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Original Article

Anaesthesia Section

Comparison of Intubating Conditions for Nasotracheal Intubation with BPL® Video Laryngoscope versus Standard Direct Macintosh Laryngoscope using Cuff Inflation Technique: A Randomised Clinical Study

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ABSTRACT

Introduction: Nasotracheal intubation is required in maxillofacial, oral and dental surgeries and it presents unique anatomical and technical challenges. The Macintosh laryngoscope is a gold standard for nasotracheal intubation but requires alignment of the oral, pharyngeal, and laryngeal axis. Conversely, video laryngoscopy helps in the visualisation of the real-time and enlarged video image of airway structures.

Aim: To compare two laryngoscopy techniques- British Physical Laboratories® (BPL) video laryngoscope and Macintosh laryngoscope - using the cuff inflation technique to optimise intubation conditions.

Materials and Methods: This randomised clinical single-blinded study was carried out in the Department of Anaesthesiology at Dhiraj Hospital, Smt. B.K. Shah Medical Institute and Research Centre (SBKS) Medical Institute and Research Centre (Deemed to be University), Piparia, Waghodia, Vadodara, Gujarat, India, between September 2023 and May 2025, on 66 adult patients divided into two equal groups. Group V patients underwent BPL® video laryngoscopy with cuff inflation, while group M patients underwent Macintosh laryngoscopy with the same technique. Patients were assessed for intubation time, Cormack–Lehane grading, number of attempts, initial 15 mL cuff inflation success, need of additional 5 mL inflation, need for Magill's forceps or external laryngeal manipulation, haemodynamic parameters like Heart Rate (HR) and Mean Blood Pressure (MBP) and post-procedural complications. The Unpaired t-test was used for numerical variables, and the Chi-square test was used for categorical variables. A p-value <0.05 was considered statistically significant, and a p-value <0.001 was considered highly important.

Results: Both groups were comparable in terms of demographic parameters like age, gender, weight, American Society of Anaesthesiologists (ASA) physical status classification and Mallampati Classification of the airway. Group V demonstrated significantly shorter intubation time (31.51±2.16 seconds vs. 45.97±3.15 seconds, p-value <0.001. Initial cuff inflation was more successful in group V (87.88% vs. 48.48%, p-value <0.001). Need for additional 5 mL inflation (12.12% vs 33.33%, p-value=0.04), need for Magill's forcep (0% vs 18.18%, p-value=0.01) and external laryngeal manipulation (9.09% vs 36.36%, p-value=0.007) were significantly lower in group V. HR and MBP were significantly lower at laryngoscopy and intubation till 5 minutes post-intubation (p-value <0.05) in Group V. The incidence of sore throat (15.15% vs 54.55%, p-value <0.001) and post-procedure bleeding (12.12% vs. 45.45%, p-value=0.003) was significantly lower in group V.

Conclusion: The BPL® video laryngoscope with cuff inflation technique demonstrated superior intubating conditions compared to the standard Macintosh laryngoscope, providing shorter intubation times, higher success with initial 15 mL cuff inflation, better haemodynamic stability, and reduced complication rates during nasotracheal intubation.

Keywords: Airway management, British physical laboratories, Haemodynamic response, Magill's forcep, Oral surgery

INTRODUCTION

Airway management is central to anaesthetic and critical care practice, with Nasotracheal Intubation (NTI) particularly valuable in maxillofacial, oral and dental surgeries [1-3]. NTI presents unique anatomical and technical challenges [4,5]. During NTI, once the tube is passed through the nasal cavity into the oropharynx, it can impinge upon the oesophagus, on the anterior commissure of the larynx, in the vallecula or in the pyriform fossa [6]. So, multiple techniques are available to facilitate entry of the Endotracheal Tube (ETT) into the larynx, like external laryngeal manipulation, Magill's forceps, or cuff inflation. Commonly, Magill's forceps are used to guide the ETT from the oropharynx to the laryngeal inlet, but Magill's forceps can lead to damage of the ETT cuff or can injure the oropharyngeal mucosa. This complication can be easily prevented by the cuff inflation technique [7]. The cuff inflation technique was suggested by Sir Gorback in 1987 for blind nasal intubation and was used clinically by Sir Van Elstraete and Sir Chung in 1993 [8]. In the cuff inflation technique, once the ETT passes through the nostril and appears in the pharynx, the ETT cuff is inflated with 10-15 mL of air. Cuff inflation lifts the cuff of the ETT off the posterior pharyngeal wall and points the tube towards the vocal cord [9]. So, it avoids instrumentation, trauma to the upper airway mucosa and ETT cuff perforation.

The Macintosh laryngoscope, though historically the gold standard [10,11], requires alignment of the oral, pharyngeal, and laryngeal axis, which can be challenging in anatomically difficult airways [12,13]. Conversely, video laryngoscopy helps in the visualisation of the real-time and enlarged video image of airway structures. In addition to providing a clearer view of the vocal cord than a regular Macintosh laryngoscope, video laryngoscopy-assisted intubation requires less force, thereby decreasing the risk of injury to soft tissues and teeth [14-17]. In view of the advantages such as simple technique of usage, precise visual control, shorter intubation time, and easy learning curve, video laryngoscopes gained popularity and led to the development of a plethora of video laryngoscopes since 2000 [18] and are effectively used for intubating patients with normal, challenging, and difficult airways and also in nasotracheal intubation [19-21].

Prior research supports video laryngoscopy's superiority in vocal cord visualisation and reducing complications during intubation, particularly in difficult airways [22]. However, very few studies have compared the specific combination of video laryngoscopes, particularly BPL® video laryngoscopes, with routine Macintosh laryngoscopy with cuff inflation technique [2,21-23]. This study addresses that gap in the literature. The present study aimed to compare two laryngoscopy techniques- BPL® video laryngoscope and Macintosh laryngoscope using the cuff inflation technique to optimise intubation conditions. The primary outcome of this study was to establish whether the BPL® video laryngoscope with cuff inflation offers superior intubating conditions compared to standard Macintosh laryngoscopy with cuff inflation in nasotracheal intubation. For that intubation time, Cormack–Lehane grade, number of intubation attempts, success with initial 15 mL cuff inflation, need for additional 5 mL cuff inflation or Magill's forceps or external laryngeal manipulation were compared between the two groups. Secondary outcomes were to compare haemodynamic stability and the complication rate. For that, HR and MBP as well as complications like sore throat, bleeding, hoarseness of voice and cuff damage, were compared between the two groups.

MATERIALS AND METHODS

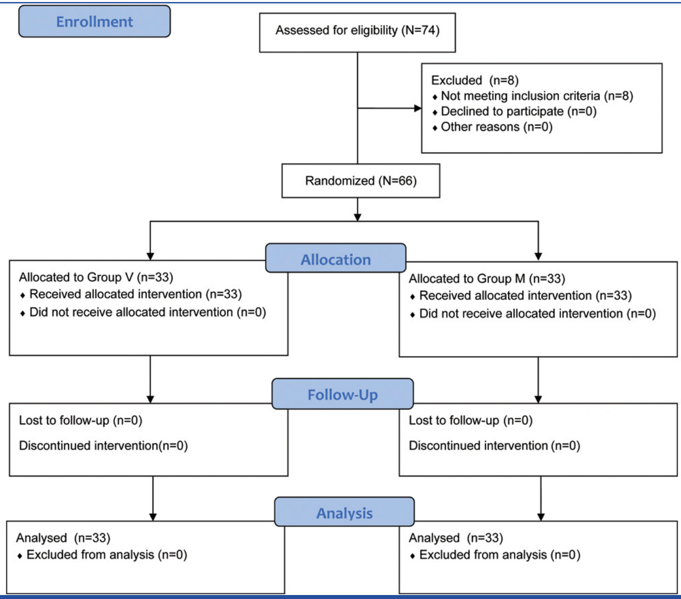
This randomised clinical single blinded study was carried out in the Department of Anaesthesiology at Dhiraj Hospital, SBKS Medical Institute and Research Centre (Deemed to be University), Piparia, Waghodia, Vadodara, Gujarat, India, between September 2023 and May 2025, after obtaining approval from the Institutional Ethics Committee (Ref. No. SVIEC/ON/MEDI/BNPG22/Sep/23/38). The study was registered in Clinical Trial Registry- India (CTRI) with registration number- CTRI/2024/12/078586. Recruitment of patient was done only after the CTRI registration. The purpose of the study was informed to all the patients, and written informed consent was taken from all the patients included in the study.

Sample size calculation: The sample size calculation was based on a previous study by Kasaudhan S et al., using successful attempt with cough inflation of 100% in video laryngoscope group and 76% in Macintosh laryngoscope group [23], it was estimated that 30 patients would be needed per group to achieve a result with 80% power and a 5% probability of a Type I error for two-sided testing. Considering a 10% margin for dropouts, 33 patients were recruited per group.

Inclusion criteria: A total of 66 adult patients, irrespective of gender, aged between 18 and 60 years, classified as ASA physical status I or II, with mouth opening ≥3 cm and Mallampati grade I or II, who were scheduled for elective surgical interventions requiring nasotracheal intubation under general anaesthesia, were enrolled.

Exclusion criteria: Patients with a history of upper respiratory tract infection, bleeding disorders, recognised airway anomalies, prior nasal surgery, nasal obstruction, Mallampati grade III or IV, mouth opening less than 3 cm, ASA physical status III, IV and V; and those unwilling to participate in the study.

Randomisation was done using computer generated random number table [Table/Fig-1]. Opaque sealed envelopes were prepared in advance and kept sealed until the participants were enrolled. Odd numbers were allocated in group V and even numbers were allocated in group M.



[Table/Fig-1]: Consolidated Standards of Reporting Trials diagram (CONSORT).

- Group V patients underwent nasotracheal intubation with BPL® video laryngoscope (BPL® Medical Technologies Pvt. Ltd. Kerala, India) employing the cuff inflation technique (n=33), while
- Group M patients underwent nasotracheal intubation with a standard Macintosh laryngoscope with cuff inflation technique (n=33).

Study Procedure

All participants received a comprehensive pre-anaesthetic assessment one day before surgery for their eligibility to participate. This study was blinded, so patients were not aware of which type of laryngoscope was used for intubation. The procedure was explained thoroughly, and written informed consent was taken. Preoperatively, patients maintained nil per oral status for 8 hours for solids and 2 hours for clear fluids. Thirty minutes before induction, all the patients received nasal preparation in the form of instillation of 0.05% xylometazoline drops into both nostrils, followed by nasal packing with gauze soaked in 2% lignocaine with adrenaline and normal saline.

Upon entering the operating theatre, a 20-gauge intravenous cannula was secured, and Ringer's lactate infusion was initiated. Anaesthesia equipment, monitors, airway devices, and drugs were checked and prepared. The standard multiparameter monitor was connected, and baseline vitals like Pulse Rate (PR) and Mean Blood Pressure (MBP) were recorded. Premedication in the form of intravenous glycopyrrolate 0.004 mg/kg, ondansetron 0.1 mg/kg, midazolam 0.02 mg/kg, and tramadol 2 mg/kg were given. After that, the concealed envelope was opened, and group allotment was done accordingly.

Pre-oxygenation with 100% oxygen was performed for three minutes, after which anaesthesia was induced using propofol at 2-2.5 mg/kg till the loss of eyelash reflex. After confirming proper ventilation, succinylcholine 2mg/kg intravenously (i.v.) was given. After observing the disappearance of fasciculation from the toes, an appropriately sized, lubricated flexometallic (wire reinforced) cuffed endotracheal tube was inserted through the chosen nostril and advanced to the oropharynx. Once the ETT reached the oropharynx, laryngoscopy was performed as per group allocation.

In group V, laryngoscopy was done with a BPL® video laryngoscope with cuff inflation technique. After ETT advancement to the oropharynx, the cuff was inflated with 15 mL of air, and additional 5 mL increments were used as necessary until the tip of the ETT aligned with the glottic opening against the posterior pharyngeal wall. Upon achieving tip entry into the glottic inlet, the cuff was deflated, and the tube was further advanced through the vocal cords. The cuff was then reinflated to an appropriate volume to maintain a tracheal seal. If the tube could not be properly aligned with the glottic opening, the cuff was inflated with an additional 5 mL of air. If the tube could not be aligned after two attempts using the cuff inflation technique, intubation was performed with the aid of Magill's forceps.

In group M, laryngoscopy was done with a standard Macintosh laryngoscope with cuff inflation technique. The procedure was the same as the group V, just the Macintosh laryngoscope was used rather than BPL® video laryngoscope.

In both the groups, proper placement of the tube was confirmed with capnography and bilateral chest auscultation and the tube was secured. In both the procedure was performed by the same anaesthesiologist to avoid performance bias.

Anaesthesia was maintained with O_2, N_2O at 1:1 ratio and Isoflurane using circle system. Inj. Atracurium loading dose 0.5 mg/kg i.v. followed by maintenance with 0.1 mg/kg i.v. intermittently was administered. Patients were mechanically ventilated on volume control mode with tidal volume of 6-8 mL/kg and respiratory rate of 12-14/min.

After completion of surgery, neuromuscular blockade was reversed with inj. neostigmine (0.05 mg/kg) i.v. and inj. glycopyrrolate (0.008 mg/kg) i.v. Patients were extubated after fulfilling the extubation criteria [24].

The following parameters were systematically recorded:

1. **Timing measurements:**
    - T1: time from insertion of ETT through the nostril to its arrival in the oropharynx (in seconds)
    - T2: time from laryngoscope insertion to visual confirmation of ETT passage through the vocal cords (in seconds)
    - T: total intubation time (T1 + T2)
2. **Cormack-Lehane grade [25]:**
    - Grade 1: Full view of the glottis.
    - Grade 2: Partial view of the glottis. This grade was later subdivided into 2a (partial view) and 2b (only the posterior extremity of the glottis or arytenoid cartilages visible).
    - Grade 3: Only the epiglottis is visible.
    - Grade 4: Neither the glottis nor the epiglottis is visible.
3. **Haemodynamic parameters:** HR and MAP were documented at baseline, after induction, at laryngoscopy and intubation and at 1, 3, 5, 7, and 10 minutes post-intubation.
4. **Number of intubation attempts** needed for successful nasotracheal intubation.
5. **Need for an additional 5 mL inflation**
6. **Need for Magill's forceps**
7. **Use of external laryngeal manipulation.**
8. **Complications:** postoperative sore throat, nasal or oral bleeding, hoarseness, and endotracheal tube cuff damage.

STATISTICAL ANALYSIS

Data analysis was performed using Statistical Package for Social Sciences version 25.0. Numerical variables were presented as mean ± Standard Deviation (SD), while categorical variables were described using frequency and percentage. The Unpaired t-test was used for numerical variables, and the Chi-square test was used for categorical variables. A p-value <0.05 was considered statistically significant, and a p-value <0.001 was considered highly significant.

RESULTS

A total of 74 patients were assessed for eligibility to participate in the study. Out of which 8 patients were excluded from the study as they did not meet the inclusion criteria, and 66 patients were included in the study [Table/Fig-1].

All 66 enrolled patients completed the study, with 33 patients in each group. The demographic data, including age, gender, weight, ASA status, and Mallampati grading, were comparable between the two groups with no statistically significant differences [Table/Fig-2].

Parameters	Group V (n=33) (%) (Mean±SD)	Group M (n=33) (%) (Mean±SD)	p-value
Age (years)	36.48±10.73	38.03±12.92	0.59
Weight (kg)	63.69±11.91	64.27±9.98	0.83
Height (m)	1.66±0.09	1.66±0.09	0.95
BMI (kg/m²)	23.23±4.33	23.22±3.25	0.99
Gender (M/F)	18/15 (54.55%/45.45%)	19/14 (57.58%/42.42%)	0.81
ASA status (I/II)	26/07 (78.79%/21.21%)	23/10 (69.7%/30.3%)	0.40
Mallampati grade (I/II)	19/14 (57.58%/42.42%)	17/16 (51.52%/48.48%)	0.61

[Table/Fig-2]: Demographic data.
Data presented as Mean±SD or frequency (percentage); SD: Standard Deviation; Unpaired t-test for numerical variable and Chi-square test for categorical variable

Intubation Parameters [Table/Fig-3]: Intubation parameters like intubation time, Cormack–Lehane grade, number of intubation attempts, initial 15 mL cuff inflation success, need for additional 5 mL cuff inflation, need for Magill's forceps and external laryngeal manipulation are shown in [Table/Fig-3].

Parameters	Group V (n=33) (%) (Mean±SD)	Group M (n=33) (%) (Mean±SD)	p-value
T1 (seconds)	12.33±0.92	12.60±0.87	0.23
T2 (seconds)	19.18±1.60	33.37±2.88	<0.001**
Total time (seconds)	31.51±2.16	45.97±3.15	<0.001**
Cormack-Lehane grade			
Grade 1	24 (60.0%)	22 (55.0%)	0.66
Grade 2a	11 (27.5%)	10 (25.0%)	
Grade 2b	5 (12.5%)	8 (20.0%)	
Number of attempts			
1	31(93.94%)	28 (84.85%)	0.23
2	2 (6.06%)	5 (15.15%)	
Initial 15 mL cuff inflation success	29 (87.88%)	16 (48.48%)	<0.001**
Need for additional 5 mL cuff inflation	4 (12.12%)	11 (33.33%)	0.04*
Need for Magill's forceps	0	6 (18.18%)	0.01*
Need for external laryngeal manipulation	3 (9.09%)	12 (36.36%)	0.007*

[Table/Fig-3]: Intubation parameters.
Data presented as Mean±SD or frequency (percentage). SD: Standard Deviation; *p-value <00.5-statistically significant, **p-value <0.001-statistically highly significant; Unpaired t-test for numerical variable and Chi-square test for categorical variable

Haemodynamic parameters: Baseline HR and MAP were comparable between both the groups as shown in [Table/Fig-4]. There was a statistically significant difference in HR and MAP during laryngoscopy and intubation, as well as till 5 minutes after that, with better haemodynamic stability in group V.

Postoperative complications: Group M showed significantly higher incidence of sore throat and bleeding compared to group V as shown in [Table/Fig-5]. Hoarseness of voice and cuff damage were higher in group M compared to group V, but it was not statistically significant.

DISCUSSION

The present study was designed to compare the intubating conditions for nasotracheal intubation with BPL® video laryngoscope versus standard direct Macintosh laryngoscope using the cuff inflation technique in adult patients. This discussion will analyse these findings in light of similar studies conducted previously.

This study showed that BPL® video laryngoscope significantly reduced total intubation time compared to the Macintosh

Parameters	Time point	Group V (n=33) (%) (Mean±SD)	Group M (n=33) (%) (Mean±SD)	p-value
Heart rate (beats/min)	Baseline	80.15±6.47	81.94±6.32	0.26
	After induction	77.20±6.10	78.50±6.20	0.39
	At laryngoscopy and intubation	86.03±6.30	90.18±6.75	0.03*
	1 min post-intubation	83.79±7.15	88.58±5.62	0.01*
	3 min post-intubation	78.70±6.40	85.94±5.77	<0.001**
	5 min post-intubation	77.45±6.37	82.30±6.35	0.003*
	7 min post-intubation	78.88±7.01	80.67±6.66	0.28
	10 min post-intubation	78.39±7.23	79.33±7.09	0.58
Mean arterial pressure (mmHg)	Baseline	89.10±4.85	88.89±4.52	0.85
	After induction	84.33±4.25	84.42±4.18	0.93
	At laryngoscopy and intubation	100.05±5.12	105.72±5.65	<0.001**
	1 min post-intubation	102.28±5.20	108.30±5.85	<0.001**
	3 min post-intubation	97.88±4.95	104.78±5.42	<0.001**
	5 min post-intubation	92.63±4.88	96.28±5.15	0.004*
	7 min post-intubation	90.45±4.75	91.97±4.95	0.22
	10 min post-intubation	89.81±4.68	90.62±4.88	0.51

[Table/Fig-4]: Haemodynamic parameters.
Data presented as mean±SD; HR: Heart Rate; MAP: Mean Arterial Pressure; SD: Standard Deviation; *p-value <00.5-statistically significant, **p-value <0.001- statistically highly significant; Unpaired t-test

Complications	Group V (n=33) (%)	Group M (n=33) (%)	p-value
Sore throat	5 (15.15%)	18 (54.55%)	<0.001**
Bleeding	4 (12.12%)	15 (45.45%)	0.003*
Hoarseness	2 (6.06%)	7 (21.21%)	0.08
Cuff damage	0	2 (6.06%)	0.15

[Table/Fig-5]: Postoperative complications.
Data presented as frequency (percentage); SD: Standard Deviation; *p-value <00.5-statistically significant, **p-value <0.001- statistically highly significant; Chi-square test

laryngoscope. These findings align with the study done by Kasaudhan S et al., [23]. They conducted a prospective randomised study on 50 patients divided into two groups: group VL (n=25) using C-MAC® video laryngoscope and group ML (n=25) using Macintosh laryngoscope. They used C-MAC® video laryngoscope with cuff inflation technique for nasotracheal intubation and found that the total duration of nasotracheal intubation was significantly lower in the C-MAC® video laryngoscope group compared to the Macintosh laryngoscope group (31.48±10.72 vs 45.88±13.47, p-value <0.001). Results of this study are also consistent with the findings of Sangamala VPK et al, who reported that the cuff inflation technique required significantly less time for successful NTI compared to the conventional group (27.86±4.47 s vs. 41.11±10.98 s, respectively; p-value <0.0001) [26]. This suggests that the combination of video laryngoscopy and cuff inflation technique provides optimal visualisation and manipulation capabilities, leading to faster intubation. In contrast, a study done by Gangishetty A et al., found contrary results, with the McGRATH™ video laryngoscope for nasotracheal intubation resulting in statistically longer intubation times compared to the Macintosh laryngoscope (p-value <0.001) [27]. This might be attributed to differences in operator experience, patient characteristics, or the specific video laryngoscope model used. The shorter intubation time observed with the video laryngoscope can be attributed to better visualisation of the glottis, which facilitates quicker and more precise tube placement. When the glottic view is improved, the anaesthesiologist can guide the tube more efficiently without the need for additional manipulations or adjustments.

Comack-Lehane grade was comparable between the two groups in this study. Similar result was found in the study done by Sengel N et al., [28]. In their study, there was no statistically significant difference in Cormack-Lehane grade between the Macgrath video laryngoscope and Macintosh laryngoscope, with p-value=0.399. In contrast, a study done by Hazarika H et al., showed a statistically significant difference in Cormack-Lehane grade between the C-MAC D blade and Macintosh laryngoscope (p-value <0.05) [29]. This might be due to differences in anesthesiologist experience in handling video laryngoscopes and differences in the study population.

In present study, there was no statistically significant difference with regard to intubation attempt between the two groups. Our findings are comparable to the study done by Şengel N at al.,and Ambulkar R et al., [28,30].

The current study demonstrated that the success rate of initial 15 mL cuff inflation was significantly higher and less patients required additional 5 mL inflation in group V compared to group M. These results are consistent with the findings of Kasaudhan S et al., [23]. The successful placement of ETT was statistically higher with initial 15 mL cuff inflation in the video laryngoscope compared to the Macintosh laryngoscope (88% vs 32%, p-value <0.001), and fewer patients required additional 5 mL inflation (12% vs 44%, p-value=0.022), in their study.

In current study, the need for Magill's forceps was significantly higher in group M. Similarly, external laryngeal manipulation was also required significantly more frequently in group M compared to group V. These results align with the study done by Kwak HJ et al., [31]. They obtained the result that showed the frequency of Magill's forceps use was lower in the McGRATH™ group than in the Macintosh group. (6% vs 34%; p-value=0.003). Zhu H et al., did a study to compare non channelled King Vision, McGRATH™ MAC video laryngoscope and Macintosh direct laryngoscope for nasotracheal intubation [32]. And they also found similar results. Use of assist maneuvers was significantly more with the Macintosh laryngoscope. (15%,12%,64%; King Vision vs McGRATH™ vs Macintosh respectively; p-value <0.0001).

Baseline HR and MAP were comparable between groups. After induction, HR and MAP decreased slightly in both groups. At laryngoscopy and intubation, and 1 min post-intubation, HR and MAP rise were significantly higher in group M. At 3 and 5 min, HR and MAP were significantly lower in group V. By 7 and 10 min, HR and MAP returned to baseline with no significant difference. These findings aligned with the results obtained by Singh T et al., [33]. In their study, mean HR and mean MAP were significantly higher during laryngoscopy and intubation as well as up to 5 minutes after it, in the standard laryngoscope group compared to the C-MAC video laryngoscope group. Gangishetty A et al., also found that mean heart rate and mean arterial pressure were significantly higher in the Macintosh laryngoscope group compared to the video laryngoscope group after nasotracheal intubation [27].

The current study showed lower post-procedure bleeding and sore throat in group V. Hoarseness and cuff damage were also less in group V, though not significantly. These results align with Hazarika H et al., and Rajan et al., who reported fewer complications with video laryngoscopy than Macintosh [29,34].

Limitation(s)

A major limitation of the present study is that it could not be double-blinded. This study has limited generalisability, as it is a single-centre study. Also, the present study was conducted on ASA I and II patients, so its usefulness needs to be tested in ASA III and IV patients in further studies.

CONCLUSION(S)

The current study found that using a BPL® video laryngoscope with cuff inflation significantly improves the conditions for nasotracheal intubation compared with the Macintosh laryngoscope. It resulted in shorter intubation times and a higher first-attempt success rate. The technique also reduced the need for Magill's forceps or external maneuvers. Patients experienced better haemodynamic stability during the procedure. Additionally, there was a lower incidence of bleeding and sore throat post-intubation. So, the take-home message is that the BPL® video laryngoscope with cuff inflation is a superior option for nasotracheal intubation in adults under general anaesthesia.

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