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ORIGINAL RESEARCH

Comparitive evaluation of video laryngoscope versus direct laryngoscope for intubationin covid 19 mucormycosis patients – A prospective, randomized study

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ABSTRACT

Background: Mucormycosis is a life-threatening,aggressive fungal infection that occursin COVID19 patients due to immune compromised state.Amphotericin B and surgical debridement are the treatment modalities. These patients can have a difficult airway owing to its inflammation, pose a challenge to the anaesthesiologist.Our aim was to compare Mc Grath MACVideo laryngoscope and direct laryngoscopeon the ease of intubation and haemodynamic response in patients with mucormycosis for debridement. **Methods:** This study was a randomised clinical trial on 100 patients with mucormycosis undergoing debridement surgery. Group A was intubated with Macinthosh laryngoscope and Group B with McGrathMAC Video laryngoscope. Primary outcome parameters were Cormack Lehane (CL) grade, time from laryngoscopy to successful intubation, number of attempts, use of airway adjuncts and any airway injury. Secondary outcome parameters were measurement of Heart Rate (HR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP),on arrival, before and after intubation, and at 1, 3, 5, and 10minutes after intubation. **Result:** Time from laryngoscopy to successful intubation was shorter in Group B (31.8 ±7.945) versus Group A (35.22±7.56) seconds. 8% patients hadairway injuries in Group A. No significant difference in the number of attempts,CormackLehane (CL) grade and use of airway adjuncts. Haemodynamic parameterswere better in Group B compared to Group A. **Conclusion:** Mc Grath MacVideo laryngoscopewas more acceptable with its glottic visualisation, shortest time for successful intubation with reduced aerosol exposure, and noairway traumawith better haemodynamic compared to direct laryngoscopefor intubation in patients with mucormycosis.

Keywords: Direct Laryngoscope,Video Laryngoscope, Endotracheal Intubation, Mucormycosis, General Anaesthesia.

INTRODUCTION

Mucormycosis is an aggressive, fulminant,rapidly progressive, opportunistic fungal infection that can occur in immunocompromised patients with diverse precipitating factors[1]. It was associatedin the second wave Coronavirus disease (COVID 19)in India.

Classical features of mucormycosis infection are angioinvasion, thrombosis, infarction and necrosis. Fungi can penetrate fascial compartments leading to invasion of surrounding subcutaneous fat, muscle and bone. Early diagnosis, treatment of predisposing factors, surgical debridement of necrotic tissue, and administration of antifungal therapy are the modalities in the management[2].Surgical debridement of rhinorbito-maxillary mucormycosis involves procedures like FESS(functional endoscopic sinus surgery), maxillectomy, mandibulectomy and orbital decompression. Anaesthetic concerns includes anticipated difficult mask ventilation and endotracheal intubation due to compromised mouth opening due to jaw erosion and pain, bleeding palatal ulcers, palatal perforations, crusts in the nose, oroantral fistulas,associated epiglottitis, sub and supraglottic oedema, and diabetes mellitus induced joint stiffness[3,4].Pulmonary fibrosis,uncontrolled/labile blood sugar levels, deranged renal and liver function, metabolic derangements due to antifungals and various organ involvementsmay have additional

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implications[5].Direct laryngoscopy using the Macintosh blade is the intubating technique of choice for most anaesthesiologist when performing elective tracheal intubation in the operating theatre[6].Indirect rigid videolaryngoscope is a relatively new add on to anaesthetic practice, and there is increasing evidence of its use during difficult tracheal intubation[7].Video laryngoscopes (VL) offer indirect laryngoscopy, combining features of both flexible fibreoptic scopes and standard rigid laryngoscopes.The McGrath MAC (Aircraft Medical, Edinburgh, UK) video laryngoscopewith an integrated, 1.7inch LCD monitor and is a portable video laryngoscope with Macintosh based blade which is angulated. Theminiature video camera enables the operator to visualise the glottis indirectly, improving the glottic view, and the success rate compared to conventional laryngoscopes[8].

The American Society of Anesthesiologists Task Force on Management of the Difficult Airway,recommends that a Videolaryngoscope to be available as a first attempt or rescue device for all patients being intubated[9], as it improves visualization of larynx, intubation success with added advantage of decreased cervical spine movement when compared to direct laryngoscopy.

Our study aimed to compare the use of video laryngoscope and direct laryngoscope for smooth and ease for successful intubationalong with hemodynamic response to laryngoscopy and intubation.We also observed for any mucosal airway injuries.

MATERIALS AND METHOD

The Institutional Ethics Committee (IEC) approved the study (BLCMCRI/IEC/APR/070/21-22)accordance with the principles of the declaration of Helsinki andregistration in the clinical trial registry India (CTRI/2022/03/041509**).** Written informed consent was taken from the patient who enrolled for the study.This study was a randomized clinical trial, conducted in a tertiary care government hospital, during September to December 2021.

Sample size was calculated based on standard deviation (SD) and minimum difference (d) detected for mean intubation time(excluding unsuccessful attempts) between McIntosh laryngoscope and KVVL from previous study by Erdivanil et al[10]where Mean ± SD for McIntosh laryngoscope was 7.2±2.2 and KVVL was 8.4±3.8.Keeping 95% confidence interval, power of study 80%, combined standard deviation of 3.0 and a minimum difference of 1.2. Sample size wascalculated using the formula: $N = 2*(Z\alpha+Z\beta)^2 \times \sigma^2/\delta^2$

$N=2*(1.96+0.84)^2 * (3)^2 / (-1.2)^2 = 98$

Substituting the values in formula we got sample size of 98 for two groups. 49 eachapproximated to 50 in each group.Hundred post COVID patients with invasive mucormycosis belonging to American Society of Anaesthesiologists(ASA)classes II and III aged between18-65 years of either sex, posted for functional endoscopic sinus surgery (FESS), maxillectomy and mandiblectomy requiring general anesthesia and endotracheal intubation were included in the study.Patients with severe systemic illness such as diabetic keto acidosis, endstage renal disease, acute coronary syndrome, heart blocks, bleeding diathesis,Chronic Obstructive Pulmonary Disease, severe asthma, ARDSand whose requiring oxygen > 6litre to maintain oxygen saturation of >92% were excluded from the study.

The McGrath Videolaryngoscope with size 3 or 4 Macintosh-based blade, and /or standard laryngoscope using a size 3 or 4 Macintosh blade was used for laryngoscopy and intubation. The choice of size 3 or 4 blade was at the discretion of the provider based on patient assessment. Patients were allocated randomly based on computer generated randomization sequence to the McGrath or direct laryngoscopy group for tracheal intubation. Procedure was explained and an informed written consent was obtained from the patients. Patients were kept nil orally for 6 hours prior to surgery. Tab Alprazolam 0.5mg was administrated night before surgery.An intravenous 18G cannula secured and intravenous fluid was started.All patients were monitored with ECG(Electrocardiogram), pulse oximetry and noninvasive blood pressure.Patients were premedicated with injection midazalom 1mg and fentanyl 2ug/kg. Preoxygenated with 100% oxygen and induced with injection propofol 2mg/kg. After confirming adequate bag-mask ventilation, injection succinylcholine 1.5 mg/kg was administered.Laryngoscopes were used for intubation depending upon the group.

Group A (n=50): Intubated using Mc Inthosh laryngoscope

Group B (n=50): Intubated using Mc Grath - MAC video laryngoscope

All intubations were performed by an experienced anaesthesiologists (≥6years)with appropriate sized cuffed endotracheal tube. All hemodynamic data were measured on arrival at operating theatre, before induction, after induction, and at 1, 3, 5 and 10 minutes after intubation by an independent observer.

Primary outcome parameters were successful intubation, CL grading, time from laryngoscopy to successful intubation, number of attempts required for intubation, use of airway adjuncts and any mucosal airway injury. Secondary outcome parameters were hemodynamic data(HR, SBP, DBP) measured on arrival, before and after induction, and at 1, 3, 5 and 10 minutes after intubation.Successful intubation is defined as placement of the endotracheal tube (ETT) in the trachea, as confirmed by endtidal CO_2($ETCO_2$) capnography and chest auscultation.Time from laryngoscopy to confirmation of successful intubation is defined as time taken from picking up a laryngoscope till confirmation of ETT placement in trachea by capnography. Anyreasons for failure of intubation on first attempt(difficulty in visualization of glottis, reduced working space in the oral cavity to

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pass endotracheal tube) were also noted. Patients, anaesthesiologistsperforming laryngoscopy and observers recording and analysing the data were all blinded to the study.

STATISTICAL ANALYSIS

Statistical analysis was done use of a Statistical Package for Social Sciences (SPSS) software, IBM manufacturer, Chicago, USA, version 22.0. The presentation of the categorical variables was done in the form of numbers and percentages (%). Quantitative data with normal distribution were presented as Mean±SD. Descriptive statistics was done for distribution of age, gender, ASA, and Airway assessment.Independent t test was done to compare mean HR, SBP,DBP on arrival,pre intubation, after intubation, 1min, 3 min,5 min,10 min between two groups, and time taken for intubation. Chi square test was used to compare number of attempts, Cormack Lehane Grade, use of airway adjuvants and mucosal injury during laryngoscopy between the two groups. Two-tailed p values < 0.05 was considered as statistically significant.

RESULTS

A total of 114 patients were entered into the study and consented to participate, were randomized into two groups. 14 patients were excluded from analysis due to change in the laryngoscope by the operators and could not determine the time for intubation. Therefore, the data of 50 patients each in group A and group B were analysed (Fig. 1). The distribution of patients in the two study groups is shown in Table 1.The two groups had comparable demographic profiles with respect to age, gender, ASA and BMI distribution,modified Mallampatti class airway assessmentwith no significant difference (P <0.05).Table 2 displays Cormack Lehane Grading was lower in group B when compared to group A, suggesting better visualisation with Video laryngoscope than with direct laryngoscope.There was 100% successful intubation rate in both groups. First pass intubation was almost similar in both groups (96% versus 94%; group A Vs group B respectively, with P >0.05.This successful intubation without using any airway adjuncts (bougie, stylet) was 78% in group A and 68% in group B that was statistically significant (P<0.05). 22 % of patients in group A and 32% of patients in group B required airway adjuncts for successful intubation.There was no failed intubation in both the groups. There was no trauma to the airway following intubation using Video laryngoscope (group B) whereas 8% of the patients had mucosal airway injuries due to preexisting loose tooth and following repeated laryngoscopywith direct laryngoscope (group A). The Mean time taken for intubation was 35.22±7.56 seconds in Group A and 31.82±7.945 seconds in Group B that was statistically significant (P<0.05).The mean heart rate was comparable between both the groups. After intubation heart rate was lower in Group B than Group A at 1 minute with a statistical significant of P value 0.047 [Fig. 2].There was no significant change in systolic blood pressure post intubation in both the groups with P value of 0.15[Fig. 3]. There was significant decrease in the diastolic blood pressure post intubation at 1 minute in group B with the P value <0.001. There was no episode of desaturation at any time during the study in both the groups.

Table 1.Baseline Demographic characteristics of included patients

Variables	Group A	Group B	P value
Age (years)	50.8±11.12	50.76±11.61	0.980
Gender			0.011*
M	25 (50)	30 (60)	
F	25 (50)	20 (40)	
BMI Kg/m^2	22.4 ± 3.62	21.9 ± 3.84	0.862
ASA physical status			0.529
II	31 (62)	34 (68)	
III	19 (38)	16 (32)	
Mallampatti Class			0.048*
II	22 (44)	32 (64)	
III	20 (40)	10 (26)	
IV	8 (16)	5 (10)	

Values are presented as mean ± SD or number (%).Group A: Direct Laryngoscope group,Group B: Mc Grath VL group.

Table 2.Comparison of Airway parameters postinduction between groups

Variables	Group A	Group B	Statistical test	P Value
MODIFIED COMARCK LEHANE GRADE			Chi square test	0.066
1	11 (22)	16 (32)		
2a	19(38)	20 (40)		

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2b	19 (38)	14 (28)		
3	1 (2)	0 (0)		
NUMBER OF ATTEMPTS TO SUCCESSFUL INTUBATION			Chi square test	0.366
1	48 (96)	47 (94)		
2	1 (2)	3 (6)		

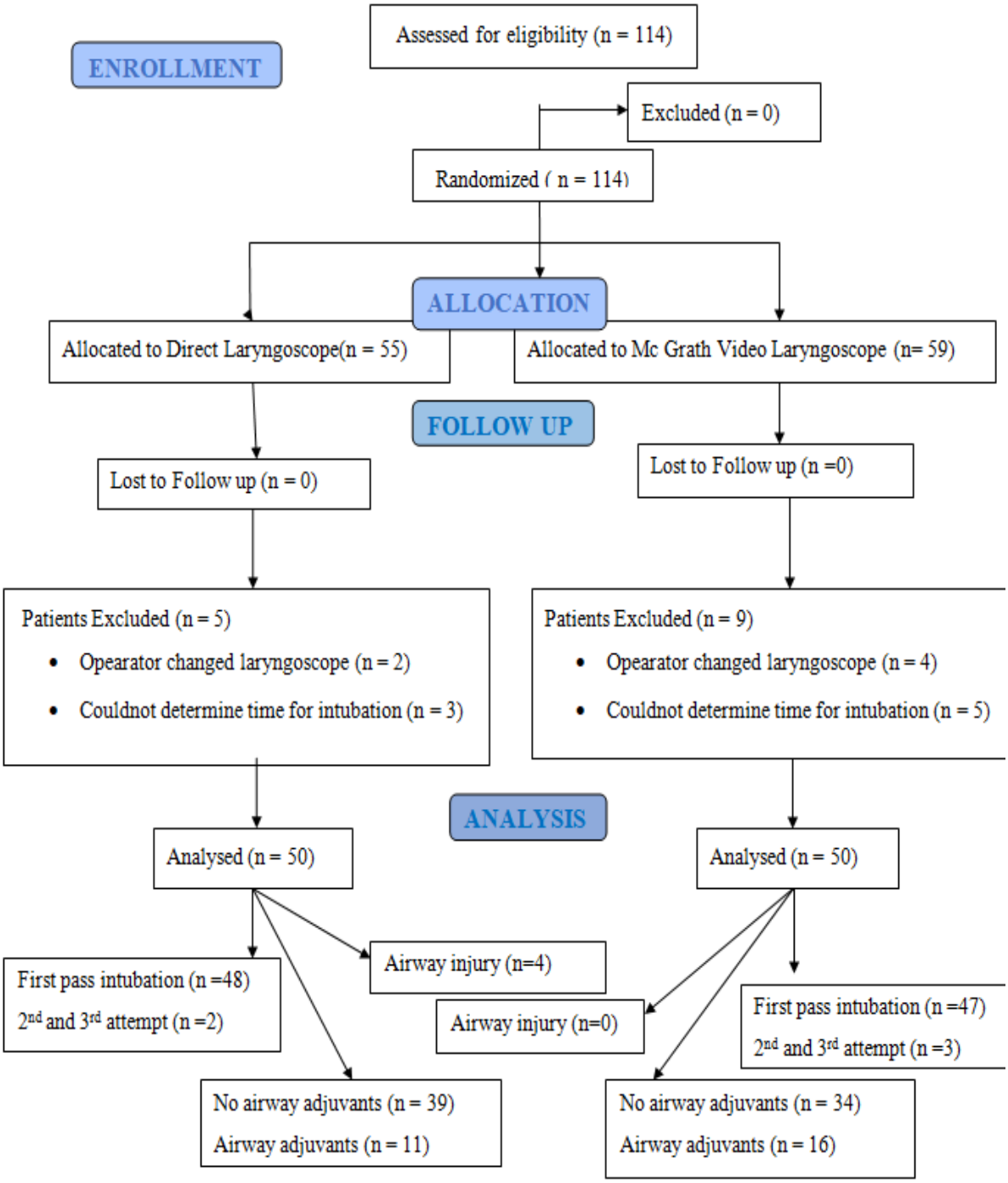

Fig. 1.Consolidated Standards of Reporting Trials (CONSORT) flow diagram.

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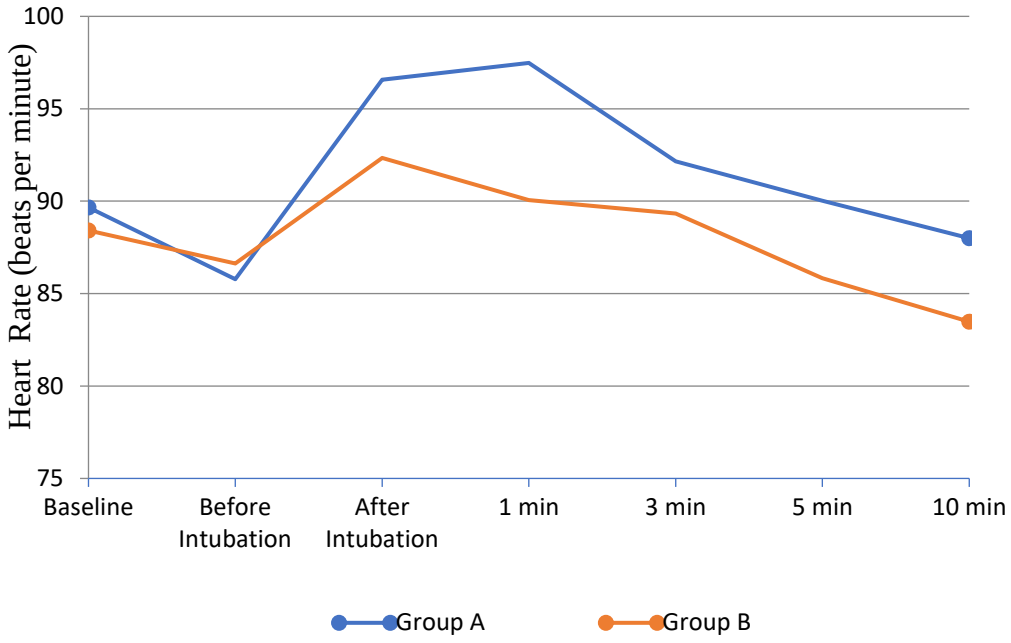

Fig. 2.Comparison of Heart Rate in the study groups

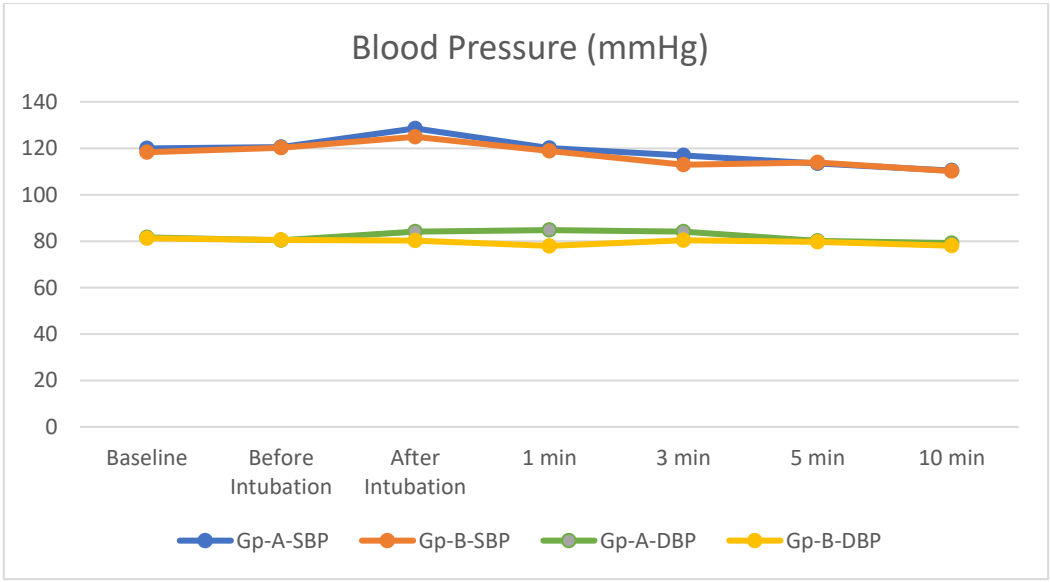

Fig 3. Comparison of Blood Pressure(mmHg) in both the groups

DISCUSSION

Patients with rhinoorbital and maxillary Mucormycosis may have difficult mask ventilation and endotracheal intubation[11]. Therefore, a difficult airway cart including supraglottic airways, video laryngoscopes, smaller sized cuffed endotracheal tubes, airway exchange catheters, bougie/stylet with tracheostomy set must be kept ready. This study was a randomised clinical trial conducted to assess the utility of Videolaryngoscopy with a Macintosh based blade with conventional direct laryngoscopy in the operating theatre for elective surgical debridement in mucormycosis patients with anticipated difficult airway.McGrath MAC is a lightweight laryngoscope with a disposable blade.The Mc Grath MAC VL combines line of sight video from its portrait display with the familiar Macintosh technique, so retains traditional laryngoscopy skills. Numerous studies showed that video laryngoscopes could provide better views of the glottis and easier insertion when compared to conventional direct laryngoscope [12]. First pass tracheal intubation success rate was (96%) with the McGrath compared with direct laryngoscopy (94%). There was 100% successful intubation rate in both the groups in our study.Video laryngoscope is the first line tool for endotracheal intubation in

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accordance with COVID 19 airway guidelines as it improves first-pass success[13]. VL allows one to visualize relevant anatomical structures without having to align the oral, pharyngeal, and laryngeal axes[14].Yung-Cheng Su et al[12] didmeta analysis to assess the value of videolaryngoscope with direct laryngoscopy for tracheal intubation.Video laryngoscopes gives a better view of the glottis and have a similar success rate to tracheal intubation when compared to direct laryngoscopy.However, in a subgroup analysis, VL's shortened the time taken for difficult intubation with a mean difference of 3.40 seconds. They concluded Video laryngoscopes are a good alternative to direct laryngoscopy during tracheal intubation, added advantage when difficult intubation is encountered.Similar observations was noticed in our study also with 100 % success rate to tracheal intubation in both the groups. Erdivanli B etal[10] compared efficiency of King Vision video laryngoscope with Macinthosh laryngoscope,observed similar parameters as in our study. They intubated patients with both laryngoscopes successively and concluded that the time taken for intubation with video laryngoscope was more, as it had longer average time to glottis viewbut with the advantage of smooth intubation without desaturation. Liu et al[15]conducted studyin patients with non difficult airways and observed similar parameters.The intubation success rate using a video laryngoscope was 100% versus 94.5% using a direct laryngoscopewith fewer postoperative complications like less oropharyngeal injuries and less post operative hoarseness.Lewis et al[16] conducted a Cochrane Systematic Review, they too observed Videolaryngoscopes reduced laryngeal/airway trauma and hoarseness. It increased easy laryngeal views, reduce the number of failed intubations, particularly among patients presenting with a difficult airway. Liu et al[17]compared Mc Grath series3 with Macinthosh laryngoscope for tracheal intubation in normal airway by inexperienced anaesthestists. They found Mc Grath provided superior glottis views, greater ease of intubation, less complications and hemodynamic fluctuations. They concluded it is potentially a favorable device to use among beginners.Abhyankar P et al[18] compared C-MAC and McGrath MAC videolaryngoscopes with Macintosh direct laryngoscope for endotracheal intubation in adult patients undergoing elective surgeries. They concluede VLs provided a superior glottic view and resulted in a superior first attempt success rate as compared to Macintosh laryngoscope. When comparing the two videolaryngoscopes, C-MAC resulted in better intubation characteristics (shorter intubation time, better glottic views, and higher first-attempt success rates) and should be preferred over McGrath for intubation in adult patients with normal airway

Sansone P et al[19] conducted a systematic review, they compared direct Macintosh laryngoscopy with McGrath videolaryngoscopy in order to assess the potential benefits of VL, showing equivalent results to successful intubation in both the device with no hemodynamic difference.

In our study we observed that despite better visualization of glottis by video laryngoscope, tracheal intubation with the aid of airway adjuvants like bougie or stylet was required in both groups, probable reason for successful intubation in all patients. This difficulty was anticipated because of mucormycosis induced inflammation and edemaof the airway, perhaps due to the lack of proficiency in the use of videolaryngoscope. Moreover, the working space in the oral cavity was relatively less with video laryngoscope than with direct conventional laryngoscope due to absence of flang part of the laryngoscope blade. This led to the requirement of airway adjuvants for successful first pass intubation with video laryngoscope even though it improved the glottic visualization. Inspite of this drawback, the time taken for intubation and the ease of intubation in terms of better hemodynamics and no risk of trauma to the structures of oral cavity during laryngoscopy and intubation was witnessed in group B patients. Whereas in group A patients during second attempt of intubation, visualization became more difficult due to trauma to the fragile tissues of oropharynx and resultant inbleeding. This would have worsened the CormackLehane grading in making it difficult to secure airway.

Video laryngoscopes are a far-reaching augmentation of the difficult airway cart. Proficiency with video laryngoscopes comes with a learning curve[20].Video laryngoscopes have an edge over other laryngoscopes when primarily studied for attenuation of pressor response in normal airways.

CONCLUSION

Video laryngoscopehad high odds of first pass tracheal intubation with improved glottic view, reducing the time taken for intubation, thereby reducing the duration of aerosol exposure, and airway traumawith improved safety when compared to direct laryngoscope. It possessed added advantage of less hemodynamic response to laryngoscopy and intubation along with benefits of both direct and video laryngoscopy in a single device in anticipated difficult airway in an unacquainted anaesthesiologist to videolaryngoscopein patients undergoing debridement for mucormycosis.

LIMITATIONS

- Blinding of the anaesthesiologist for the device was not possible and hence this was a single blinded study.
- Laryngoscopic grading using the Cormack and Lehane classification is subjective in nature.
- Cormack–Lehane is a validated instrument for glottic exposure assessment in direct laryngoscopy but not in videolaryngoscopy.

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- This study was carried out by experienced users for standard direct laryngoscopy and not for VL.

FURTHER SCOPE

We could have included variables such as interincisor, thyromental and sternomental distance in the preoperative airway assessment for predicting difficult intubation. Median percentage of glottis opening (POGO) score at the time of intubation and incidence of post operative hoarseness and sorethroatcan be assessed.Thestudy was done on elective surgical patients and extrapolation in parturients and morbid obese patients can be done.

REFERENCES

1. Wali U, Balkhair A, Al-Mujaini A. Cerebro-rhino orbital mucormycosis: An update. J Infect Public Health 2012;5:116-26.
2. Viterbo S, Fasolis M, Garzino-Demo P, Griffa A, Boffano P, Iaquinta C, et al. Management and outcomes of three cases of rhinocerebral mucormycosis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;112:69-74
3. Karaaslan E. Anesthetic management of rhinoorbitocerebral mucormycosis: Focus on challenges. J Mycol Med 2019;29:219-22
4. Gupta KK, Singh A, Kalia A, Kandhola R. Anaesthetic considerations for post-COVID-19 mucormycosis surgery- A case report and review of literature. Indian J Anaesth 2021;65:545-7
5. Malhotra N, Bajwa SJS, Joshi M, Mehdiratta L, Hemantkumar I, Rani RA, et al. Perioperative management of post-COVID-19 surgical patients: Indian Society of Anaesthesiologists (ISA National)Advisory and Position Statement. Indian J Anaesth 2021;65:499-507
6. Cook TM, Woodall N, Frerk C.Fourth National Audit Project ofthe Royal College of Anaesthetists and Difficult AirwaySociety. Major Complications of Airway management in theUnited Kingdom. Report and Findings. March 2011. ISBN 978-1-9000936-03-3. Royal College of Anaesthetists, London
7. Kristensen SM, Behringer EC. Evidence for benefit vs novelty in new intubation equipment.Anaesthesia2011;66(Suppl.2): 57–64
8. Kaur G, Gupta S, Mehta N, Dhingra JS. Comparative evaluation of McGrath MAC, truview video laryngoscopes and macintosh laryngoscope for endotracheal intubation in patients undergoing surgery under general anaesthesia. Anaes Essays Res 2020;14:20-4.
9. Jeffrey L. Apfelbaum, Carin A. Hagberg, Richard T. Connis, Basem B. Abdelmalak, Madhulika Agarkar, Richard P. Dutton, John E. Fiadjoe, Robert Greif, P. Allan Klock, David Mercier, Sheila N. Myatra, Ellen P. O'Sullivan, William H. Rosenblatt, Massimiliano Sorbello, Avery Tung; 2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway. Anesthesiology 2022; 136:31–81 doi: https://doi.org/10.1097/ALN.0000000000004002
10. Erdivanli B, Sen A, Batcik S, Koyuncu T, Kazdal H. Comparison of King Vision video laryngoscope and Macinthosh laryngoscope: a prospective randomized controlled clinical trial. Revista Brasileira De Anestesiologia. 2018;68(5):499-506.
11. Eckmann DM, Seligman I,Coté CJ, Hussong JW. Mucormycosis supraglottitis on induction of anesthesia in an immunocompromised host. Anesth Analg 1998;86:729-30.
12. Su YC, Chen CC, Lee YK, Lee JY, Lin KJ. Comparison of video laryngoscopes with direct laryngoscopy for tracheal intubation: a meta-analysis of randomised trials. European Journal of Anaesthesiology| EJA. 2011 Nov 1;28(11):788-95.
13. Hall D, Steel A, Heij R, Eley A, Young P. Videolaryngoscopy increases 'mouth-to-mouth' distance compared with direct laryngoscopy. Anaesthesia. 2020 doi: 10.1111/anae.15047. [PubMed] [CrossRef] [Google Scholar]
14. Sun Y, Lu Y, Huang Y, Jiang H. Pediatric video laryngoscope versus direct laryngoscope: a meta-analysis of randomized controlled trials. Pediatric Anesthesia. 2014 Oct;24(10):1056-65.
15. Liu DX, Ye Y, Zhu YH, Li J, He HY, Dong L, Zhu ZQ. Intubation of non difficult airways using video laryngoscope versus direct laryngoscope: a randomized, parallel-group study. BMC Anesthesiology. 2019;19:75
16. Lewis SR, Butler AR, Parker J, Cook TM, Schofield-Robinson OJ, Smith AF. Videolaryngoscopy versus direct laryngoscopy for adult patients requiring tracheal intubation: a Cochrane Systematic Review. British Journal of Anaesthesia. 2017 Sep 1;119(3):369-83.
17. Liu ZJ, Yi J, Guo WJ, Ma C, Huang YG. Comparison of McGrath Series 3and Macintosh Laryngoscopes for Tracheal Intubation in Patients with Normal Airway by Inexperienced Anesthetists: A Randomized Study. Medicine (Baltimore). 2016 Jan;95(2):e2514.
18. Abhyankar P, Sabharwal N, Gupta A, Das AK. Comparative evaluation of C-MAC and McGrath MAC videolaryngoscopes with Macintosh direct laryngoscope for endotracheal intubation in adult patients undergoing elective surgeries. J Anaesthesiol Clin Pharmacol. 2023 Jul-Sep;39(3):422-428. doi: 10.4103/joacp.joacp_451_21. Epub 2023 Sep 18. PMID: 38025548; PMCID: PMC10661630.
19. Sansone P, Giaccari LG, Bonomo A, Gargano F, Aurilio C, Coppolino F, Passavanti MB, Pota V, Pace MC. Comparison of McGrath Videolaryngoscope versus Macintosh Laryngoscope in Tracheal Intubation: An Updated Systematic Review. J Clin Med. 2023 Sep 24;12(19):6168. doi: 10.3390/jcm12196168. PMID: 37834812; PMCID: PMC10573091.
20. Niforopoulou P, Pantazopoulos I, Demestiha T, Koudouna E, Xanthos T. Video-[25] laryngoscopes in the adult airway management: A topical review of the literature. Acta Anaesthesiol Scand. 2010;54(9):1050-61.