter	Group C (Mean ± SD) N=50	Group M (Mean ± SD) N=50
Duration of Laryngoscopy (Seconds)	12.15 ± 3.11	14.47 ± 3.55
Mean Difference	-02.32	
p- value	0.0001	

The mean duration of Laryngoscopy was 12.15 ± 3.11 and 14.47 ± 3.55 seconds in group C and group M respectively. The duration of laryngoscopy was shorter with group C and it was statistically significant as the p value is 0.0001.

Chart 4: Mean Duration of Laryngoscopy for Group C and Group M

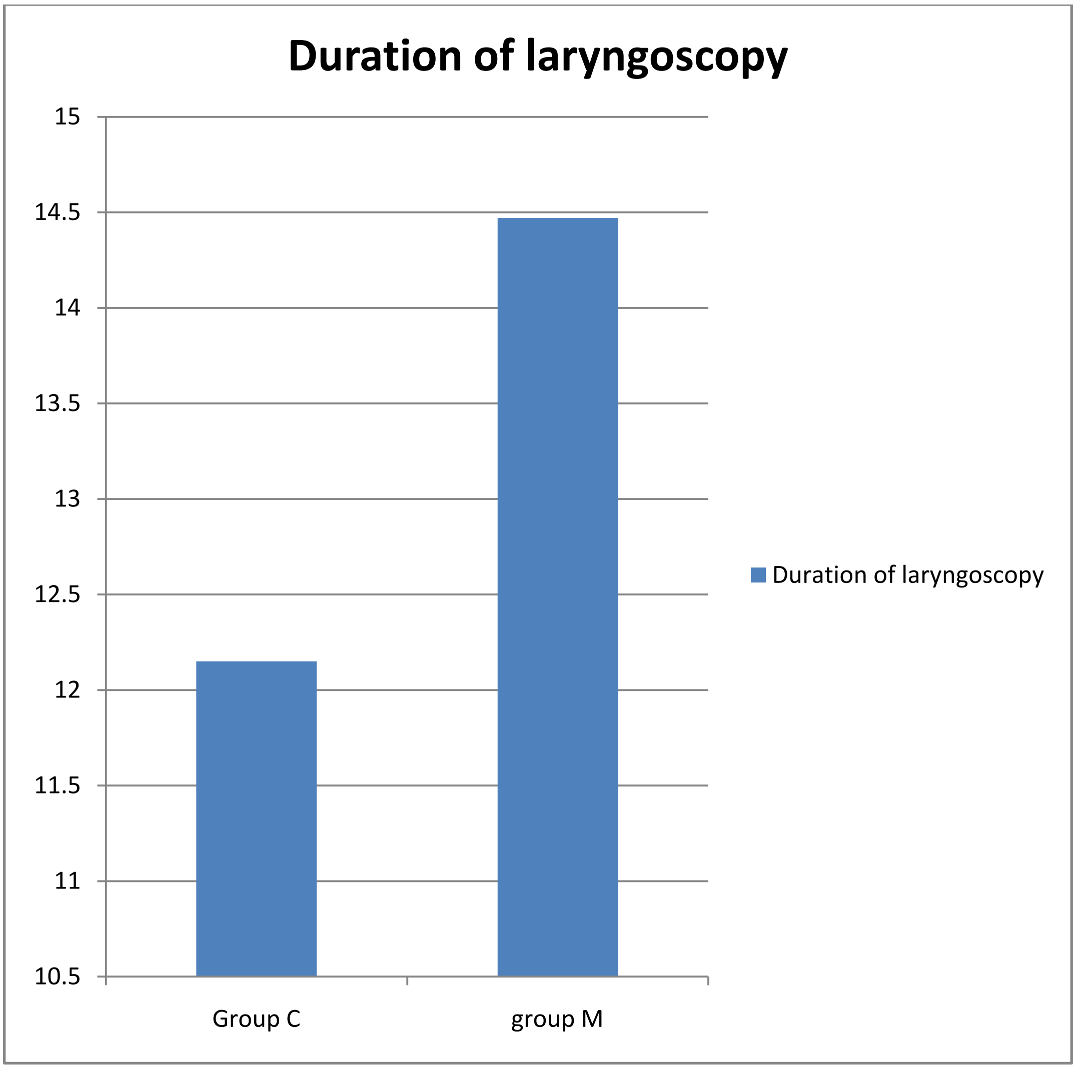


Table 5: Duration of Intubation for Group C and Group M

Parameter	Group C (Mean ± SD) N=50	Group M (Mean ± SD) N=50
Duration of Intubation (Seconds)	13.85 ± 3.51	12.07 ± 3.23
Mean Difference	1.78	
p- value	0.01	

The mean duration of Intubation was 13.85 ± 3.51and 12.07 ± 3.23 in group C and group M respectively. Group C patients had prolonged duration of intubation and it was statistically significant as the p value is 0.01.

Chart 5: Mean Duration of Intubation for Group C and Group M

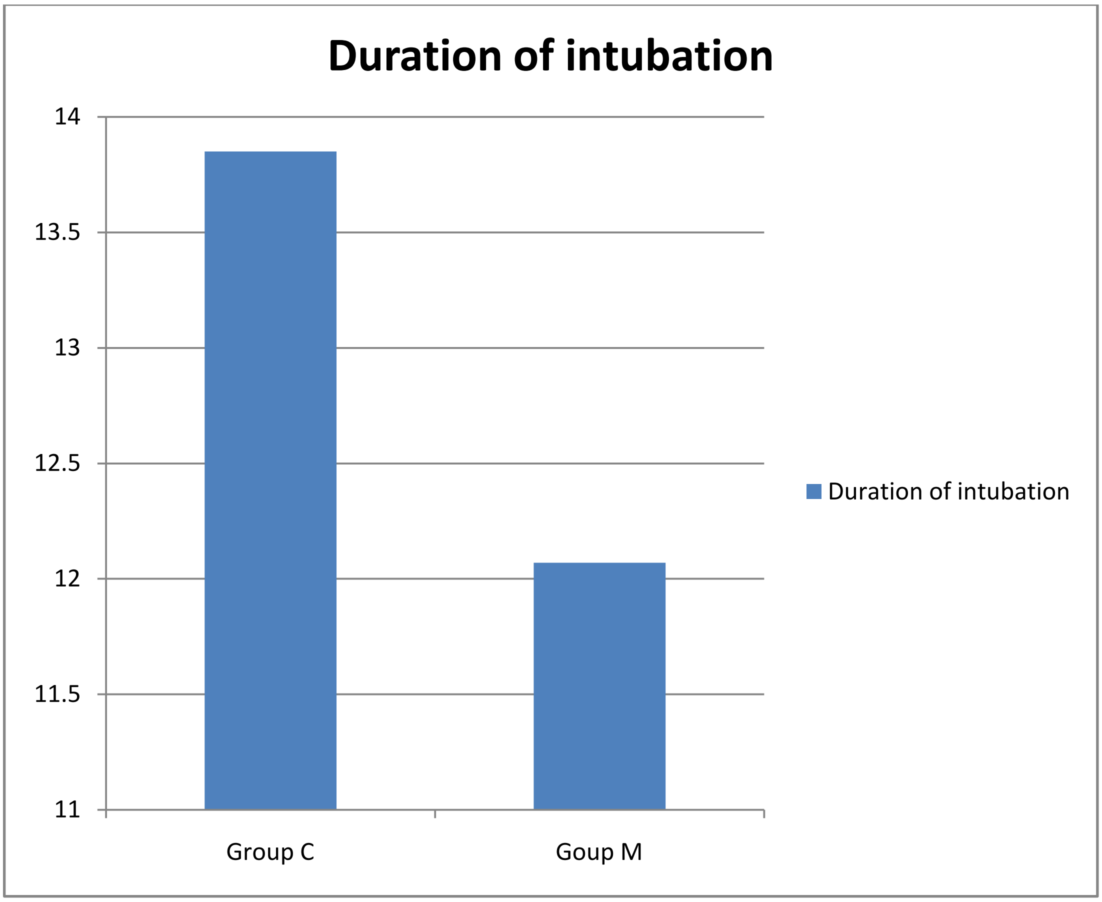


Table 6: Total duration of Intubation for Group C and Group M

Parameters	Group C (Mean ± SD) N=50	Group M (Mean ± SD) N=50
Total duration of Intubation (Seconds)	26 ± 5.65	26.55 ± 5.99
Mean Difference	-0.55	
p- value	0.639	

The mean total duration of Intubation was 26 ± 5.65 and 26.55 ± 5.99 seconds in group C and group M respectively. The mean total duration of intubation was comparable between the groups.

Chart 6: Mean Total Duration of Intubation for Group C and Group M

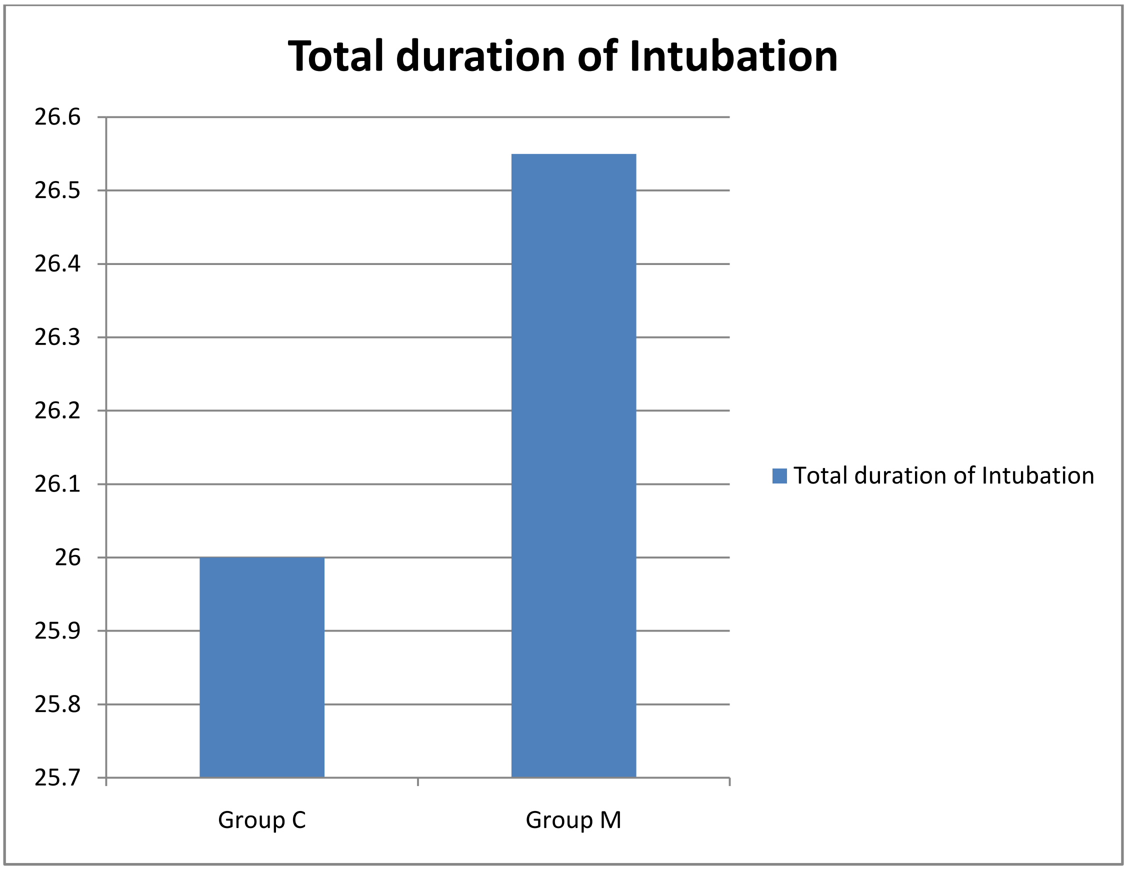


Table 7: Intubation Difficulty Scale (IDS) score for Group C and Group M

IDS score	Group C n (%)	Group M n (%)	P value	Results
N_1 (Attempts)			0.143	Not significant
1st - score 0	48(96)	44(88)		
2nd - score 1	2(4)	6(12)		
N_2 (operators)			0.080	Not significant
1 – score 0	50(100)	47(94)		
2 – score 1	0(0)	3(6)		
N_3 (alternative techniques)				
Not used – score 0	50(100)	50(100)		
N_4 (CL grade)			0.001	Significant
1 – score 0	47(94)	34(68)		
2 - score 1	3(6)	16(32)		
N_5(lifting force)			0.002	Significant
normal – score 0	45(90)	32(64)		
Increased– score 1	5(10)	18(36)		
N_6(laryngeal pressure)			0.150	Not significant
Not applied – score 0	36(72)	42(84)		
Applied – score 1	14(28)	8(16)		
N_7 (vocal cord position)				
Abducted – score 0	50(100)	50(100)		

Table 7 shows the individual parameters in the Intubation Difficulty Scale(IDS) score. Number of attempts and number of operators in both the groups were comparable and not statistically significant. Though 28% of patients in Group C required external laryngeal pressure for intubation when compared to group M (16%) it was not statistically significant.

47 patients in group C (94%) and 34 patients in group M (68%) had CL grade 1.3 patients in group C (6%) and 16 patients in group M (32%) had CL grade 2. Group C had better CL grading and it was statistically significant.

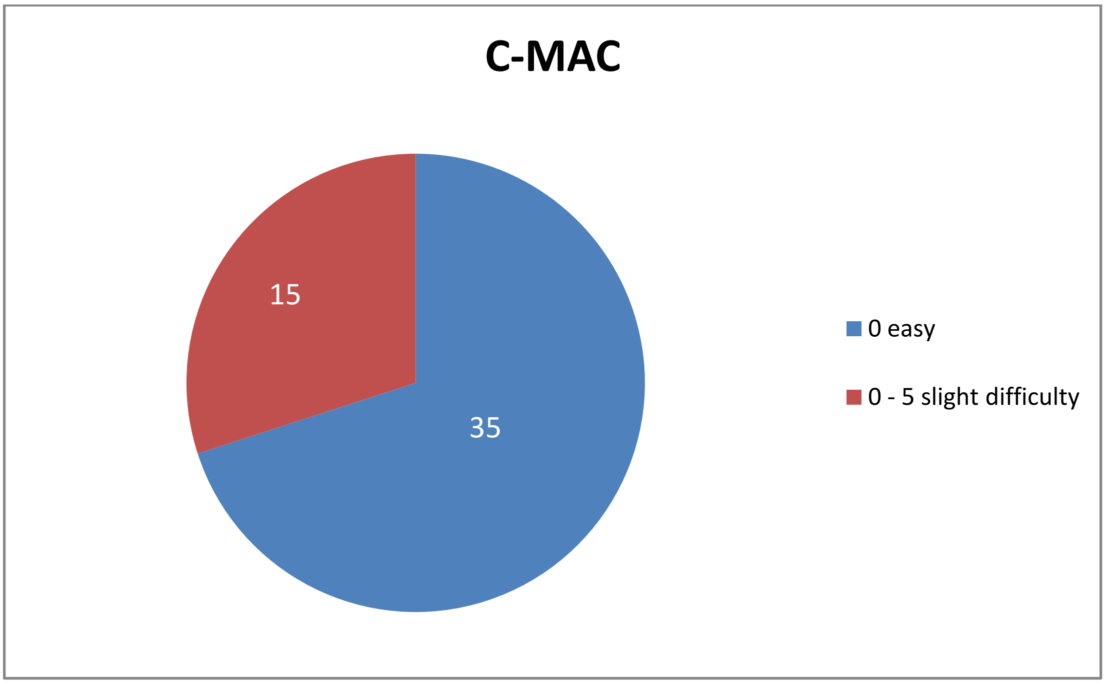
18 patients of Group M (36%) required extra lifting force when compared to 5 patients of group C (10%) and it was statistically significant.

Table 8: Ease of Intubation (IDS score) for Group C and Group M

S. No	IDS	No of patients (%)		P value
		Group C	Group M	
1	0 (easy)	35 (70)	27 (54)	0.009
2	0-5 (Slight difficulty)	15 (30)	22 (44)	
3	> 5 (moderate to major difficulty)	0	1 (2)	

Laryngoscopy and intubation was easy in majority of patients (70%) in C-MAC group. In McCoy group laryngoscopy was easy in 54% of patient, slightly difficult in 44% of patients and moderate to major difficulty in 2% of patients. The IDS score was better in C-MAC group and was statistically significant.

Chart 7: Ease of intubation (IDS score)



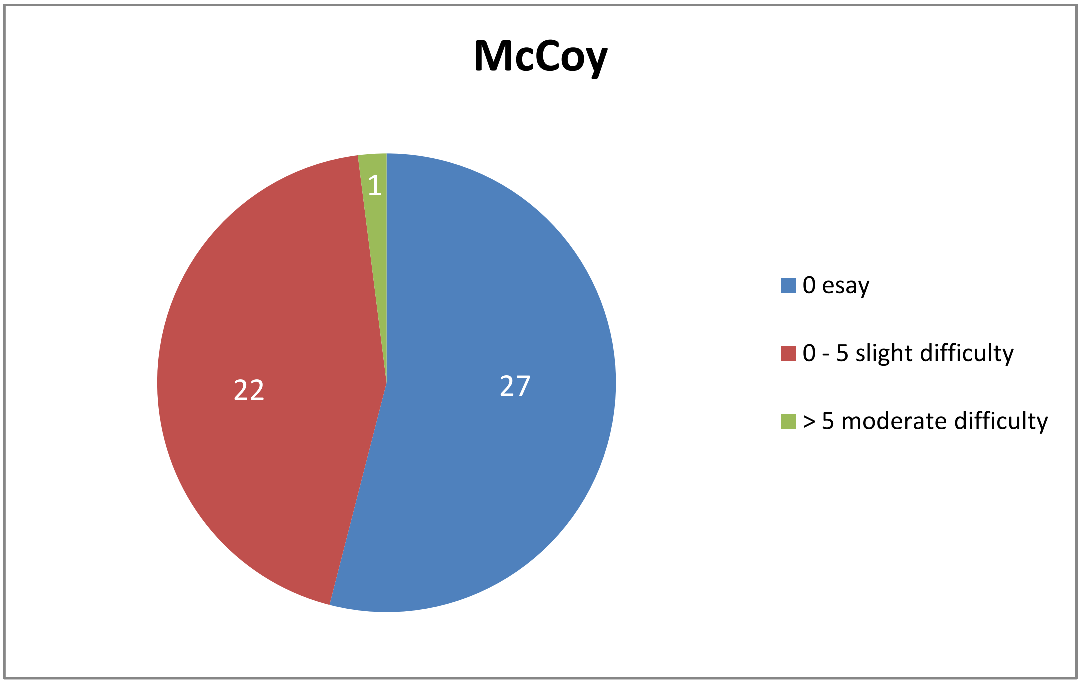


Table 9: Intergroup comparison of mean Heart rate between Group C & Group M

Sl .No	Time	Group C N=50	Group M N=50	p value
1.	Baseline	87.5 ± 14.5	84.7 ± 12.1	0.30
2.	Before Intubation	87.9 ± 11.6	87.7 ± 10.6	0.93
3.	1st min	99.9 ± 15.3	102.3 ± 16.6	0.45
4.	3rd min	88.2 ± 13.0	89.9 ± 13.4	0.50
5.	5th min	80.2 ± 10.9	79.9 ± 11.4	0.90

The mean heart rate at baseline, before intubation and after intubation was comparable in both the groups.

Graph 9: Heart rate between Group C and Group M

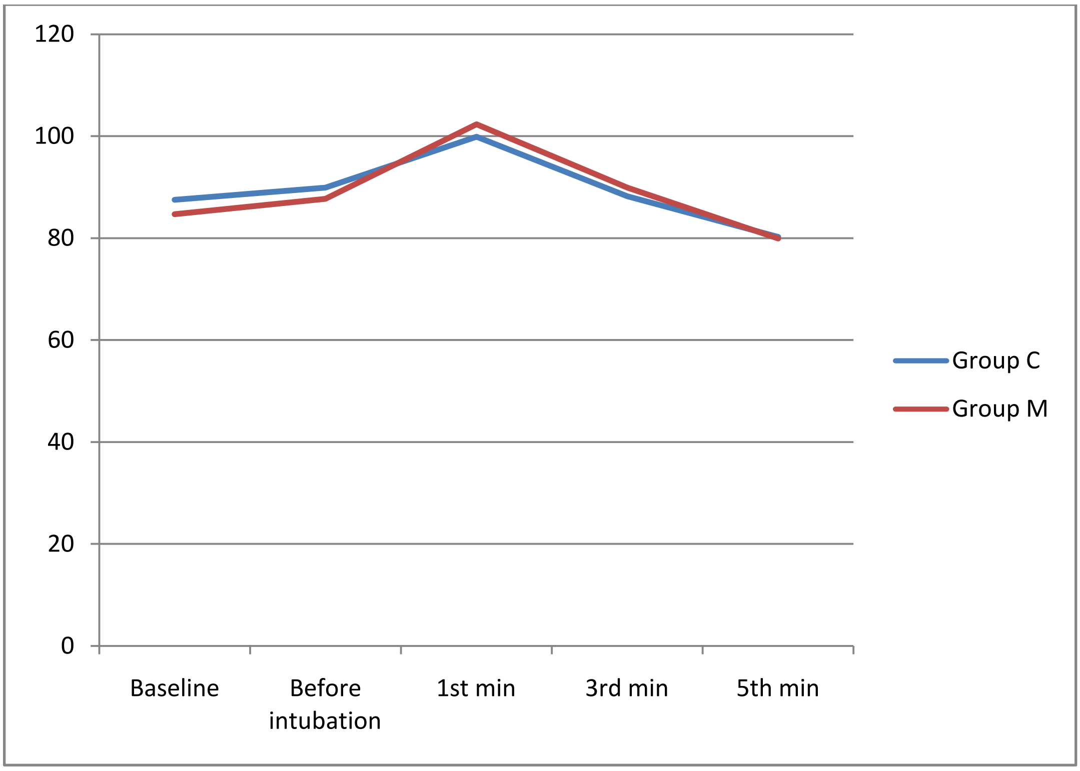


Table 10: Intergroup comparison of Mean Systolic BP between Group C & Group M

Sl.No	Time	Group C N=50	Group M N=50	p value
1.	Baseline	126.5 ±13.8	122.1 ±10.8	0.078
2.	Before Intubation	106.6 ± 13.2	104.3 ± 8.8	0.309
3.	1st min	124.6 ± 15.8	128.8 ± 15.3	0.179
4.	3rd min	107.8 ± 11.7	110.3 ± 14.2	0.340
5.	5th min	100.16 ± 11.2	102.6 ± 14.2	0.335

The mean systolic blood pressure at baseline, before intubation and after intubation was comparable in both the groups.

Graph 10: Mean Systolic BP between Group C and Group M

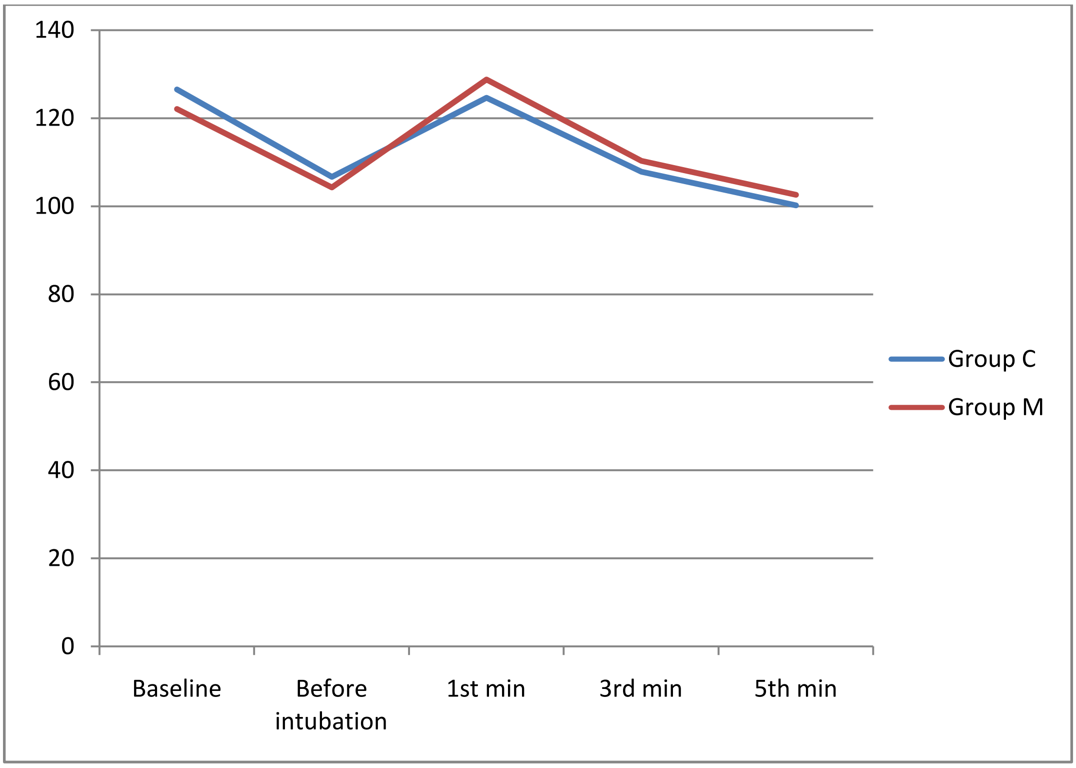


Table 11: Intergroup comparison of mean Diastolic BP between Group C & Group M

Sl.No	Time	Group C N=50	Group M N=50	p value
1.	Baseline	77.12 ± 7.2	75.3 ± 8.4	0.256
2.	Before Intubation	65.7 ± 8.1	75.3 ± 8.4	0.457
3.	1st min	78.4 ± 12.8	82.7 ± 12.9	0.098
4.	3rd min	68.1 ± 9.2	70.8 ± 12.6	0.210
5.	5th min	63.2 ± 8.1	65.5 ± 10.5	0.210

The mean diastolic blood pressure at baseline, before intubation and after intubation was comparable in both the groups.

Graph 11: Mean Diastolic BP between Group C and Group M

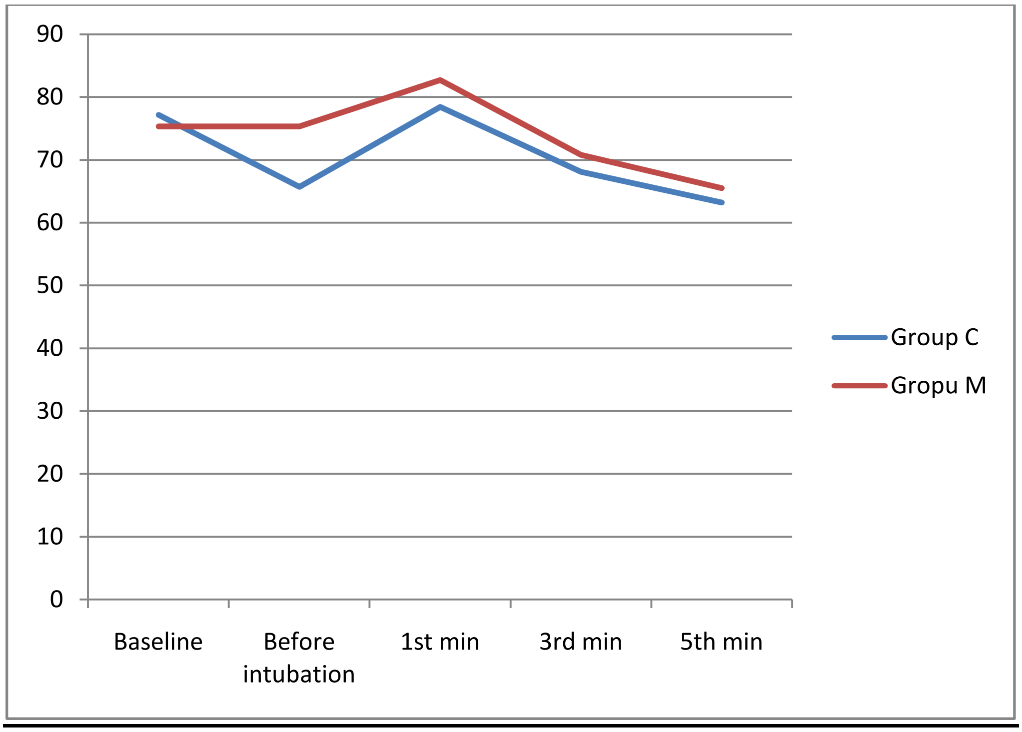
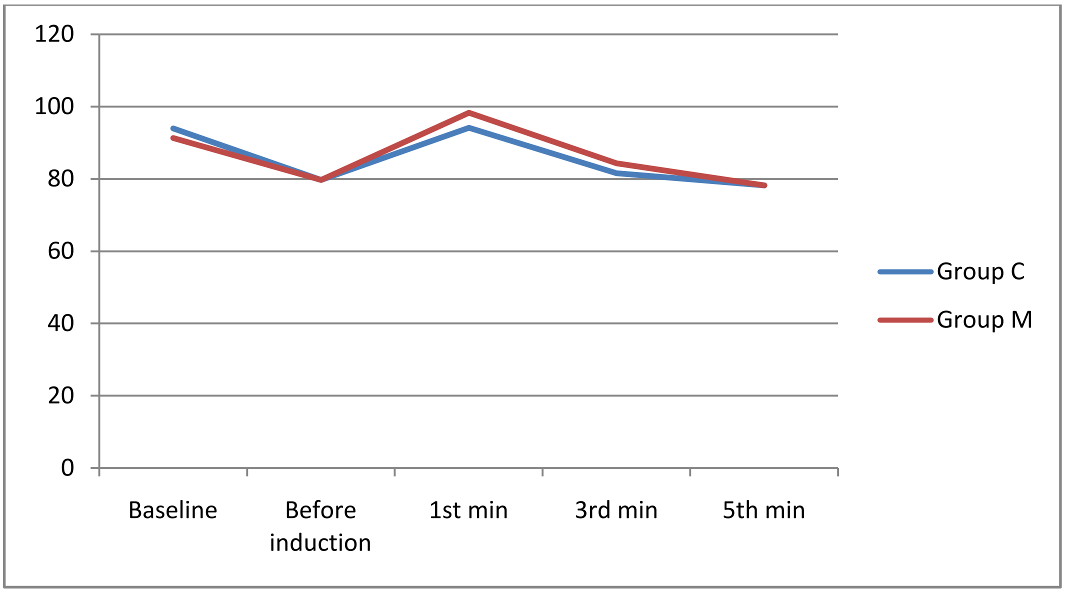


Table 12: Intergroup comparison of mean MAP between Group C & Group M

Sl.No	Time	Group C N=50	Group M N=50	p value
1.	Baseline	93.9 ± 8.3	91.3 ± 8.6	0.112
2.	Before Intubation	79.7 ± 8.6	79.7 ± 6.2	0.963
3.	1st min	94.1 ± 13.3	98.3 ± 13.5	0.112
4.	3rd min	81.6 ± 9.2	84.3 ± 12.9	0.222
5.	5th min	75.8 ± 8.3	78.2 ± 11.4	0.231

The mean MAP at baseline, before intubation and after intubation was comparable in both the groups.

Graph 12: Mean MAP for Group C and Group M



DISCUSSION

Approximately 2-5% of trauma patients will have cervical spine injury. Patient with cervical spine injury may require airway management for airway protection, to prevent hypoxia and hypoventilation.[1]

Trauma life support guidelines recommend the use of Manual in line stabilization (MILS) or a rigidcollar to stabilize the spine in suspected cervical spine injury patients. The presence of collar can worsen the laryngoscopic view and makes the intubation difficult with conventional laryngoscope.[4]To overcome this various devices and options like direct laryngoscope with the aid of gum elastic bougie, fibre-optic bronchoscope, airway scope, McCoy laryngoscope, Intubating laryngeal mask airway, C-Trach and Bullard laryngoscope has been recommended by many authors.[6]

The McCoy levering laryngoscope is a modification of the standard Macintosh blade.[6]It has a hinged tip. The hinged tip aids in improving the Cormac and Lehane laryngoscopic view by 1 grade in comparison to Macintosh blade in patient with cervical spine injury.[4]

The latest generation C-MAC video laryngoscope has several distinct improvements.[8]It has external light source and small digital camera attached to a video display monitor.[9]It provides optimum view of the glottis by direct and indirect view.[9] A special D blade with greater curvature is designed to facilitate intubation in difficult airway patients.[8]

Both the devices have been independently compared with Macintosh laryngoscope in simulated difficult airway. Only a few studies are available comparing C-MAC and McCoy laryngoscope.[4]

In our study we have compared the efficacy of C-MAC D blade and McCoy blade laryngoscope in simulated cervical spine injury by comparing duration of laryngoscopy, duration of intubation, total duration of intubation, ease of intubation (IDS score) and haemodynamic response.

In our study the demographic variables like age, gender and BMI were comparable between both the groups.

The primary outcome in our study was to compare the duration of laryngoscopy, duration of intubation, total duration of intubation, ease of intubation – IDS scoring.

The mean duration of laryngoscopy when compared between two groups, it was shorter in C-MAC group (12.5 seconds) than McCoy group (14.47 seconds) and it was statistically significant. The mean duration of intubation when compared between two groups, it was longer in C-MAC group (13.85 seconds) than McCoy group (12.07 seconds) and it was statistically significant. The mean total duration of intubation was comparable between C-MAC group (26 sec) and McCoy group (26.55 sec) and statistically not significant.

Even though the time taken for laryngoscopy was shorter in C-MAC group, the time taken for successful intubation was prolonged. So the mean total duration of intubation was comparable and statistically insignificant between the groups.Our results of duration of laryngoscopy, duration of intubation and total duration of intubation were similar with the study done by **Jain et al**.,[4] comparing McCoy and C-MAC video laryngoscope in simulated cervical spine injury.

The ease of intubation was observed in our study using IDS scoring.

In our study 48 patients in C-MAC group and 44 patients in McCoy group were intubated in the first attempt and were comparable. This results were similar to study by **Jain et al**.,[10] who compared the conventional C-MAC and the C-MAC D blade with direct laryngoscopes in simulated cervical spine injury (manikin study) and observed that out of 33 patients, 30 patients were intubated in first attempt using C-MAC D blade and 24 patients using McCoy and was not statistically significant.

50 patients in group C and 47 patients in group M required single operator and all the patients were intubated using single technique in our study.

In C-MAC group 47 patients had CL grade 1 and 3 patients had CL grade 2. In McCoy group 34 patients had CL grade 1 and 16 patients had CL grade 2. Hence the glottis exposure was better with C-MAC group than McCoy group and it was statistically significant which was similar in studies by **Jain et al.,**[4] and **Sabry et al**.,[8]

Jain et al.,[4] compared McCoy laryngoscope and C-MAC video laryngoscope in simulated cervical spine injury and observed that out of 30 patients, 29 patients in C-MAC group and 16 patients in McCoy group had CL grade 1 and was statistically significant. **Sabry et al.,**[8] compared C-MAC D blade and McCoy laryngoscopes during cervical immobilization and observed that out of 30 patients, 16 patients in C-MAC group and 4 patients in McCoy group had CL grade 1 and was statistically significant.

The McCoy group (18 patients) needed more lifting force for visualisation of glottis than C-MAC group (5 patients) and it was statistically significant. 14 patients in C-MAC group needed external laryngeal pressure during intubation compared to 8 patients in McCoy group, but it was not statistically significant.

The IDS score between both the groups was found to be statistically significant. The use of C-MAC resulted in more number of easy intubation when compared to McCoy. This was similar to a study by **Jain et al.,**[4] comparing C-MAC and McCoy laryngoscopes where C-MAC resulted in lower IDS than McCoy group.

In our study the heart rate, systolic BP, diastolic BP and mean BP recorded at all times were comparable between C-MAC, McCoy group and was statistically insignificant. This was similar to study by **Jain et al**.,[4]

SUMMARY

A study titled as “Comparison of C-MAC D blade and McCoy blade for laryngoscopy in adult patients undergoing tracheal intubation for elective surgeries with simulated cervical spine injury using Manual In Line Stabilization (MILS) was done in PSG Institute of Medical Sciences & Research, Coimbatore.

In our study though there was a statistical significance in duration of laryngoscopy and duration of intubation, the total duration of intubation was comparable and insignificant. Because with C-MAC the time taken for successful intubation was prolonged though the duration of laryngoscopy was shorter.

The C-MAC group had better glottic visualisation, needed optimal lifting force and clinically insignificant external laryngeal pressure with lower IDS score when compared to McCoy group.

CONCLUSION

C-MAC video laryngoscope requires less time for laryngoscopy, provides better visualisation of glottis, lower IDS score with similar duration of intubation and haemodynamic responses when compared to McCoy laryngoscope in patients with simulated cervical spine injury.

BIBLIOGRAPHY

1. Austin N, Krishnamoorthy V, Dagal A. Airway management in cervical spine injury. International Journal of Critical Illness and Injury Science. 2014;4(1):50-56. doi:10.4103/2229-5151.128013.

2. Pal R, Chauhan S, Ved BK, Lad SR. Evaluation of laryngoscopic view, intubation difficulty and sympathetic response during direct laryngoscopy in sniffing position and simple head extension: A prospective and randomized comparative study. Int J Res Med Sci 2015;3:1895-901.

3. Magill IW. Endotracheal anaesthesia. American Journal of Surgery 1936; **34**:450 – 5.

4. Jain D, Bala I, Gandhi K. Comparative effectiveness of McCoy laryngoscope and CMAC(®) videolaryngoscope in simulated cervical spine injuries. J AnaesthesiolClinPharmacol. 2016 Jan;32(1):59-64.

5. Joseph J, Sequeira T, Upadya M. Comparison of the use of McCoy and TruView EVO2 laryngoscopes in patients with cervical spine immobilization. Saudi J Anaesth. 2012;6:248–53.

6. Bharti N, Arora S, Panda NB. A comparison of McCoy, TruView, and Macintosh laryngoscopes for tracheal intubation in patients with immobilized cervical spine. Saudi Journal of Anaesthesia. 2014;8(2):188-192. doi:10.4103/1658-354X.130705.

7. Laurent SC, de Melo AE, Alexander-Williams JM. The use of the McCoy laryngoscope in patients with simulated cervical spine injuries. Anaesthesia. 1996;51:74–5.

8. Sabry LA, Shaarawy SS, Ellakany MH, Elmasry AA. Comparison between C-MAC D-blade and McCoy laryngoscopes in intubating patients during cervical immobilization. Res OpinAnesth Intensive Care 2016;3:122-8.

9. Kilicaslan, A. Topal, A. Tavlan, A. Erol, and S. Otelcioglu, "Effectiveness of the C-MAC video laryngoscope in the management of unexpected failed intubations," Brazilian Journal of Anesthesiology, vol. 64, no. 1, pp. 62–65, 2014.

10. Jain D, Dhankar M, Wig J, Jain A. Comparison of the conventional CMAC and the D-blade CMAC with the direct laryngoscopes in simulated cervical spine injury-a manikin study. Braz J Anesthesiol. 2014 Aug 31;64(4):269-274.

11. Ali QE, Amir SH, Jamil S, Ahmad S. A comparative evaluation of the Airtraq and King Vision video laryngoscope as an intubating aid in adult patients. Actaanaesthesiol Belg. 2015;66:81–85.

12. Moningi S, Kuikarni DK, Ramachandran G, Aluri A, Atluri SK, Yadav A. A randomized comparative study between Airtraq and McCoy for intubation in patients with cervical spine injury. Karnataka Anaesth J 2016;2:7-13.

13. Kılıçaslan A, Topal A, Erol A, Uzun ST. Comparison of the C-MAC D-Blade, Conventional C-MAC, and Macintosh Laryngoscopes in Simulated Easy and Difficult Airways. Turk J Anaesthesiol Reanim. 2014;42:182–9.

14. Bharti N, Arora S, Panda BP. A comparison of McCoy, TruWiew and Macintosh laryngoscopes for tracheal intubation in patients with immobilized cervical spine. Saudi J Anesth. 2014;8(2):188-92. doi: 10.4103/1658-354X.130705.

15. Standring S. Gray's Anatomy - The Anatomical basis of clinical practice. 41st ed p718-724. Elsevier; 2016.

16. Crosby ET: Airway management in adults after cervical spine trauma. Anesthesiology 2006; 104:1293–318.

17. White AA III, Johnson RM, Panjabi MM, Southwick WO: Biomechanical analysis of clinical stability in the cervical spine. ClinOrthop 1975; 109:85–95.

18. Sawin PD, Todd MM, Traynelis VC, Farrell SB, Nader A, Sato Y, Clausen JD, Goel VK: Cervical spine motion with direct laryngoscopy and orotracheal intubation: An in vivo cinefluoroscopic study of subjects without cervical abnormality. Anesthesiology1996; 85:26–36.

19. Horton WA, Fahy L, Charters P: Disposition of the cervical vertebrae, atlanto-axial joint, hyoid and mandible during x-ray laryngoscopy. Br J Anaesth 1989; 63:435–8.

20. White AA III, Panjabi MM: Clinical Biomechanics of the Spine, 2nd edition. Philadelphia, JB Lippincott, 1990, pp 314–7.

21. Goldberg W, Mueller C, Panacek E, Tigges S, Hoffman J, Mower WR: Distribution and pattern of blunt traumatic cervical spine injury. Ann Emerg Med 2001; 38:17–21.

22. Stiell IG, Wells GA, Vandemheen KL, Clement CM, Lesiuk H, De Maio VJ, Laupacis A, Schull M, McKnight RD, Verbeek R, Brison R, Cass D, Dreyer J, Eisenhauer MA, Greenberg GH, MacPhail I, Morrison L, Reardon M, Worthington J: The Canadian C-spine rule for radiography in alert and stable trauma patients. JAMA 2001; 286:1841–8.

23. Tator CH: Update on the pathophysiology and pathology of acute spinal cord injury. Brain Pathol 1995; 5:407–13.

24. Kwon BK, Tetzlaff W, Grauer JN, Beiner J, Vaccaro AR: Pathophysiology and pharmacologic treatment of acute spinal cord injury. Spine J 2004; 4:451–64.

25. Panjabi M, White AA III: Biomechanics of nonacute cervical spinal cord trauma, The Cervical Spine, 2nd edition. Edited by the Cervical Spine Research Society Editorial Committee. Philadelphia, JB Lippincott, 1989, pp 91–6.

26. Podolsky S, Baraff LJ, Simon RR, Hoffman JR, Larmon B, Ablon W: Efficacy of cervical spine immobilization methods. J Trauma 1983; 23:461–5.

27. Bednar DA: Efficacy of orthotic immobilization of the unstable subaxial cervical spine of the elderly patient: Investigation in a cadaver model. Can J Surg 2004; 47:251–6.

28. Goutcher CM, Lochhead V: Reduction in mouth opening with semi-rigid cervical collars. Br J Anaesth 2005; 95:344–8.

29. Majernick TG, Bienek R, Houston JB, Hughes HG: Cervical spine movement during orotracheal intubation. Ann Emerg Med 1986; 15:417–20.

30. Watts ADJ, Gelb AW, Bach DB, Pelz DM: Comparison of Bullard and Macintosh laryngoscopes for endotracheal intubation of patients with a potential cervical spine injury. Anesthesiology 1997; 87:1335–42.

31. Lennarson PJ, Smith D, Todd MM, Carras D, Sawin PD, Brayton J, Sato Y, Traynelis VC: Segmental cervical spine motion during orotracheal intubation of the intact and injured spine with and without external stabilization. J Neurosurg (Spine 2) 2000; 92:201–6.

32. Gerling MC, Davis DP, Hamilton RS, Morris GF, Vilke GM, Garfin SR, Hayden SR: Effects of cervical spine immobilization technique

and laryngoscope blade selection on an unstable cervical spine in a cadaver model of intubation. Ann Emerg Med 2000; 36:293–300.

33. Heath KJ: The effect on laryngoscopy of different cervical spine immobilization techniques. Anaesthesia 1994; 49:843–5.

34. Hastings RH, Wood PR: Head extension and laryngeal view during laryngoscopy with cervical spine stabilization maneuvers. Anesthesiology 1994; 80:825–31.

35. Wood PR, Dresner M, Hayden Smith J, Kumar CM, Lawler PGP: Direct laryngoscopy and cervical spine stabilization. Anaesthesia 1994; 49:77–8.

36. Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. Anaesthesia 1984; **39**: 1105–11.

37. Adnet F, Borron SW, Racine SX, et al. The intubation difficulty scale (IDA). Anesthesiology 1997; 87: 1290–7.

38. Davey A, Diba A. Ward's Anaesthetic Equipment. 6th ed p179-80. Saunders Elsevier; 2012.

39. Dorsch J, Dorsch S. Understanding Anaesthesia Equipment. 5th ed p521-24, 550-51. Wolters Kluwer; 2008.

40. *McCoy EP, Mirakhur RK*. The levering laryngoscope. Anaesthesia 1993; 48: 516–9.

41. Xue, F., Li, H., Liu, Y. and Yang, G. (2017). Current evidence for the use of C-MAC videolaryngoscope in adult airway management: a

review of the literature. Therapeutics and Clinical Risk Management, [online] 13, pp.831 -841.

42. Aziz M, Brambrink A. The Storz C-MAC video laryngoscope: description of a new device, case report, and brief case series. J ClinAnesth. 2011;23(2):149–152.

43. Green-Hopkins I, Nagler J. Endotracheal intubation in pediatric patients using video laryngoscopy: an evidence-based review. PediatrEmerg Med Pract. 2015;12(8):1–22.

44. Kaplan MB, Ward DS, Berci G. A new video laryngoscope-an aid to intubation and teaching. J ClinAnesth. 2002;14(8):620–626.

45. Xue FS, Liu QJ, Li HX, Liu YY. Videolaryngoscopy assisted intubation–new era for airway management. J AnesthPerioper Med. 2016;3(6):258–269.

46. Cavus E, Thee C, Moeller T, Kieckhaefer J, Doerges V, Wagner K. A randomized, controlled crossover comparison of the C-MAC videolaryngoscope with direct laryngoscopy in 150 patients during routine induction of anesthesia. BMC Anesthesiol. 2011;11:6.

47. Levitan RM, Heitz JW, Sweeney M, Cooper RM. The complexities of tracheal intubation with direct laryngoscopy and alternative intubation devices. Ann Emerg Med. 2011;57(3):240–247.

48. Karl Storz GmbH & Co. KG; Tuttlingen, Germany: [Accessed May 4, 2017].

49. Greenland KB. Disposable C-MAC® video laryngoscope blade-not the same as the re-usable blade. Anesthesia. 2014;69(12):1402–1403.

50. vanZundert A, Maassen R, Lee R, et al. A Macintosh laryngoscope blade for video laryngoscopy reduces stylet use in patients with normal airways. AnesthAnalg. 2009;109(3):825–831.

51. Gupta N, Rath GP, Prabhakar H. Clinical evaluation of C-MAC video-laryngoscope with or without use of stylet for endotracheal intubation in patients with cervical spine immobilization. J Anesth. 2013;27(5):663–670.

52. Xue FS, Liu QJ, Li HX, Liu YY. Video laryngoscopy assisted intubation–new era for airway management. J AnesthPerioper Med. 2016;3(6):258–269.

53. Brown CA, 3rd, Pallin DJ, Walls RM. Video laryngoscopy and intubation safety: the view is becoming clear. Crit Care Med. 2015;43(3):717–718.

54. Kaplan MB, Hagberg CA, Ward DS, et al. Comparison of direct and video-assisted views of the larynx during routine intubation. J ClinAnesth. 2006;18(5):357–362.

55. Shimada N, Mogi K, Niwa Y, et al. The C-MAC video laryngoscope: its utility in tracheal intubation by novice personnel. Masui. 2012;61(6):649–452.

56. Sarkılar G, Sargın M, Sarıtaş TB, et al. Hemodynamic responses to endotracheal intubation performed with video and direct laryngoscopy in patients scheduled for major cardiac surgery. Int J ClinExp Med. 2015;8(7):11477–11483.

57. Purugganan RV, Jackson TA, Heir JS, Wang H, Cata JP. Video laryngoscopy versus direct laryngoscopy for double-lumen endotracheal tube intubation: a retrospective analysis. J CardiothoracVascAnesth. 2012;26(5):845–848.

58. Apfelbaum JL, Hagberg CA, Caplan RA, et al. Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Anesthesiology. 2013;118(2):251–270.

59. Frerk C, Mitchell VS, McNarry AF, et al. Difficult Airway Society 2015 guidelines for management of unanticipated difficult intubation in adults. Br J Anaesth. 2015;115(6):827–848.

60. Japanese Society of Anesthesiologists JSA airway management guideline 2014: to improve the safety of induction of anesthesia. J Anesth. 2014;28(4):482–493.

61. Jungbauer A, Schumann M, Brunkhorst V, Börgers A, Groeben H. Expected difficult tracheal intubation: a prospective comparison of direct laryngoscopy and video laryngoscopy in 200 patients. Br J Anaesth. 2009;102(4):546–550.

62. Aziz MF, Dillman D, Fu R, Brambrink AM. Comparative effectiveness of the C-MAC video laryngoscope versus direct laryngoscopy in the setting of the predicted difficult airway. Anesthesiology. 2012;116(3):629–636.

63. Maldini B, Hodžović I, Goranović T, Mesarić J. Challenges in the use of video laryngoscopes. ActaClin Croat. 2016;55(Suppl 1):41–50.

64. Byhahn C, Iber T, Zacharowski K, et al. Tracheal intubation using the mobile C-MAC video laryngoscope or direct laryngoscopy for patients with a simulated difficult airway. Minerva Anestesiol. 2010; 76 (8):577–583.

65. Piepho T, Fortmueller K, Heid FM, Schmidtmann I, Werner C, Noppens RR. Performance of the C-MAC video laryngoscope in patients after a limited glottic view using Macintosh laryngoscopy. Anesthesia. 2011;66(12):1101–1105.

66. Lee AH, Nor NM, Izaham A, Yahya N, Tang SS, Manap NA. Comparison of the Bonfils intubation fibrescope versus C-MAC videolaryngoscope. Middle East J Anaesthesiol. 2016;23(5):517–525.

67. Ng I, Hill AL, Williams DL, Lee K, Segal R. Randomized controlled trial comparing the McGrath videolaryngoscope with the C-MAC videolaryngoscope in intubating adult patients with potential difficult airways. Br J Anaesth. 2012;109(3):439–443.

68. Brück S, Trautner H, Wolff A, et al. Comparison of the C-MAC and GlideScopevideolaryngoscopes in patients with cervical spine disorders and immobilization. Anesthesia. 2015;70(2):160–165.

69. Yumul R, Elvir-Lazo OL, White PF, et al. Comparison of the C-MAC video laryngoscope to a flexible fiberoptic scope for intubation with cervical spine immobilization. J ClinAnesth. 2016;31:46–52.

PSG Institute of Medical Science and Research, Coimbatore

Institutional Human Ethics Committee

INFORMED CONSENT FORMAT FOR RESEARCH PROJECTS

I Rohini Sagadhevan carrying out a study on the topic: Comparison of C-MAC D blade and McCoy blade for laryngoscopy in patients with simulated cervical spine injury as part of my research project being carried out under the aegis of the Department of Anesthesia. My research guide is:
Dr.Dhanabagyam.G

The justification for this study

Manual Inline Stabilization (MILS) is widely used in patients with actual or suspected cervical spine injury to reduce the risk of cord injury during tracheal intubation. MILS makes more difficult to visualize the larynx using conventional laryngoscopes whereas video laryngoscopes provide a better view of larynx. Hence we are comparing C-MAC D blade and McCoy blade for laryngoscopy in patients with simulated cervical spine injury.

The objectives of this study are:

To compare ease, duration and hemodynamic responses of intubation with C-MAC D blade and McCoy blade for laryngoscope in adult patients undergoing tracheal intubation for elective surgeries with simulated cervical spine injury using manual inline stabilization (MILS).

Sample size: 100; 50 in each group

Study volunteers / participants are (specify population group & age group): 18-65 years

Location: PSGIMS & R

We request you to kindly cooperate with us in this study. We propose to collect background information and other relevant details related to this study. We will be carrying out:

Clinical examination : Pre anaesthetic assessment will be done the day prior to surgery

Benefits from this study: To identify an optimum and safe device for endotracheal intubation in patients with actual or suspected cervical spine injury.

Risks involved by participating in this study: nil

How the **results** will be used: To identify a device that has better ease, minimum duration and minimum hemodynamic responses of intubation in patients with simulated cervical spine injury.

If you are uncomfortable in answering any of our questions during the course of the interview / biological sample collection, **you have the right to withdraw from the interview / study at anytime.** You have the freedom to withdraw from the study at any point of time. Kindly be assured that your refusal to participate or withdrawal at any stage, if you so decide, will not result in any form of compromise or discrimination in the services offered nor would it attract any penalty. You will continue to have access to the regular services offered to a patient. You will **NOT** be paid any remuneration for the time you spend with us for this interview / study. The information provided by you will be kept in strict confidence. Under no circumstances shall we reveal the identity of the respondent or their families to anyone. The information that we collect shall be used for approved research purposes only. You will be informed about any significant new findings **-** including adverse events, if any, – whether directly related to you or to other participants of this study, developed during the course of this research which may relate to your willingness to continue participation.

Consent: The above information regarding the study, has been read by me/ read to me, and has been explained to me by the investigator/s. Having understood the same, I hereby give my consent to them to interview me. I am affixing my signature / left thumb impression to indicate my consent and willingness to participate in this study (i.e., willingly abide by the project requirements).

Signature / Left thumb impression of the Study Volunteer / Legal Representative:

Signature of the Interviewer with date: Witness:

Contact number of PI: 9500411174

Contact number of Ethics Committee Office: During Office hours: 0422 2570170 Extn.: 5818

After Office hours: 9865561463

ஒப்புதல் படிவம்

டாக்டர் ரோகினி சகாதேவன் ஆகிய நான் PSG மருத்துவக் கல்லூரியில் மயக்கவியல் துறையின் மேற்படிப்பின் ஒரு பகுதியாக, ஒப்பீடு முறையில் முதுகெலும்பின் கழுத்துப் பகுதியில் முறிவு ஏற்பட்டுள்ளதாக பாவித்து லெரிங்கோஸ்கோபி முறைக்கு C-MAC D blade மற்றும் Mccoy blade உபயோகிப்பதில் எது சிறந்தது என்ற தலைப்பில் ஆய்வு மேற்கொள்ள உள்ளேன்.

என் ஆய்வு வழிகாட்டி டாக்டர் தனபாக்கியம். G
பேராசிரியர்
மயக்கவியல் துறை
PSG மருத்துவக் கல்லூரி

ஆய்வு மேற்கொள்வதற்கான அடிப்படை

கழுத்து எலும்பு முறிவு உள்ளவர்களுக்கும் / இருப்பதாக சந்தேகப் படுபவர்களுக்கும் மயக்க மருந்து கொடுப்பதற்காக மூச்சுக்குழாயில் ட்யூப் செலுத்தும் போது கழுத்து தண்டுவடத்திற்கு பாதிப்பு ஏற்படாமல் இருப்பதற்காக மானுவல் இன்லைன் ஸ்டிபிலைசேஷன் என்ற முறை பரவலாக உபயோகிக்கப்படுகிறது. அப்போது சாதாரணமாக உபயோகப்படுத்தப்படும் லெரிங்கோஸ்கோப் மூலமாக மூச்சுக்குழாயை பார்ப்பது மிகவும் சிரமம். வீடியோ லெரிங்கோஸ்கோப் மூலம் இது எளிதாகிறது. எனவே C-MAC D blade ஐயும் Mccoy blade யும் ஒப்பிட்டு பார்ப்பதற்காக இந்த ஆய்வு மேற்கொள்ள உள்ளேன்.

ஆய்வின் நோக்கம்

முதுகெலும்பின் கழுத்துப் பகுதியில் எலும்பு முறிவு ஏற்பட்டுள்ளதாக பாவித்து மேனுவல் இன்லைன் ஸ்டெபிலைசேஷன் செய்யப்பட்டவர்களுக்கு C-MAC D blade மற்றும் Mccoy blade உபயோகிக்கும் போது அதை எவ்வளவு எளிதாக உபயோகிக்க முடிகிறது, லெறிங்கோஸ்கோபி செய்ய மேற்கொள்ள நேரம் எவ்வளவு மற்றும் நாடித்துடிப்பு இரத்த அழுத்தத்தில் என்ன மாறுதல்கள் ஏற்படுகின்றன என்று ஒப்பிடுதல்.

ஆய்வில் பங்கு பெறும் நபர்களின் எண்ணிக்கை 100

ஆய்வு மேற்கொள்ளும் இடம் PSG மருத்துவக் கல்லூரி

ஆயிவின் பலன்கள்

முதுகெலும்பின் கழுத்து பகுதியின் முறிவு ஏற்பட்டுள்ளவர் / ஏற்பட்டுள்ளதாக பாவிக்கப்படுபவர்களுக்கு மூச்சுக்குழாயில் ட்யூப் போடுவதற்காக சிறந்த கருவி மற்றும் முறையைக் கண்டறிதல்.

ஆய்வினால் ஏற்படும் அசௌகரியங்கள் எதுவும் இல்லை

இந்த ஆய்வில் கிடைக்கும் தகவல்கள் 3 வருடங்கள் பாதுகாக்கப்படும். இவை வேறு எந்த ஆய்விற்கும் பயன்படுத்தப் பட மாட்டாது. எந்த நிலையிலும் உங்களைப் பற்றிய தகவல்கள் யாருக்கும் தெரிவிக்கப்பட மாட்டாது. அவை இரகசியமாக வைக்கப்படும்.

இந்த ஆய்வில் பங்கேற்க ஒப்புக்கொள்வதால் எந்த விதமான பலனும் உங்களுக்குக் கிடையாது. எந்த நேரத்தில் வேண்டுமானாலும் ஆய்விலிருந்து விலகிக்கொள்ளும் உரிமை உங்களுக்கு உண்டு. ஆய்விலிருந்து விலகிக்கொள்வதால் உங்களுக்கு அளிக்கப்படும் சிகிச்சையில் எந்த வித மாற்றமும் இருக்காது.

மேலும் இந்த ஆய்வில் பங்கு கொள்வது உங்கள் சொந்த விருப்பம். இதில் எந்த விதக் கட்டாயமும் இல்லை. நீங்கள் விருப்பப்பட்டால் இந்த ஆய்வின் முடிவுகள் உங்களுக்குத் தெரியப்படுத்தப்படும்.

ஆய்வாளரின் கையொப்பம் தேதி

ஆய்வுக்குட்படுபவரின் ஒப்புதல்

நான் இந்த ஆய்வின் நோக்கம் மற்றும் அதன் பயன்பாட்டினைப் பற்றி தெளிவாக தெரியப்படுத்தப் பட்டுள்ளேன். இந்த ஆய்வில் பங்கு கொள்ளவும், இந்த ஆராய்ச்சியின் மருத்துவரீதியான குறிப்புகளை வரும் காலத்திலும் உபயோகப்படுத்திக் கொள்ளவும் முழு மனதுடன் சம்மதிக்கிறேன்.

ஆய்வுக்குட்படுபவரின் பெயர் மற்றும் கையொப்பம்

தேதி

ஆய்வாளரின் தொலைபேசி எண் 95004 11174

மனித நெறிமுறைக் குழு அலுவலகத்தின் தொலைபேசி எண் 04222570170

EXTN 5818

PATIENT PROFORMA

Serial number:

Name: Age: Sex:

OP No: IP No: HT: WT:

ASA: Mallampatti:

Diagnosis: Procedure:

Duration of laryngoscopy:

Duration of intubation:

Ease of intubation: Intubation Difficulty Scale **(IDS score)**

		SCORE
Number of intubation attempts	>1	
Number of operators	>1	
Number of alternative intubation techniques		
Glottic exposure	CL grade minus 1	
Lifting force required	0 – normal, 1 - increased	
Necessity for external laryngeal pressure	0 – not applied 1 - applied	
Position of the vocal cords at intubation	0 – abduction 1 - adduction	
Total score		

VITAL PARAMETERS

Parameters	Heart Rate	Blood Pressure		
		SBP	DBP	MAP
Baseline				
Before Laryngoscopy				
1 minute				
3 minutes				
5 minutes				

MASTER CHART

Age	Age_C	Sex	B.M.I	BMI_C	Group	MP_Class	DOL	DOI	N1	N2	N3	N4	N5	N6	N7	Total	HR1	HR2	HR3	HR4	HR5	SBP1	SBP2	SBP3	SBP4	SBP5	DBP1	DBP2	DBP3	DBP4	DBP5	MAP1	MAP2	MAP3	MAP4	MAP5	HR	SBP	DBP	MAP
58	3	F	26	2	C	2	8	22	0	0	0	0	0	1	0	0	110	84	85	88	91	180	158	100	104	96	98	90	62	66	68	126	113	75	79	78	92	128	77	94
41	2	F	29	2	M	2	17	19	0	0	0	1	1	1	0	3	84	84	98	99	100	120	126	170	154	154	68	74	100	96	96	86	92	124	116	116	93	145	87	107
35	2	F	23	3	C	2	10	8	0	0	0	0	0	0	0	0	73	82	88	89	89	108	98	84	100	98	62	54	46	62	68	78	69	59	75	78	84	98	58	72
22	1	M	24	3	C	2	9	10	0	0	0	0	0	0	0	0	51	63	71	71	62	154	132	136	128	122	76	80	74	64	62	102	98	95	86	82	64	134	71	93
30	1	M	17	4	C	3	12	11	0	0	0	0	0	0	0	0	78	87	104	102	69	134	110	154	128	110	90	60	90	86	66	105	77	112	100	81	88	127	78	95
43	2	M	29	2	M	2	8	15	0	0	0	0	0	1	0	1	72	86	78	70	68	100	96	116	120	118	56	66	68	72	66	71	76	84	88	84	75	110	66	81
32	2	F	24	3	M	1	16	13	0	0	0	1	0	0	0	1	85	94	96	88	86	108	106	136	88	88	70	62	76	46	54	83	77	96	60	66	90	105	62	76
37	2	M	29	2	C	2	11	18	0	0	0	0	0	1	0	1	105	114	92	96	100	124	120	116	110	110	86	58	72	68	66	99	79	87	82	81	101	116	70	86
60	3	M	22	3	C	2	18	16	1	0	0	0	1	1	0	3	62	67	79	75	77	172	136	128	140	138	78	62	70	66	76	110	87	90	91	97	72	143	70	95
56	3	F	20	3	M	2	5	10	0	0	0	0	0	0	0	0	91	95	83	81	77	146	114	140	108	88	84	70	83	64	62	105	85	102	79	71	85	119	73	88
36	2	F	17	4	M	1	11	10	0	0	0	0	0	0	0	0	82	101	94	65	62	114	108	116	100	114	66	70	80	58	60	82	83	92	72	78	81	110	67	81
27	1	M	18	4	C	2	9	16	0	0	0	0	0	1	0	1	60	76	80	74	70	138	106	112	106	96	74	52	62	52	48	96	70	79	70	64	72	112	58	76
53	3	F	24	3	M	2	8	6	0	0	0	0	0	0	0	0	91	86	76	71	70	164	114	100	90	92	80	62	54	48	50	108	80	70	62	64	79	112	59	77
27	1	F	21	3	M	2	23	14	0	0	0	0	0	0	0	0	65	81	80	67	57	112	124	102	80	88	65	72	60	48	60	81	90	74	59	70	70	101	61	75
63	4	F	24	3	C	2	9	9	0	0	0	0	0	0	0	0	96	102	98	101	96	136	98	106	90	82	74	64	62	58	54	95	76	77	69	64	99	102	62	76
39	2	F	24	3	M	2	11	9	0	0	0	0	0	0	0	0	86	92	99	94	88	126	104	120	110	112	74	68	78	66	64	92	80	92	81	80	92	114	70	85
55	3	M	30	2	C	2	12	21	0	0	0	0	1	1	0	2	91	94	96	85	82	130	110	116	102	108	86	68	74	72	68	101	82	88	82	82	90	113	74	87
31	2	F	24	3	M	2	12	7	0	0	0	0	0	0	0	0	85	96	104	106	100	110	92	124	112	110	68	54	72	68	70	82	67	90	83	84	98	110	66	81
24	1	M	25	2	M	2	14	11	0	0	0	0	0	0	0	0	95	108	116	106	99	128	106	134	122	120	88	72	92	84	84	102	84	106	97	96	105	122	84	97
34	2	F	20	3	C	2	12	10	0	0	0	0	0	0	0	0	110	94	99	94	82	100	86	104	90	92	64	52	70	58	62	76	64	82	69	72	96	94	61	73
42	2	M	27	2	M	2	11	8	0	0	0	1	1	0	0	2	86	89	102	82	83	120	108	126	114	116	68	58	70	66	62	86	75	89	82	80	88	117	65	82
56	3	M	28	2	C	2	11	12	0	0	0	0	0	0	0	0	96	78	84	70	66	136	104	110	96	92	78	58	62	58	60	98	74	78	71	71	79	108	63	78
31	2	F	22	3	C	2	11	9	0	0	0	0	0	0	0	0	99	84	82	76	78	124	92	102	106	104	72	56	58	60	64	90	68	73	76	78	84	106	62	77
36	2	M	27	2	M	2	16	11	0	0	0	1	1	0	0	2	84	82	94	88	86	108	100	132	116	106	70	66	88	72	68	83	78	103	87	81	87	112	73	86
64	4	M	27	2	M	2	13	14	0	0	0	0	0	0	0	0	72	70	92	96	90	128	112	146	130	122	74	68	98	92	84	92	83	114	105	97	84	128	83	98
44	2	F	25	2	C	2	13	13	0	0	0	0	0	0	0	0	78	84	88	76	72	116	96	124	118	104	80	68	74	76	68	92	78	91	90	80	80	112	73	86

Age	Age_C	Sex	B.M.I	BMI_C	Group	MP_Class	DOL	DOI	N1	N2	N3	N4	N5	N6	N7	Total	HR1	HR2	HR3	HR4	HR5	SBP1	SBP2	SBP3	SBP4	SBP5	DBP1	DBP2	DBP3	DBP4	DBP5	MAP1	MAP2	MAP3	MAP4	MAP5	HR	SBP	DBP	MAP
29	1	F	29	2	M	2	25	17	0	0	0	2	1	1	0	4	52	76	64	63	62	110	112	122	94	90	58	58	68	54	52	76	76	86	68	65	63	106	58	74
37	2	M	26	2	M	2	9	7	0	0	0	0	0	0	0	0	76	98	72	68	62	120	98	102	98	86	70	66	72	60	50	87	77	82	73	62	75	101	64	76
33	2	M	27	2	C	2	10	10	0	0	0	0	0	0	0	0	88	80	82	76	78	122	106	114	104	94	78	66	72	64	58	93	80	86	78	70	81	108	68	81
26	1	F	19	3	C	1	10	11	0	0	0	0	0	0	0	0	106	78	84	82	76	124	98	108	98	86	76	66	72	62	54	92	77	84	74	65	85	103	66	78
56	3	F	26	2	M	2	17	16	1	0	0	1	1	1	0	4	89	98	124	112	92	124	102	142	134	128	74	66	102	96	78	91	78	116	109	95	103	126	83	98
41	2	M	25	2	C	2	14	17	0	0	0	0	0	0	0	0	69	64	70	63	54	140	128	108	98	86	88	54	62	56	50	106	79	78	70	62	64	112	62	79
38	2	F	25	3	M	2	13	17	0	0	0	0	0	1	0	1	88	100	116	104	92	118	98	124	108	96	72	64	80	74	64	88	76	95	86	75	100	109	71	84
35	2	M	26	2	C	2	9	8	0	0	0	0	0	0	0	0	110	112	108	94	90	136	126	134	108	100	86	82	90	68	60	103	97	105	82	74	103	121	77	92
26	1	M	28	2	M	2	10	10	0	0	0	0	0	0	0	0	88	94	97	89	74	124	102	108	92	88	74	64	64	62	58	91	77	79	72	68	88	103	64	77
63	4	F	30	1	M	2	16	14	0	0	0	1	1	0	0	2	77	68	86	82	76	132	124	146	122	106	82	78	92	88	70	99	94	110	100	82	78	126	82	97
32	2	F	27	2	C	2	11	16	0	0	0	0	0	1	0	1	85	76	95	84	88	122	114	126	98	102	76	72	84	66	64	92	86	98	77	77	86	112	72	86
41	2	F	26	2	C	2	10	16	0	0	0	0	0	0	0	0	99	76	87	74	77	124	112	126	104	96	78	74	86	64	66	94	87	100	78	76	83	112	74	87
53	3	M	30	2	M	2	17	14	0	0	0	2	1	0	0	3	91	84	102	93	78	130	104	146	124	126	88	72	94	88	80	102	83	112	100	96	90	126	84	99
25	1	M	28	2	M	2	17	12	1	1	0	1	1	0	0	4	75	70	92	86	81	128	122	136	126	118	78	72	94	86	84	95	89	108	100	96	81	126	83	98
39	2	F	24	3	C	2	10	11	0	0	0	0	0	0	0	0	74	82	85	76	69	116	96	104	92	86	74	66	68	62	56	88	76	80	72	66	77	99	65	76
59	3	M	29	2	C	2	22	18	0	0	0	1	1	1	0	3	107	112	134	117	105	136	128	160	113	126	96	77	94	68	70	110	94	116	83	89	115	133	81	98
21	1	M	21	3	M	2	14	9	0	0	0	0	0	0	0	0	92	88	95	83	76	110	92	108	96	88	72	58	66	58	60	85	70	80	71	70	87	99	63	75
47	3	F	21	3	C	2	11	11	0	0	0	0	0	0	0	0	114	89	96	84	81	126	112	128	104	98	76	68	78	66	66	93	83	95	79	77	93	114	71	85
26	1	M	24	3	C	2	9	11	0	0	0	0	0	0	0	0	90	106	110	85	81	112	94	118	98	88	76	62	74	66	64	88	73	89	77	72	94	102	68	80
35	2	F	19	3	M	2	16	12	0	0	0	1	1	0	0	2	85	94	111	98	91	124	100	128	116	102	78	68	84	76	68	94	79	99	90	80	96	114	75	88
58	3	M	25	2	M	2	14	10	0	0	0	0	0	0	0	0	74	86	94	78	69	114	96	122	96	84	76	68	74	62	56	89	78	90	74	66	80	102	67	79
61	4	M	27	2	C	2	13	17	0	0	0	0	0	1	0	1	78	82	114	102	91	128	104	146	124	110	78	72	96	82	78	95	83	113	96	89	93	122	81	95
22	1	F	22	3	M	1	10	9	0	0	0	0	0	0	0	0	99	85	92	78	79	122	98	110	94	82	72	66	72	62	58	89	77	85	73	66	87	101	66	78
33	2	M	19	3	M	2	16	11	0	0	0	0	0	0	0	0	64	55	83	70	58	128	92	130	98	88	72	48	84	56	46	91	63	100	70	60	66	107	61	77
42	2	M	26	2	C	2	16	15	1	0	0	0	0	0	0	1	110	94	118	106	92	124	102	134	118	100	78	72	84	76	68	94	82	101	90	79	104	116	76	89
47	3	F	27	2	C	2	12	13	0	0	0	0	0	0	0	0	80	92	106	87	72	118	98	122	100	88	76	64	80	68	62	90	76	94	79	71	87	105	70	82
38	2	F	28	2	M	2	18	15	0	0	0	2	1	1	0	4	77	84	124	108	84	130	104	152	132	108	86	74	102	78	72	101	84	119	96	84	95	125	82	97

Age	Age_C	Sex	B.M.I	BMI_C	Group	MP_Class	DOL	DOI	N1	N2	N3	N4	N5	N6	N7	Total	HR1	HR2	HR3	HR4	HR5	SBP1	SBP2	SBP3	SBP4	SBP5	DBP1	DBP2	DBP3	DBP4	DBP5	MAP1	MAP2	MAP3	MAP4	MAP5	HR	SBP	DBP	MAP
64	4	M	21	3	M	2	15	9	0	0	0	0	0	0	0	0	74	88	110	95	76	124	100	128	104	94	78	66	84	72	64	94	78	99	83	74	89	110	73	86
27	1	M	23	3	C	2	15	21	0	0	0	0	0	1	0	1	89	95	128	110	93	128	102	148	130	114	76	64	102	86	74	94	77	118	101	88	103	124	80	96
57	3	F	25	2	M	2	16	11	0	0	0	0	0	0	0	0	92	99	114	96	84	120	96	132	106	96	72	66	84	72	62	88	76	100	84	74	97	110	71	84
35	2	F	28	2	C	2	21	18	0	0	0	1	1	1	0	3	83	92	135	120	102	126	100	156	122	102	74	66	108	74	68	92	78	124	90	80	106	121	78	93
47	3	M	26	2	M	2	15	10	0	0	0	0	0	0	0	0	108	94	116	94	72	118	96	126	100	92	76	62	88	74	62	90	74	101	83	72	97	106	72	84
42	2	F	24	3	M	3	16	13	0	0	0	0	0	0	0	0	81	89	115	99	83	122	100	128	106	98	76	66	78	68	60	92	78	95	81	73	93	111	70	84
52	3	M	24	3	C	2	14	13	0	0	0	0	0	0	0	0	78	92	110	91	79	120	98	128	98	92	74	64	82	66	58	90	76	98	77	70	90	107	69	82
23	1	M	27	2	M	2	14	10	0	0	0	0	0	0	0	0	91	86	115	99	87	114	96	132	104	96	72	64	88	72	62	86	75	103	83	74	96	108	72	84
33	2	F	25	2	C	2	9	7	0	0	0	0	0	0	0	0	79	87	94	92	85	120	100	112	108	104	70	54	70	56	52	87	70	84	74	70	87	109	60	77
27	1	F	20	3	C	1	13	14	0	0	0	0	0	0	0	0	86	89	110	91	78	122	104	130	106	98	76	66	88	74	62	92	79	102	85	74	91	112	73	86
52	3	M	24	3	M	2	14	9	1	0	0	0	0	0	0	1	98	86	112	89	75	128	102	132	110	100	84	70	88	70	64	99	81	103	84	76	92	114	75	89
43	2	F	27	2	C	2	16	15	0	0	0	0	0	0	0	0	79	85	113	95	77	124	106	128	110	104	82	74	88	72	68	96	85	102	85	80	90	114	77	90
65	4	M	20	3	C	1	11	12	0	0	0	0	0	0	0	0	84	90	105	86	72	118	102	128	110	100	76	68	80	72	66	90	80	96	85	78	87	112	72	86
29	1	M	24	3	M	2	16	12	0	0	0	0	1	0	0	1	76	75	86	78	61	128	110	136	124	108	86	72	94	86	72	100	85	108	99	84	75	121	82	95
31	2	F	26	2	M	2	17	13	0	0	0	2	1	0	0	3	74	83	115	92	72	132	100	146	108	102	94	70	100	74	68	107	80	116	86	80	87	118	81	94
47	3	M	28	2	M	2	14	14	0	0	0	0	0	0	0	0	93	82	109	86	71	124	110	136	116	98	78	70	86	76	66	94	84	103	90	77	88	117	75	90
34	2	F	23	3	M	2	9	12	0	0	0	0	0	0	0	0	86	76	82	76	76	122	94	98	102	86	64	56	60	54	52	84	69	73	70	64	79	100	57	72
51	3	M	27	2	C	2	11	14	0	0	0	0	0	0	0	0	82	78	96	81	72	118	96	128	102	92	82	64	76	66	60	94	75	94	78	71	82	107	70	82
43	2	M	25	2	C	2	10	13	0	0	0	0	0	0	0	0	86	80	94	78	70	110	96	124	100	88	74	64	78	64	56	86	75	94	76	67	82	104	67	80
26	1	F	27	2	C	2	12	16	0	0	0	0	0	1	0	1	84	91	116	94	85	124	108	134	112	98	82	74	98	76	68	96	86	110	88	78	94	115	80	92
46	3	M	27	2	M	2	16	13	1	0	0	1	1	0	0	3	76	94	121	98	77	118	96	136	110	100	76	64	88	74	64	90	75	104	86	76	93	112	73	86
25	1	F	16	4	C	1	11	11	0	0	0	0	0	0	0	0	72	78	97	81	70	118	94	124	98	90	74	66	76	64	58	89	76	92	76	69	80	105	68	80
57	3	F	24	3	M	2	15	18	0	0	0	0	0	1	0	1	94	86	130	105	95	126	102	138	120	108	82	74	96	74	68	97	84	110	90	82	102	119	79	93
32	2	M	24	3	C	2	13	15	0	0	0	0	0	0	0	0	87	90	101	88	73	124	100	130	104	94	76	70	86	68	60	92	80	101	80	72	88	110	72	85
59	3	M	18	4	M	2	14	11	0	0	0	0	1	0	0	1	93	85	98	80	68	112	98	128	108	102	76	66	84	76	70	88	77	99	87	81	85	110	74	86
25	1	F	19	3	C	2	9	16	0	0	0	0	0	1	0	1	90	82	102	82	78	134	114	132	106	98	64	50	60	46	44	88	72	84	66	62	87	117	53	74
36	2	M	26	2	C	2	11	13	0	0	0	0	0	0	0	0	88	86	99	86	71	120	96	126	98	88	68	62	74	64	60	86	74	92	76	70	86	106	66	80

Age	Age_C	Sex	B.M.I	BMI_C	Group	MP_Class	DOL	DOI	N1	N2	N3	N4	N5	N6	N7	Total	HR1	HR2	HR3	HR4	HR5	SBP1	SBP2	SBP3	SBP4	SBP5	DBP1	DBP2	DBP3	DBP4	DBP5	MAP1	MAP2	MAP3	MAP4	MAP5	HR	SBP	DBP	MAP
27	1	M	22	3	M	2	14	9	0	0	0	0	0	0	0	0	72	80	96	84	71	122	100	130	106	96	74	62	78	72	60	90	75	96	84	72	81	111	69	83
42	2	F	25	3	C	2	10	14	0	0	0	0	0	0	0	0	101	100	112	70	68	140	125	128	112	110	80	76	80	66	64	100	93	96	82	80	90	123	73	90
56	3	F	26	2	M	2	19	14	1	1	0	1	1	0	0	4	81	93	121	105	92	132	104	142	116	106	86	70	96	74	72	102	82	112	88	84	98	120	80	94
26	1	F	23	3	C	2	13	15	0	0	0	0	0	0	0	0	83	86	99	81	75	118	96	134	106	94	76	60	86	74	56	90	72	102	85	69	85	110	70	84
41	2	M	28	2	C	2	19	20	0	0	0	0	0	1	0	1	71	80	127	108	84	134	106	140	116	112	86	72	96	78	72	102	84	111	91	86	94	122	81	95
47	3	F	28	2	M	2	15	12	0	0	0	0	0	0	0	0	115	89	118	94	76	136	104	128	106	98	86	72	80	74	64	103	83	96	85	76	98	114	75	89
25	1	M	22	3	C	2	13	15	0	0	0	0	0	0	0	0	96	96	109	85	77	126	112	134	108	104	78	72	88	74	74	94	86	104	86	84	93	117	77	91
32	2	M	27	2	M	2	16	13	0	0	0	0	0	0	0	0	91	94	122	99	85	132	114	144	120	104	86	72	98	74	70	102	86	114	90	82	98	123	80	95
36	2	F	26	2	M	2	18	21	1	1	0	2	1	1	0	6	83	85	138	114	96	120	100	154	130	122	72	66	106	88	78	88	78	122	102	93	103	125	82	97
45	2	M	28	2	C	2	12	14	0	0	0	0	0	0	0	0	71	93	99	90	76	118	98	126	104	100	76	64	82	76	72	90	76	97	86	82	86	109	74	86
42	2	F	25	2	M	2	16	13	0	0	0	0	0	0	0	0	80	94	114	105	89	124	112	136	126	110	82	74	90	76	72	96	87	106	93	85	96	122	79	93
34	2	F	24	3	C	2	11	10	0	0	0	0	0	0	0	0	96	102	100	88	76	116	98	102	100	96	76	68	74	64	58	90	78	84	76	71	92	102	68	80
51	3	M	28	2	M	2	15	15	0	0	0	0	1	0	0	1	89	92	114	105	90	126	120	134	126	118	86	76	92	86	76	100	91	106	100	90	98	125	83	97
58	3	F	27	2	C	2	14	17	0	0	0	0	0	1	0	1	74	72	81	75	76	128	106	142	134	108	74	66	88	86	72	92	80	106	102	84	76	124	77	93
37	2	M	27	2	C	2	18	14	0	0	0	1	1	0	0	2	112	104	126	118	104	118	106	146	132	120	68	62	98	92	84	85	77	114	106	96	113	124	81	96
23	1	M	27	2	M	2	11	8	0	0	0	0	0	0	0	0	122	120	123	104	90	100	110	102	92	86	56	70	54	46	44	71	84	70	62	58	112	98	54	69
46	3	M	26	2	M	2	13	9	0	0	0	0	0	0	0	0	77	76	82	74	75	116	100	108	98	92	72	64	68	56	54	87	76	82	70	67	77	103	63	76
24	1	F	21	3	M	2	18	13	0	0	0	1	1	0	0	2	85	96	104	102	94	110	96	130	104	102	70	64	88	72	76	84	75	102	83	85	96	108	74	86
36	2	F	23	3	C	2	9	13	0	0	0	0	0	0	0	0	88	94	99	88	86	118	98	104	94	88	68	56	62	54	48	85	70	76	68	62	91	100	58	72
55	3	M	25	2	C	2	13	14	0	0	0	0	0	0	0	0	98	102	112	104	94	124	104	128	104	102	72	68	84	76	58	90	80	99	86	73	102	112	72	86