COMPARISON OF THE EFFECTIVENESS BETWEEN C-MAC D-BLADE AND GLIDESCOPE FOR TRACHEAL INTUBATION IN PATIENTS WITH CERVICAL SPINE IMMOBILISATION SIMULATED BY A SEMI-RIGID COLLAR

By

DR FARAH FATMAWATI BT CHE WIL

MD (UPM)

DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF MEDICINE (ANAESTHESIOLOGY)

UNIVERSITI SAINS MALAYSIA

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ACKNOWLEDGEMENTS

In the name of Allah, the Most Gracious, Most Merciful. Praise to Allah, by His Grace, this manuscript was able to be completed.

This manuscript appears in its current form due to the assistance and guidance of several people. I would therefore like to offer my sincere thanks to all of them.

I want to express my deepest gratitude to my esteemed supervisor Dr Rhendra Hardy Mohd Zaini for the trust, the insightful discussion, offering valuable advice, for your support during the whole period of the study, and especially for your patience and guidance during the writing process.

Special thanks to Professor Dr Shamsul Kamaruljan, our Head of Department of Anaesthesia and Intensive Care HUSM, as well as Dr Wan Nazaruddin Wan Hassan my co-supervisor for their advices and encouragement.

I warmly thank all my fellow colleagues and OT nurses who have always support and help me in the preparation of this thesis until the end.

Not to forget Dr Najib Mat Pa, Dr Wan Ariffin and team whom providing direct coaching on statistical issues throughout this dissertation.

To my dearest ‘mama’, ‘abah’ and family members, thanks for their prayer and of course, the endless love, support and patience.

May Allah (SWT) bless all of us

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ABBREVIATIONS

ASA	American Society of Anaesthesiologist
DBP	Diastolic Blood Pressure
SBP	Systolic Blood Pressure
HR	Heart rate
MAP	Mean arterial pressure
ETT	Endotracheal tube
VL	Videolaryngoscope
DL	Direct laryngoscope (Macintosh)
CL	Cormack Lehane
BIS	Bispectral index
DB	C-MAC D-Blade
GS	GlideScope Ranger
GA	General Anaesthesia
SD	Standard deviation
CI	Confidence interval
POGO	Percentage of Glottic Opening
TMD	Thyromental distance
BMI	Body mass index
LMA	Laryngeal mask airway
IHD	Ischaemic heart disease

ABSTRAK

PERBANDINGAN KEBERKESANAN ANTARA TEKNIK INTUBASI TRAKEA MENGGUNAKAN C-MAC D-BLADE DENGAN GLIDESCOPE KEPADA PESAKIT MEMAKAI KOLAR SEPARA KERAS SEBAGAI SIMULASI MENGELAKKAN PERGERAKAN SPINA SERVIKAL

Objektif: Di antara teknik untuk mengelakkan pergerakan spina servikal adalah dengan pemakaian kolar separa keras tetapi ia akan menyebabkan kesusahan dalam proses intubasi trakea. Oleh itu, kajian ini bertujuan membandingkan keberkesanan dua jenis videolaringoskop iaitu C-MAC D-Blade (DB) dan GlideScope (GS) yang selalu digunakan untuk kes kesukaran intubasi. Kajian ini akan menilai peningkatan dari segi pandangan glottic, masa untuk intubasi dan kestabilan hemodinamik ke atas pesakit yang memakai kolar separa keras itu.

Methodologi: Kajian ini berbentuk prospektif, ‘single-blinded randomized controlled trial‘ yang melibatkan 80 orang pesakit yang dijadualkan untuk menjalani pembedahan dengan bius am. Pesakit berkelas ASA I-II tanpa ciri-ciri kesukaran intubasi menggunakan teknik biasa. Mereka dibahagikan secara rawak kepada dua kumpulan, 40 orang setiap kumpulan mengikut jenis videolaringoskop kajian. Pesakit diberi bius penuh sebelum pemakaian kolar separa keras kemudian laringoskopi dilakukan kepada pesakit dengan alat Macintosh dan diikuti dengan videolaringoskop samaada C-MAC D-Blade (DB) atau GlideScope Ranger (GS). Proses intubasi menggunakan tiub endotrakea yang telah dibentuk menggunakan stilet, GlideRite. Pemandangan glottic

diukur dengan Cormack Lehane dan POGO skor menggunakan alat Macintosh dan videolaringoskop yang telah ditentukan, kemudian masa yang diambil untuk intubasi dicatatkan. Proses intubasi telah berjaya dilakukan oleh seorang doktor bius sahaja, yang mempunyai pengalaman menggunakan kedua-dua jenis videolaringoskop. Data hemodinamik setiap pesakit termasuk tekanan darah dan degupan jantung dicatatkan pada sebelum, selepas; minit pertama, ketiga, kelima dan kesepuluh proses intubasi.

Keputusan: Kedua-dua videolaringoskop telah menunjukkan peningkatan dari segi Cormack Lehane dan POGO skor berbanding dengan alat Macintosh. Majoriti pemandangan glottic Macintosh hanya mendapat CL skor III and IV bagi kedua-dua kumpulan. Selepas menggunakan C-MAC D-Blade kesemua 40 pesakit (100%) mendapat CL skor I dan bagi GlideScope 30 pesakit (75%) mendapat CL I dan 9 pesakit (22.5%) mendapat CL II. Hanya seorang pesakit sahaja mendapat CL III bagi kumpulan GlideScope tetapi tiada bagi kumpulan C-MAC D-Blade. Masa yang diambil untuk mendapatkan pemandangan glottic adalah lebih singkat bagi kumpulan DB dengan min (SD) 11.68 (3.24) saat berbanding 14.69 (5.59) saat bagi kumpalan GS. Masa yang diambil untuk mencapai kejayaan intubasi juga lebih singkat di dalam kumpulan DB berbanding GS dengan catatan masa 37.57 (10.81) saat dan 53.03 (14.45) saat. Tetapi tiada perbezaan yang ketara dari segi kestabilan hemodinamik (tekanan darah dan denyutan jantung) sebelum proses intubasi dilakukan, kecuali pada minit ke-5 selepas intubasi di dalam kumpulan GS. Cuma secara keseluruhannya ada penurunan tekanan darah (SBP, DBP dan MAP) bagi kedua-dua kumpulan di antara sebelum dan selepas intubasi. Tiada perbezaan dari segi komplikasi antara kedua-dua alat ini.

Kesimpulan: Berbanding alat Macintosh, kedua-dua videolaringoskop iaitu C-MAC D-Blade dan GlideScope menunjukkan prestasi lebih baik kerana meningkatkan pemandangan glottic dan kejayaan intubasi. C-MAC D-Blade terbukti lebih berkesan berbanding GlideScope dalam proses intubasi bagi pesakit yang memakai kolar separa keras dengan memberikan CL skor yang lebih baik dan masa yang lebih singkat untuk intubasi. Oleh sebab itu, DB boleh dijadikan antara alatan pilihan untuk kes kesukaran intubasi atau intubasi di situasi yang sukar. Namun kajian lebih lanjut perlu dilakukan untuk memastikan hasil penemuan dari kajian ini.

ABSTRACT

COMPARISON OF THE EFFECTIVENESS BETWEEN C-MAC D-BLADE AND GLIDESCOPE FOR TRACHEAL INTUBATION IN PATIENT WITH CERVICAL SPINE IMMOBILISATION SIMULATED BY A SEMI-RIGID COLLAR

Objective: Among the technique for cervical spine immobilisation is putting on semi-rigid collar but it renders difficult tracheal intubation. In this study, our aim is to compare the effectiveness of two available videolaryngoscopes meant for difficult intubation C-MAC D-Blade (DB) and GlideScope (GS). In terms of improvement of glottic view, time for successful intubation and haemodynamic changes on patients with a semi-rigid cervical collar.

Methodology: This was a prospective, single-blinded, controlled trial with eighty patients scheduled for elective surgery under general anaesthesia. They were selected during premedication round with ASA I-II without any features of difficult intubation. They were randomized equally into two groups, 40 patients each group according to the studied videolaryngoscopes. After induction of general anaesthesia the semi-rigid collar was placed and repeated laryngoscopy was performed using conventional direct Macintosh laryngoscope, C-MAC D-Blade or GlideScope according to randomisation groups before patients were intubated with GliteRite styleted endotracheal tube. Glottic view was scored using Cormack Lehane (CL) and Percentage of Glottic Opening (POGO) scores with Macintoch and respective videolaryngoscope and time for successful intubation were recorded. All patients were successfully intubated by one operator experienced in the use of each laryngoscopes. Patient’s blood pressure, MAP and heart rate were recorded as a baseline value, post intubation at 1, 3, 5 and 10 minutes.

Results: Both videolaryngoscopes showed significantly better Cormack Lehane grade and POGO scores than direct laryngoscope by Macintosh (DL). Majority of glottic view by DL were CL III and IV in both group. It was significantly reduced with the C-MAC D-Blade (DB), 40 patients (100%) had CL I and GlideScope (GS), 30 patients (75%) and 9 patients (22.5%), had CL I and CL II respectively. Only 1 patient had CL III by GlideScope and none had CL IV. Time to best achievable glottic view was significantly better in DB group with mean (SD) 11.68 (3.24) seconds vs 14.69 (5.59) seconds in GS group, $p<0.001$. Successful intubation time was significantly shorter in DB 37.57 (10.81) seconds than GS 53.03 (14.45) seconds, $p<0.001$. There were no significant changes in the baseline hemodynamic parameters (SBP, DBP, MAP and HR) and after intubation except reduced SBP in GS at 5 minutes post intubation. However there were significantly reduced SBP, DBP and MAP in both DB and GS between pre-intubation and post intubation. Hence no difference on incidence of complication in both groups.

Conclusions: Compared to direct Macintosh laryngoscopy, both C-MAC D-Blade and GlideScope resulted in an improved view of glottic opening with successful intubation in all patients. The C-MAC D-Blade showed superior performance than GlideScope in this group of patient with semi-rigid collar applied during intubation on improvement of CL score and shorter duration for intubation. DB may serve as device of choice for intubation in difficult situation but further study needed to confirm these findings.

LAMPIRAN A: ABSTRACT

COMPARISON OF THE EFFECTIVENESS BETWEEN C-MAC D-BLADE AND GLIDESCOPE FOR TRACHEAL INTUBATION IN PATIENT WITH CERVICAL SPINE IMMOBILISATION SIMULATED BY A SEMI-RIGID COLLAR

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Intoduction: Establishing and maintaining a patent airway has been a key responsibility of the anaesthesiologist, tracheal intubation is among the technique of choice. Among the technique for cervical spine immobilisation is putting on semi-rigid collar but it renders difficult tracheal intubation. In view of the limitation, indirect videolaryngoscopy using C-MAC D-Blade (DB) and GlideScope (GS) is suggested for intubation in difficult airway cases with advantages of easy to use and reduced cervical spine motion and force during intubation.

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Dr Rhendra Hardy Bin Mohd Zaini : Supervisor

Dr Wan Nazaruddin Wan Hassan : Co-Supervisor

CHAPTER 1: INTRODUCTION

Since the early days of modern anaesthesiology, establishing and maintaining a patent airway has been a key responsibility of the anaesthesiologist. In order to secure the airway, tracheal intubation is among the technique of choice.

However, standard tracheal intubation via direct laryngoscopy performed by untrained medical personnel or personnel who seldom perform intubation would have higher risk of failure (Nouruzi-Sedeh *et al.*, 2009). Since the introduction of the Macintosh blade for direct laryngoscopy, several attempts have been made to modify and improve laryngoscopes, to ease tracheal intubation. The basic principle has always been to align the three axes – oral, pharyngeal and laryngeal – to obtain a straight line of view (Figure 1.1). Attempts at adapting new imaging techniques for laryngoscopy were also made over the years.

Intubation is process of inserting endotracheal tube through the vocal cord. This can be done by direct vision of the vocal cord with the asssistance of curved Macintosh or straight Miller. However if the vocal cord is being too anterior to be visualised, certain types of blade for example McCoy blade or a gum elastic bougie will be helpful. Indeed, with the advancement of optical technologies, various types of indirect laryngoscopes have been invented to provide the best intubation condition and increase successfulness. Among the examples are supraglottic device, fibreoptic, bonfils and videolaryngoscopes.

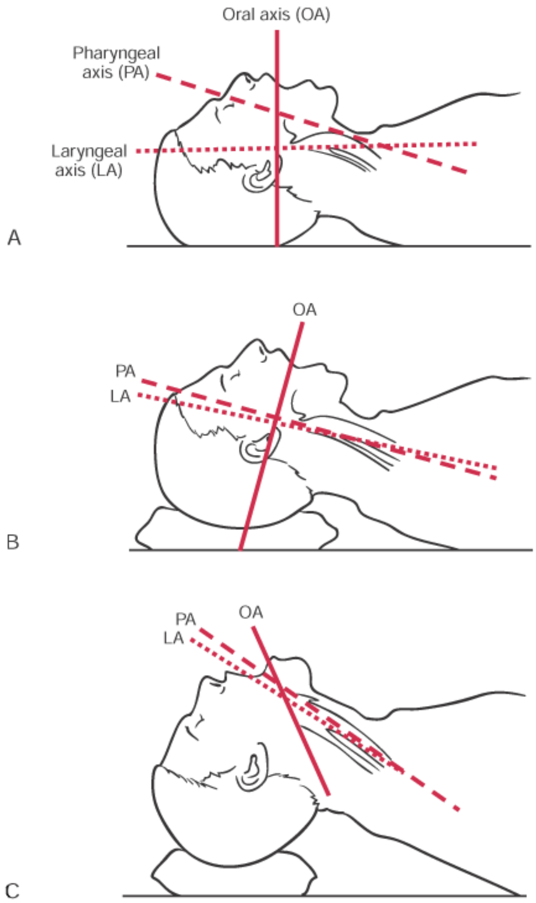

Figure 1.1: Schematic diagram demonstrating the head position for endotracheal intubation. A, Successful direct laryngoscopy for exposure of the glottic opening requires alignment of all 3 axes. B, Elevation of the head about 10 cm with pads below the occiput and with the shoulders remaining on the table aligns the laryngeal and pharyngeal axes. C, Head extension at the atlanto-occipital joint creates almost straight line from the incisor teeth to glottic opening. (Miller, 2005)

The aim of intubation is securing airway and prevent hypoxia so failure to do so will lead subsequence damage. However in an emergency situation, process of securing the airway may lead to failure or inadequate ventilation which would increase mortality and morbidity (Peterson *et al.*, 2005).

In patient with cervical spine injury (CSI), securing the airway while maintaining cervical spine immobilisation is difficult, in order to avoid secondary neurological damage (Trauma, 2008). Among method to reduce cervical spine movement is application of rigid cervical collar as advices by ATLS but renders tracheal intubation with a standard laryngoscope difficult (Trauma, 2008). This is due to limited mouth opening and impaired glottic view.

The chief concern during the initial management of patients with potential CSI is that neurologic function may be further compromised by pathologic motion of the injured vertebrae.

Management of the potentially traumatized spine emphasizes three principles:

- Restoration and maintenance of spinal alignment
- Protection of the cord with preservation of intact pathways
- Establishment of spinal stability

To achieve these principles, immobilization of the cervical spine before radiographic assessment and clearance is the accepted standard of care (Crosby, 2006).

Difficult intubation is a condition where a trained anaesthetist facing problem to intubate a patient after more than three attempts or taking more than ten minutes. Awake fibreoptic intubation is considered as a gold standard technique for difficult intubation (Puchner *et al.,* 2011). But in emergency situation awake tracheal intubation is almost impossible as patients conscious level are not predictable, time consuming and require special expertise to handle those equipment.

In view of the limitation, indirect videolaryngoscopy using GlideScope is suggested for intubation in difficult airway cases with advantages of easy to use and reduced cervical spine motion and force during intubation.

Videolaryngoscopy provides superior views compared with traditional laryngoscopy in both normal and difficult intubation situations and is relatively easy to use, making it potentially advantageous for this type of patient (Cattano *et al.*, 2012).

Since the availability of newer videolaryngoscope system by Storz, C-Mac D-Blade will be compare to GlideScope for the efficacy of the device in cervical immobilised patients. In this study, we compare 2 videolaryngoscopes intubation which are the C-Mac D-Blade and Glidescope.

C-Mac Videolaryngoscope is the 4th generation of Karl Storz Videolaryngoscope. In the late 2010, D-Blade component for C-Mac was introduced. It has an elliptical tapering shape which anatomicaly adapts to oropharynx so that it can be easily and quick placed in front of the glottis to ensure raid and safe intubation. On the other hand, Glidescope which was launched in 2006 possesing a unique 60 degree curvature so as to glide along the oropharynx with minimal manipulation. Both intubation aids are proven in difficult airways setting compare to conventional direct laryngoscope. There were few studies comparing the performance of Glidescope and C-Mac (Cavus *et al.*, 2010; Serocki *et al.*, 2013). Bathory *et al.* (2009) did evaluation on tracheal intubation on patient with semi-rigid collar but only using Glidescope. However none of them compare the effectiveness and hemodynamic changes between these two videolaryngoscopes in patient with cervical spine immobilisation via semi rigid collar.

CHAPTER 2: LITERATURE REVIEW

2.1 INTUBATION

Despite many advances in patient safety, endotracheal intubation remains a specialized learned skill, and a difficult endotracheal intubation remains an important adverse event. The development of algorithms for airway management has been helpful, and certain technological advances, such as the laryngeal mask airway, have helped make airway management safer. Over the past several years, enhanced visualization of the airway has been accomplished with the adaptation of fiberoptic bronchoscopes for this purpose. These instruments, however, largely remain in the operating room environment and are awkward to use in emergency situations. The skill of fiberoptic intubation is difficult to learn, and the scopes are expensive to maintain. Hence, the goals of making endotracheal intubation an easier skill to learn and maintain and a highly reliable procedure remain unattained.

Endotracheal intubation is the process for placement of a tube into the trachea in order to maintain an open airway in patients who are unconscious or unable to protect their airway for any reasons. Other that supplying oxygen, anesthetics agent or other medications can also be delivered through the endotracheal tube. Intubation can be in elective or emergency situation depends on the indication for it. Intubation typically performed using direct laryngoscope (DL) Machintosh or Miller, but alternative techniques such as indirect laryngoscopy via video laryngoscope, fiberoptic intubation or retrograde intubation are used in specific setting (larry chu, 2012).

In 1967, flexible fibreoptic intubation was introduced by Dr Peter Murphy as a technique used in managing difficult airway (Murphy, 1967). Elective awake fibreoptic intubation is considered as a gold technique for anticipating difficult intubation (Morris, 1994; Puchner *et al.*, 2011). It is a direct visualization of the laryngeal structures included vocal cord before placing the endotracheal tube into the trachea via a video monitor.

New intubation equipment can be categorised as follows (Behringer and Kristensen, 2011):

- *Macintosh blade-shaped optical laryngoscopes* e.g. Storz V-MAC/C-MAC video laryngoscope (Karl Storz, Culver City CA, USA), McGrath MAC (Aircraft Medical, Edinburgh, Scotland). These devices have Macintosh-shaped blades combined with video technology. They can be used either as a conventional direct laryngoscope or as an indirect video laryngoscope. The video option is beneficial when coordinating optimal external laryngeal manipulation with an assistant or teaching laryngoscopy. The camera is placed distally on the blade, providing a slightly more distal and wider angle view than is achieved with direct laryngoscopy.

- *Angulated blade rigid indirect optical devices* e.g. GlideScope (Verathon Medical, Bothell WA, USA), McGrath series 5 (Aircraft Medical), TruView Devices (Truphatek International Limited, Netanya Israel), Bullard laryngoscope, Storz D-blade (Storz), AP Venner scope (Intavent Direct, Maidenhead, UK). These devices provide only an indirect video laryngoscopic view of the glottis and require use of a pre-shaped, styleted tracheal tube during intubation.

- *Channelled rigid indirect optical devices* e.g. Airtraq (Prodol, Vizcaya, Spain), Pentax-Airway Scope (Pentax-AWS, Ambu Glen Burnie MD, USA). These devices have a guiding channel that directs the tracheal tube towards the glottic opening. The Airtraq is a single-use device with an optional wireless video monitor. A variety of sizes are available (infant to adult) as well as devices for nasotracheal or endobronchial intubation. The Pentax AWS consists of a reusable 2.4″ high-resolution colour LCD video monitor and a disposable single-use conduited blade.

2.1.1 Difficult Airway

Adopted from American Society of Anaesthesiologist (ASA) Difficult Airway Algorithm in 2002 and published in 2003, difficult airway is defined as clinical situation in which a conventionally trained anaesthesiologist experiences difficulty with face mask ventilation, difficulty with laryngoscopy or tracheal intubation or both (Apfelbaum *et al.*, 2013).

Difficult laryngoscopy is where limited visualisation of any part of vocal cord, as described by Cormack Lehane grading system. It is classified as the relationship of the glottis opening to the surrounding structure during laryngoscopy. Commack Lehane grade III and IV generally considered as difficult laryngoscopy (Cormack and Lehane, 1984). However the glottis view grading is also influence by operator skill and different type of laryngoscope used. **(Figure 2.1)**

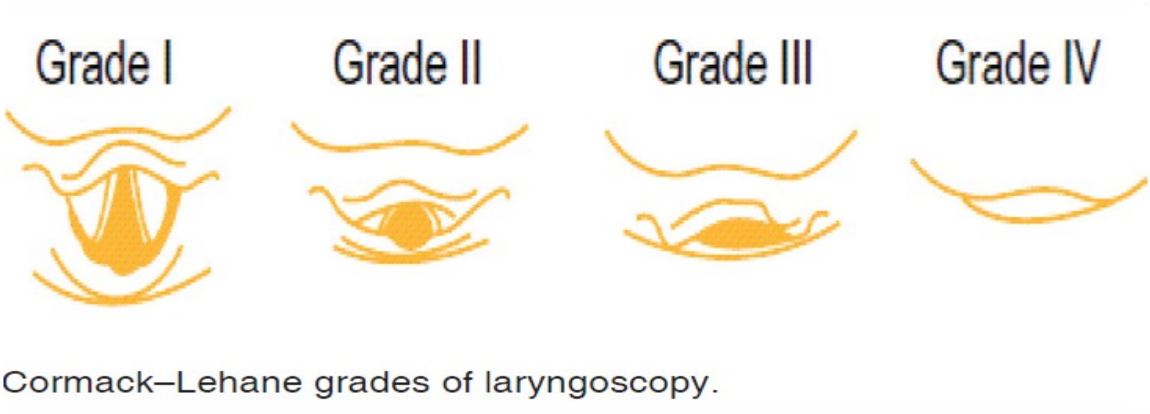

Figure 2.1: Cormack Lehane Grading

Reported by Crosby *et al.* (1998) incidence of laryngoscopy is between 2-8 percent in operating room whereas up to 14 percent in emergency room. The higher percentage noted outside operation room could be due to level of training of the personnel, patient's condition and the use of drugs eg muscle relaxant.

No text-book has a systematic analysis of difficult intubation. Normally the tongue blocks the line of vision, and lifting it forward clears the view. It follows that three main factors can cause difficulty (Cormack and Lehane, 1984):

- Forward displacement of the larynx
- Difficulty in opening the mouth or extending the head or prominent upper teeth
- Backwards displacement of the tongue

In order to reduce incidence of unexpected difficult intubation, it is important to identify patients who are at risk during premedication round. It is done by taking detail history and significant physical examination to show risk of difficulties in managing the airways. There are a lot of ways to predict difficult intubation in apparently normal patient such as Mallampati classification (**Figure 2.2)**, thyromental distance, sternomental distance, protuberant teeth, mouth opening and Wilson risk score (Eberhart *et al.*, 2010). Facial trauma, dental fracture (Le Fort Fracture), abnormal face, tumor, pregnant lady, obese with short neck may also cause difficulty in intubation. Other factors associated to difficult intubation include rheumatoid disease of the neck, degenerative disease of spine, or cervical spine fracture may have reduction in neck movement (Ed George and Kenneth L. Haspel, 2000).

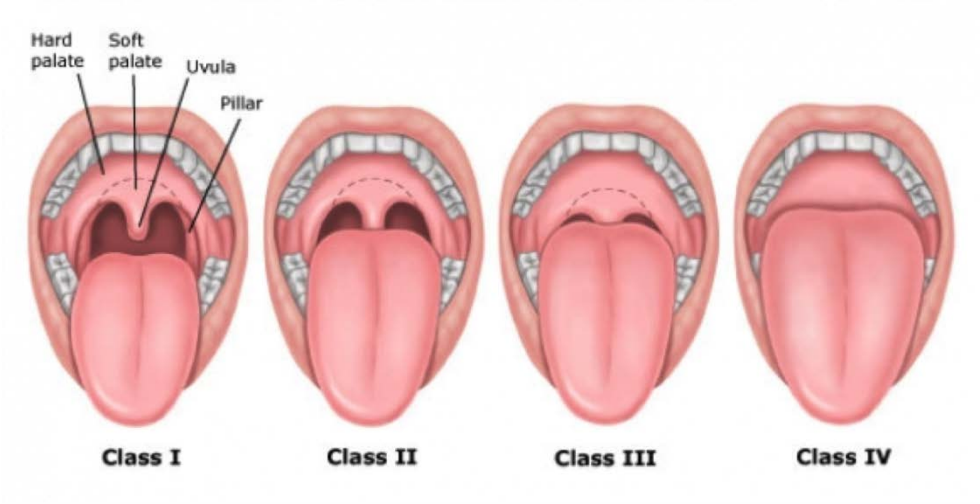

Figure 2.2 Mallampati Classification (*source from AnaesthesiaUK*)

Hence, it is mandatory to recognise these patients because unanticipating difficult intubation can be challenging and may cause a lot of complication to them (Eberhart *et al.*, 2010).

According to Niforopoulou *et al.* (2010) only 0.1–0.5% of the general population is likely to be truly difficult. This means that many unselected patients, or patients who are known to be difficult to intubate, need to be studied. However, it is not easy to identify pre-operatively patients who may be difficult to intubate, as all the diagnostic tests have low sensitivity and positive predictive value (Shiga *et al.*, 2005).

Despite the above finding, in this study pre-operative assessment done in ward prior surgery to exclude any sign predictive difficult airway that lead to difficult intubation.

2.1.2 Haemodynamic Changes

Despite the emergence of new airway devices in the recent years direct laryngoscopy and tracheal intubation still remains the gold standard in airway management. Laryngoscopy and endotracheal intubation are mandatory for most patients undergoing general anesthesia, which is invariably associated with certain cardiovascular changes such as tachycardia or bradycardia, rise in blood pressure and a wide variety of cardiac arrhythmias. These effects are deleterious in susceptible individuals culminating in perioperative myocardial ischemia, acute heart failure and cerebrovascular accidents.

Commonly, the sympathetic response following laryngoscopy and intubation peaks at 1-2 minutes and returns to normal within 5-10 minutes. Various systemic as well as topical agents were used to reduce these untoward hemodynamic responses due to laryngoscopy and intubation. Study on haemodynamic changes including HR, SBP, DBP and MAP during intubation comparing Labetolol, Esmolol and placebo group. It shows better sympathetic response attenuation in Labetolol group (Lakshmi *et al.*) but haemodynamic changes in placebo group is still comparable. This may be contributed by the induction agent, opioids and adequate muscle relaxant that attenuated the sympathetic response during laryngoscopy and intubation.

Besides causing haemodynamic instabillity, intubation also can cause stress and pain to the patient, which can be considered as contributing factors that might increase the neuroendocrine hormones such as ACTH, cortisol and cathecholamines. This surge of neuroendocrine hormones can lead to higher morbidity and length of stay in hospital with high cost.

This sympathetic stimulation also can increase in intracranial pressure and cardiac arrest also has been reported (S.Beebe, 2001). Reported by McElwain and Laffey (2011) the effects of the laryngoscopy and tracheal intubation on MAP and HR were relatively modest and no difference between C-MAC, Airtraq and Macintosh groups. They were using IV Fentanyl and IV Propofol for induction agent without any additional topical or IV Lignocaine to attenuate sympathetic response.

2.2 CERVICAL SPINE IMMOBILISATION

In patients who have sustained high impact trauma, are at risk of unstable cervical spine injuries. Neck immobilisation is mandatory in these groups of patient, prior to any form of airway manipulation. The cervical spine may be effectively immobilised with a rigid collar, wide cloth tape across the forehead securing the head to a firm base and sandbags on either side of the neck. Alternatively, manual in-line stabilisation is also an effective method for immobilising the cervical spine (Heath, 1994). Paramedics are taught to apply a rigid collar to any patient with possible cervical spine injury at the scene of the accident. These patients may subsequently require intubation either by the paramedics or upon arrival in emergency department. Any attempt to immobilise the cervical spine will make visualisation of the larynx more difficult, thus prolonged intubation time and predisposing to hypoxaemia in these high risk patients.

Heath (1994) demonstrates that when these two methods for cervical spine immobilisation during orotracheal intubation are compared, laryngoscopy is considerably improved when manual in-line immobilisation is employed to stabilise the neck rather than a rigid collar, tape and sandbags. The presence of a rigid collar significantly impedes mouth opening and is the main reason for the deterioration in the view of the larynx.

The improvement in the neurologic status of patients has been attributed to improved initial care and retrieval systems including recognition of the importance of instituting prehospital spinal immobilization, maintaining immobilization until clearance is obtained or definitive therapy is applied and hospital practices to prevent secondary injury. The routine use of spine immobilization for all trauma patients, particularly those with a low likelihood of spinal injury, has been challenged on the basis that it is unlikely that all patients rescued from the scene of an accident or site of traumatic injury require spine immobilization (Crosby, 2006).

A semi-rigid cervical collar is recommended for immobilization of the cervical spine in patients with suspected cervical spine injury (Trauma, 2008). These patients often require tracheal intubation with a degree of urgency, frequently under less than ideal conditions. The presence of a semi-rigid cervical collar has been shown previously to result in a poorer view at laryngoscopy (Goutcher and Lochhead, 2005).

The application of cervical collars has also been associated with increased intracranial pressure (ICP) in both injured patients and healthy volunteers. Davies *et al.* (1996) prospectively analyzed ICP in a series of injured patients treated with a rigid collar. Although the difference in ICP of 2.47 mm H2O was statistically significant, it remains uncertain that it has clinical relevance. Nonetheless, this modest increase in pressure may be magnified in patients who already have increased ICP and poor intracranial compliance (Crosby, 2006). The potential for complications should not discourage the use of immobilization where indicated.

Actually none of the techniques and devices for spinal immobilization is conclusive. The position in which the injured spine should be placed and held immobile is describe as the neutral position is poorly defined. Evaluation on efficacy of cervical spine immobilization techniques shows hard foam and hard plastic collars were better at limiting cervical spine motion than soft foam collars (PODOLSKY *et al.*, 1983).

Although 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 of the other individual methods tested. Adding a Philadelphia collar to the sandbag–tape construct reduced neck extension but had no effect on any other motion of the cervical spine. These authors found that sandbags and tape combined with a rigid cervical collar was the most effective construct of those evaluated to limit cervical spine motion, restricting movement to approximately 5% of the normal range.

Goutcher and Lochhead (2005) did assessment on three collars; 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) on the interincisor distance. Application of a collar significantly reduced interincisor distance. They concluded that the presence of a semirigid collar significantly reduced mouth opening and would likely often interfere with airway management.

The goal of manual in-line immobilization (MILI) is to apply sufficient forces to the head and neck to limit the movement which might result during airway management. MILI is typically provided by an assistant positioned either at the head of the bed or, alternatively, at the side of the stretcher facing the head of the bed. The patient is positioned supine with the head and the neck in neutral position. Assistants either grasp the mastoid processed 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 MILI is in place, the anterior portion of the cervical collar can be removed to allow for greater mouth opening, facilitating airway interventions. During laryngoscopy, the assistant ideally applies 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.

In term of lagyngoscopic view, MILI reduced the amount of head extension that was necessary for laryngoscopy so resulted in a poorer glottis view. Although manual in-line immobilization may have lesser impact on airway interventions than do other forms of immobilization. The experience supports routinely removing at least the anterior portion of collars to facilitate airway interventions provided that cervical spinal immobilization is maintained by MILI. Removal of the anterior portion of the collar improves mouth opening and facilitates airway management; reapplication of the mechanical immobilization should occur promptly when airway interventions are complete. MILI may increase laryngoscopic grade in some patients; this may be countered with anterior laryngeal or cricoid pressure (Crosby, 2006). The disadvantage of MILI is requirement of at least two trained assistance during intubation procedure that might not always available in emergency or trauma situation.

2.3 VIDEOLARYNGOSCOPE

Video laryngoscopes resemble a traditional laryngoscope, but have a video chip embedded in the blade. The video chip transmits magnified images to a display screen where they can be seen and recorded. The fundamental difference is that the laryngeal view is generated indirectly with a videocamera focused at the laryngeal inlet, and alignment of the oral, pharyngeal and laryngeal axes (i.e. a line of sight) is not essential to view the glottis. Video laryngoscopes differ from optical laryngoscopes such as the Airtraq, which do not have a videocamera, and in which the image is generated by a series of optical lenses and prisms. The image can be displayed on a remote screen or on a monitor attached to the laryngoscope itself.

When performing laryngoscopy, the first step is to determine whether one can see the vocal cords and in that respect, video laryngoscopes certainly fulfil their promise. There is a large amount of data, from both normal and simulated difficult airways in patients, demonstrating that video laryngoscopes consistently give a better view of the larynx than conventional direct laryngoscopes (Cooper *et al.*, 2005; Brown III *et al.*, 2010). This is because the image is captured using a camera with a wide-angled lens positioned close to the vocal cords (Kaplan *et al.*, 2006).

Eventhough a better glottis view is often assumed to facilitate intubation but with video laryngoscopes, there is evidence that insertion of the tracheal tube through the vocal cords may be difficult (Nusrath, 2011). This is due to the distal parts of the blades of the Glidescope and McGrath, and the D-blade of the C-MAC laryngoscope are angulated with a sharp anterior deflection that focuses the camera towards the larynx, giving a better view of an anterior or high larynx.

Furthermore this view does not reflect the difficulty while advancing the tube, when the acute anterior curve in the oropharynx has to be negotiated to reach the vocal cords. Also, oropharyngeal tissues do not need to be retracted and compressed to achieve a straight line of sight; this may limit the airspace available for manipulating the tracheal tube. In addition, videolaryngoscopy requires a degree of hand–eye coordination and practice is needed to develop the skill needed for advancing the tracheal tube while viewing the monitor. These problems are being addressed by both manufacturers and investigators, and pre-shaped stylets that match the distal curve of the blade and direct the tube anteriorly are now available (McElwain *et al.*, 2010a).

In video laryngoscopes with an integrated tube channel, the tracheal tube is placed in a slot adjacent to the camera and after a good view is achieved, theoretically, the tube then has merely to be advanced further to reach the glottis. It is plausible that this could make directing the tracheal tube easier, although there is very limited evidence to support this assumption.

Video laryngoscopes are new intubation devices, which provide an indirect view of the upper airway. In difficult airway management, they improve Cormack–Lehane grade and achieve the same or a higher intubation success rate in less time, compared with direct laryngoscopes (Bathory *et al.*, 2009). Despite the very good visualization of the glottis, the insertion and advancement of the endotracheal tube with video laryngoscopes may occasionally fail depending on the situation and skill the anaesthesiologist (Niforopoulou *et al.*, 2010).

Niforopoulou *et al.* (2010) reviewed few device includes Glidescope and CMAC concludes that video laryngoscopes are promising intubation devices, which provide a great visualization of the larynx and have a high intubation success rate. Each particular device has different features, which may constitute advantages or disadvantages. Their precise role in airway management remains to be established.

These optical intubation devices or videolaryngoscopes (VLS) have dramatically improved the quality of glottic view. Multiple studies have proven enhanced visibility but not necessarily faster intubation times. Interestingly, in a study on manikins simulating difficult airway with stiff collars, VL was not superior to direct laryngoscopy, but the sample size was low (Wetsch *et al.*, 2012). Furthermore, while VL improve visualization of the airway, it is important to realize that a good view of the laryngeal opening does not automatically lead to intubation success. For example, in a recent study, the C-MAC VL showed a good view of the larynx in 95% of cases, but the actual success rate of the intubation was only 88% (Byhahn *et al.*, 2010). These different success rates cannot directly be compared since these studies were performed in different patient populations by different operators, in different settings regarding difficult airways, and with different outcome parameters. Most importantly, the majority of patients enrolled presented with a normal airway, or only manual inline stabilization was used to simulate a difficult airway. No study compared all these devices in the same setting, and no sufficiently powered study used extrication collars to adequately simulate a clinically important difficult airway situation (Theiler *et al.*, 2013).

2.4 GLIDESCOPE RANGER

The Glidescope (designed by vascular and general surgeon John Allen Pacey) was first launched in 2001. It became the first commercially available video laryngoscope. It incorporates a high resolution digital camera, connected by a video cable to a high resolution LCD monitor (http://verathon.com/Products/Glidescope/ranger.aspx). The special features of the GlideScope that have been described by Verathon include:

- The steep 60-degree curve blade improves the view of the glottis by reducing the requirement for anterior displacement of the tongue.
- The CMOS (complementary metal-oxide-semiconductor) APS (active pixel sensor) digital camera is attached at the point of angulation of the blade (rather than at the tip). This placement allows the operator to more effectively view the field in front of the camera.
- The video camera is recessed for protection from blood and secretions which might otherwise obstruct the view.
- The video camera has a relatively wide viewing angle of 50 degrees.
- The heated lens innovation helps to prevent fogging of the lens, which might obscure the view.

Tracheal intubation with the GlideScope can be facilitated by the use of the Glidelite Rigid Stylet, a stylet that is curved to follow the 60° angulation of the blade. To achieve a 99% successful rate of intubation with the GlideScope requires the operator to acquire a new skill set with this stylet.

GlideScope Ranger is a product by Verathon Medical which was designed for United States Air Force. It is a portable-type of classic GlideScope and is currently been widely used in Emergency unit and military site (Figure 1.1).

GlideScope Ranger is made up of 3 components:

- Ranger Video monitor
- Ranger GVL 3 or GVL 4
- Gliderite Rigid Stylet

Figure 2.3: Components of GlideScope Ranger (*source from Verathon Medical*)

The Ranger monitor is a non-glare monitor which show real-time picture with wide-view angle of 50 degree. The blade or known as Ranger GVL is a reusable, medical-grade plastic shell that houses a CMOS camera, LED (light emitting diode) light source, and anti-fogging mechanism. It is integrated with a video cable and is available in adult, peadiatric and neonate. For adult, it came with two sizes, which are 3 and 4.

Manufacturer claims that intubations using the Ranger GVL only require approximately 0.5 - 1.5 kg of lifting force. This is similar to a study by Russell *et al.* (2012) that compared forces applied during intubation between Glidescope and Macintosh. In this study, the median peak force in Glidescope and Macintosh were 0.9 kg and 2 kg respectively.

Gliderite Rigid stylet has been designed to complement the angle of the GVL to facilitate intubation, and should be used with endotracheal tubes 6.0mm and larger. A malleable stylet may be used with a 60°– 90° angle.

In order to guide the passage of the endotracheal tube when at the vocal cords, the stylet need to be gradually withdrawn approximately 2 inches (5 cm). A 1cm withdrawal adjustment of the laryngoscope may be beneficial to reduce the viewing angle and allow the glottis to drop.

Below is the listed indication for GlideScope using as suggested by Verathon Medical:

- First choice: elective oral intubation.
- First choice: nasal intubation.
- Anticipated difficult laryngoscopy
    - ✓ GlideScope awake intubation strategy
    - ✓ GlideScope rapid-sequence induction
    - ✓ Unanticipated failed laryngoscopy
- Combined use of the GlideScope and flexible video or fiberscope for management of the extremely difficult airway.
- Combined use of the GlideScope and Trachlight device.

- Combined use of the GlideScope video laryngoscope and the video stylet class of devices. The GlideScope serves to allow the rigid visualizing stylet to be accurately guided to the glottis and ultimately deliver the endotracheal tube.
- Operating room: ear, nose, and throat used to document the recurrent laryngeal nerve status after neck operations.
- Placement of esophageal echo probes under direct vision.
- Placement of double-lumen tubes for thoracic surgery.
- Emergency department applications
  - ✓ Bloody contamination in the airway
  - ✓ Combative and drug-dependent patients
  - ✓ High-risk intubation: severe acute respiratory syndrome and Ebola virus
  - ✓ Inline stabilization for trauma for unknown neck status.
- Intensive care unit (ICU) applications
  - ✓ Endotracheal extubation backup support strategy
  - ✓ GlideScope-assisted endotracheal tube-exchange catheter strategies
  - ✓ Placement of nasogastric tubes to avoid lung-feeding errors
- Air medical applications
  - ✓ Critical care air transport issues
  - ✓ Air medical in-flight intubation procedures
- Teaching airway anatomy to novice airway managers. You *et al.* (2009) reported that Glidescope gives a high degree of satisfaction of learning tool among premedical students
- Telemedicine: Wi-Fi, G3, or G4 transmission for coaching, military secure networks, civil wide-area networks, optical trunks or cell node

- Pediatric
  - ✓ Neonatal ICU (NICU) applications: intubation of low birth weight infants
  - ✓ NICU confirmation of stability and position of endotracheal tubes
  - ✓ Intubation “syndrome children” eg, Pierre Robin Sequence

Despite a long list of beneficial usage of GS Ranger, there must be risk from the device. The only absolute contraindication to use of the GlideScope is restricted mouth opening of less than 14mm, as this is the width of the widest portion of the blade. Relative contraindications to use of the device are situations in which the tube must be placed rapidly, for example a patient who desaturates very quickly. When using the GlideScope it frequently takes longer to pass the tube into the trachea once the glottis is visualized as compared to direct laryngoscopy (Healy *et al.*, 2012a).

According to Sun *et al.* (2005) GlideScope provide an equal or better laryngoscopic view than conventional laryngoscope in most patients though it takes longer time for intubation. The better glottic view is due to it 60 degree blade curvature compare to the normal curve of conventional laryngoscope. Glidescope may reduce attempts of intubation and improve the Cormack Lehane score markedly compare to direct laryngoscope (Cooper *et al.*, 2005).