



EVALUATION OF NASOTRACHEAL INTUBATION WITH VIDEOLARYNGOSCOPE (TUOREN™) AND MACINTOSH DIRECT LARYNGOSCOPE – A PROSPECTIVE RANDOMISED COMPARATIVE STUDY

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Abstract

Background: Nasotracheal intubation (NTI) is a common method for securing the airway during head and neck surgeries. This study was undertaken to compare NTI with videolaryngoscope (Tuoren™) and Macintosh direct laryngoscope in patients undergoing elective surgeries under general anaesthesia (GA) with NTI.

Method: Exclusion criteria were difficult mask ventilation or tracheal intubation, history of respiratory insufficiency and nasal pathology. Taking minimum required sample size for 80% power of study and 5% level of significance, 25 patients were included in each study group : Group D (Macintosh direct laryngoscope) or Group V (Videolaryngoscope).

Formula used for comparing mean of two groups was: $N \geq 2(\text{standard deviation})^2 X (Z\alpha + Z\beta)^2$ (mean difference)²

(Where $Z\alpha$ is value of Z at two sided alpha error of 5%, $Z\beta$ is value of Z at power of 80% and mean difference is difference in mean values of two groups)

Time to intubation, number of attempts, ease of insertion of endotracheal tube (ETT), use of Magill's forceps, any ETT cuff tear and hemodynamic parameters at intubation were compared. For statistical analysis, SPSS version 25.0 was used with Independent t test, Chi-Square and Fisher's Exact test. A p value of less than 0.05 was considered significant.

Results: Demographic profile, time to intubation, number of attempts and cuff tear between the groups were comparable. Group V was better regarding ease of insertion, use of Magill's forceps and hemodynamic response.

Conclusion: Videolaryngoscope (Tuoren™) is better than the Macintosh direct laryngoscope for ease of NTI and hemodynamic response during NTI.

Keywords: Nasotracheal Intubation, Videolaryngoscope, Macintosh Direct Laryngoscope, Time to intubation, Hemodynamics

Introduction

Nasotracheal intubation (NTI) is a common method for securing the airway during many head and neck surgeries, especially when an oral tube would hinder the surgeon's access to the operative field. Some indications of NTI are fractured mandible, limitation of movement at the temporomandibular joints, patients with neck injury or cervical spine disease, intraoral pathology including mechanical obstructio. NTI has many advantages such as easy securing of a tube, elimination of the possibilities of the tube being occluded by biting and less cervical spine movement than oral intubation. Disadvantages include use of smaller tube resulting in increased resistance, difficulty in suctioning, longer time taken for intubation, airway trauma and high incidence of bacteremia, sinusitis and otitis [1]. Nasal intubation technique was first described in 1902 by Kuhn. The other pioneers of NTI were Macewen, Rosenberg, Meltzer and Auer, and Elsberg. During World War I, Rowbotham and Magill developed and practiced the technique of “blind” nasal intubation and coined the same term [2]. Various techniques can be used for NTI including blind nasal intubation, conventional laryngoscopy, videolaryngoscopy (VL) or fiberoptic guided intubation.

Videolaryngoscopy is an adjunctive technique in anesthesia that utilizes a camera at the tip of the laryngoscope blade to provide an indirect view of the glottis and surrounding structures unlike the DL that gives us a direct view. Use of VL has been shown to result in higher intubation success at first attempt, better laryngoscopic view, less mucosal trauma, a perception of easier intubation and decreased intubation time [3]. The advantage of Macintosh direct laryngoscopy (DL) are familiarity, direct glottis visualization, cost effectiveness and a steep learning curve [4]. Many studies comparing different laryngoscopes have been conducted for ease of orotracheal intubation while few studies have compared nasotracheal intubation as well. Stress response to laryngoscopy and tracheal intubation has a profound influence on the circulatory parameters and the intracranial pressure. Different laryngoscopes have been shown to cause varied hemodynamic stress responses after endotracheal intubation, again mostly in studies where orotracheal intubation [3,5].

The purpose of this study is to compare NTI with the videolaryngoscope (Tuoren™) and Macintosh direct laryngoscope regarding time to intubation, number of attempts needed, ease of insertion of endotracheal tube (ETT), use of Magill's forceps, any ETT cuff tear and hemodynamic parameters at intubation.

Methodology:

This study was conducted after clearance from the hospital ethics and scientific committees with the primary objective to compare the time required for NTI with Videolaryngoscope (Tuoren™) and Macintosh direct laryngoscope along with the secondary objectives to compare the number of attempts taken to intubate in each group, need for Magill's forceps usage, ease of intubation, hemodynamic parameters during intubation and any endotracheal tube cuff tear. The procedures were conducted in accordance with the Helsinki Declaration of 2013. The study has been registered with the Clinical trial registry of India (CTRI/2023/08/057109). The study was designed as a randomized comparative study to be conducted over a period of about one year in 2023-2024. Inclusion criteria were patients undergoing elective surgeries under general anaesthesia (GA) who required NTI and who were ASA (American Society of Anesthesiologists) grade I/II, aged between 18 to 60 years belonging to both sexes. Exclusion criteria were known allergy to any drugs used for GA, known or anticipated difficult mask ventilation or tracheal intubation, BMI more than 25 kg/m², neck range of motion < 30 degrees, Mallampati grade score III and IV, neck circumference > 40 cm, thyromental distance < 6 cm, cervical spine instability or cervical myelopathy, patients with history of respiratory insufficiency/ reactive airway disease and any patient with nasal pathology such as symptomatic deviated nasal septum, inferior turbinate hypertrophy, epistaxis, recurrent sinusitis and polyps.

The study of Brett J King et al observed that total intubation time (in minutes) in direct laryngoscopy was 2.22 ± 1.30 and in Videolaryngoscopy (Tuoren™) was 1.34 ± 0.54 [3]. Taking these values as reference, the minimum required sample size with 80% power of study and 5% level of significance came out be 21 patients in each study group. To reduce margin of error and to account for any attrition during the study, total sample size taken was 50 (25 patients per group).

Formula used for comparing mean of two groups was:

$$N \geq 2(\text{standard deviation})^2 X (Z_{\alpha} + Z_{\beta})^2 (\text{mean difference})^2$$

(Where Z_{α} is value of Z at two sided alpha error of 5%, Z_{β} is value of Z at power of 80% and mean difference is difference in mean values of two groups).

No blinding was done for the study. Patients were allocated to one of the two study groups (25 patients each) after block randomization with sealed envelope technique:

Group D: Patients intubated with Macintosh direct laryngoscopy.

Group V: Patients intubated with Videolaryngoscopy (Tuoren™).

After informed written consent was taken in the patient's own language, preanesthetic evaluation with detailed history, examination (including airway examination), and relevant investigations was done and the patient's nostril was chosen for NTI after Cotton Wool test [6]. Tab Alprazolam 0.25 mg and Tab Ranitidine 150 mg were advised for the night before surgery. Nil per orally (NPO) status was confirmed on the morning of surgery and the patient was taken into a well prepared operating room (OR). Two drops of xylometazoline nasal drops were applied locally in both nostrils in the preoperative holding area and once right before induction. All the patients were preoxygenated with 100% oxygen and premedicated with intravenous (IV) Midazolam 1 mg, Fentanyl 2 microg/kg and Ondansetron 4 mg. Lignocaine 2% jelly was used to lubricate the endotracheal tube (ETT). GA was induced with IV Propofol 2mg/kg, and Vecuronium 0.1mg/kg was administered to facilitate NTI after ability to ventilate was confirmed. Laryngoscope blade size 3 or 4 and cuffed PVC ETT with an internal diameter 6.5 mm and 7.5 mm were used to intubate female and male patients respectively. The ETT was fixed after confirming EtCO₂ and bilateral air entry. Anesthesia was maintained with oxygen, nitrous oxide and sevoflurane. Once the surgery was over, patients were reversed with IV Neostigmine 0.05 mg/kg and Glycopyrrolate 0.01mg/kg.

Time to intubation was defined as the time from the passage of the tip of the laryngoscope into the oral cavity to the appearance of the EtCO₂ on the monitor. Failure to intubate was defined as more than 2 attempts or reduction of oxygen saturation below 95%. In such cases an alternative device such as McCoy laryngoscope or Fiberoptic Bronchoscope would be used. Ease of insertion was noted with Likert's scale where very difficult, difficult, neutral, easy, or very easy were assigned numbers 1, 2, 3, 4 and 5 respectively [7]. Need to use the Magill's forceps to aid the insertion of the ETT into the trachea or any tear in the ETT cuff was noted. Hemodynamic parameters such as heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP) and oxygen saturation (SpO₂) were noted at baseline (T0), immediately before laryngoscopy (T1), immediately after laryngoscopy (T2), 2 minutes after laryngoscopy (T3), 5 minutes after laryngoscopy (T4) and 10 minutes after Laryngoscopy (T5).

For statistical analysis, data entry was done in Microsoft EXCEL spreadsheet and the final analysis was done with the use of Statistical Package for Social Sciences (SPSS) software, IBM manufacturer, Chicago, USA, version 25.0. Presentation of Categorical variables was done in the form of number and percentage (%). On the other hand, the quantitative data were presented as mean $\pm$ SD and as median with 25th and 75th percentiles (interquartile range). Data normality was checked by using Shapiro-Wilk test. Independent t test was used for comparison of variables which were quantitative and normally distributed in nature and Chi-Square test for qualitative variables. If any cell had an expected value of less than 5 then Fisher's exact test was used. For statistical significance, p value of less than 0.05 was considered significant.

Results:

Data of 49 patients out of 50 were included in the study as one patient had to be excluded from group V as more than two attempts were required to intubate and Spo2 fell to 88% transiently (figure 1).

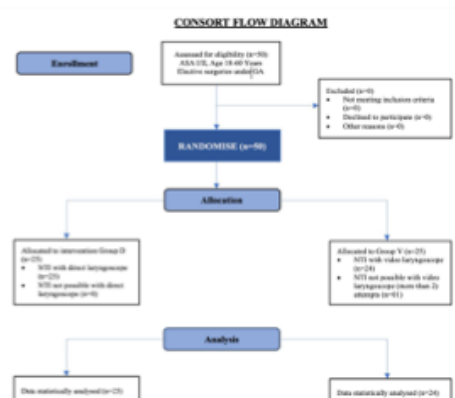


Figure 1. Consort diagram showing data analysis of Group D and V

Demographic characteristics of the patients enrolled in the study are presented in table 1.

Table 1: Comparison of demographic variables between group D and V.

Variables	Group D	Group V	P value §
Age (years)	32.36 ± 12.19*	34.12 ± 12.59*	0.832 [†]
Gender (M/F)	12 /13	16 /9	0.254 [‡]
ASA Grade	18/7	16/9	0.544 [‡]
BMI	20.32 ± 1.28*	20.48 ± 1.12*	0.641 [‡]

* Values are presented as mean ± SD

[†]Fisher's exact test

[‡]Independent t test

§ p < 0.05 significant

Indications for surgery in the 49 patients included in the study were chronic tonsillitis, hemithyroidectomy, superficial parotidectomy, facial basal cell carcinoma and so on. The mean ± SD of time taken for intubation (in seconds) in Group D was 57.2 ± 10.84, and in Group V it was 53.62 ± 35.19, demonstrating no significant difference between the two groups (p value=0.638). (Figure 2)

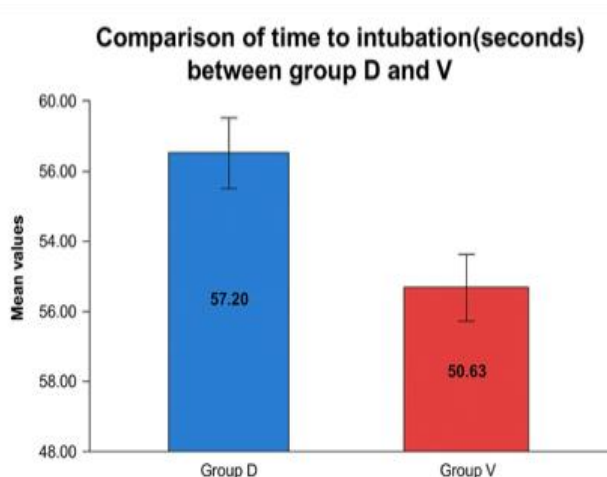


Figure 2. Comparison of time to intubation (in seconds) between Groups D and V

Number of attempts needed for successful NTI was found to be comparable between Group D and Group V, with 100% and 87.50% single attempt respectively, and 0% and 12.50% two attempts respectively (p value=0.11). The proportion of patients in whom Magill's forceps were used was significantly higher in Group D compared to Group V (92% vs 62.50%) with a statistically significant p value of 0.018. (Figure 3).

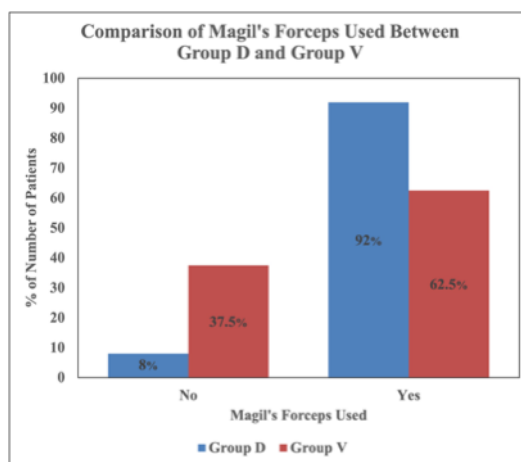


Figure 3. Comparison of Magill's Forceps usage between Groups D and V

Analysis of ease of insertion, as assessed on Likert's scale, revealed significant differences between the two groups ($p=0.041$). (Table 2) While the mean scores did not significantly differ, the percentage reporting insertion as "Hard" and "Easy" showed distinctions between the two groups, suggesting a nuanced perception of ease of insertion. Notably, none of the participants in Group D reported finding the insertion "Hard," while 16.67% of participants in Group V did. Additionally, a higher percentage of participants in Group D (60%) reported insertion as "Easy" compared to Group V (33.33%). The distribution across other categories, including "Neutral" and "Very easy," varied between the groups. The mean Likert score for ease of insertion was 4.16 ± 0.64 for Group D and 4.08 ± 1.10 for Group V, showing no significant difference ($P=0.764$). No endotracheal tube cuff tear was reported in any of the patients in both the groups.

Table 2: Comparison of ease of insertion on Likert's scale between group D and V.

Ease of insertion on Likert's scale	Group D(n=25)	Group V(n=24)	Total	p value*
Hard	0 (0%)	4 (16.67%)	4 (8.16%)	0.041 [†]
Neutral	3 (12%)	1 (4.17%)	4 (8.16%)	
Easy	15 (60%)	8 (33.33%)	23 (46.94%)	
Very easy	7 (28%)	11 (45.83%)	18 (36.73%)	
Mean $\pm$ SD	4.16 $\pm$ 0.64	4.08 $\pm$ 1.10	4.12 $\pm$ 0.88	0.764 [‡]
Median(25th-75th percentile)	4(4-5)	4(4-5)	4(4-5)	
Range	3-5	2-5	2-5	

* $p < 0.05$ significant [†] Fisher's exact test [‡] Independent t test

The hemodynamic effects of laryngoscopy were noted in both the groups. (Table 3) Mean $\pm$ SD of heart rate per minute at T0, T1, T2, T3, T4, T5 in group D was 92.48 ± 16.69 , 92.08 ± 11.61 , 92.2 ± 12.28 , 91.36 ± 10.63 , 90.6 ± 11.47 , 90.44 ± 11.83 respectively and in group V was 88.88 ± 13.77 , 89.12 ± 15.06 , 87.96 ± 14.61 , 87.12 ± 17.61 , 83.6 ± 14 , 83.12 ± 14.1 respectively with no significant difference between the groups ($p>0.05$). Mean $\pm$ SD of SBP (mmHg) at T0, T1, T2 in group D was 113.84 ± 15.86 , 111.52 ± 15.65 , 108.48 ± 9.6 respectively and in group V was 117.92 ± 19.17 , 114.92

± 17.13 , 113.04 ± 16.83 respectively with no significant difference between them. Mean $\pm$ SD of SBP at T3, T4, T5 in group D was 112.4 ± 11.37 , 109.4 ± 15.06 , 111.44 ± 13.09 respectively which was significantly higher as compared to group V (104.08 ± 12.33 ($p = 0.017$), 101.32 ± 10.14 ($p = 0.031$), 101.72 ± 6.92 ($p = 0.002$)) respectively. No significant difference between the groups was seen for DBP at T0, T1 and T2 but mean $\pm$ SD of DBP (mmHg) at T3, T4, T5 in group D was 77.2 ± 10.46 , 75.48 ± 10.06 , 78.88 ± 8.55 respectively which was significantly higher as compared to group V (69.2 ± 12.33 ($p = 0.017$), 67.8 ± 10.63 ($p = 0.012$), 69 ± 8.02 ($p \text{ value} = 0.0001$)) respectively. Mean $\pm$ SD of MAP also showed no significant difference between the groups T0, T1, T2 while mean $\pm$ SD of MAP (mmHg) at T3, T4, T5 in group D was 88.93 ± 8.63 , 86.79 ± 10.56 , 89.73 ± 8.93 respectively which was significantly higher as compared to group V (80.83 ± 11.61 ($p = 0.009$), 78.97 ± 9.79 ($p = 0.009$), 79.91 ± 6.83 ($p < 0.00001$)) respectively. No significant difference was seen in SpO₂ (%) between the groups at any point of time.

Table 3. Comparison of Hemodynamic Parameters

	Heart Rate			Systolic BP(mmHg)			Diastolic BP(mmHg)			MeanBP(mmHg)			Spo2		
	D*	V†	P‡	D	V	P	D	V	P	D	V	P	D	V	P
T 0	92.48 $\pm$ 16.69	88.88 $\pm$ 13.77	0.41	113.84 $\pm$ 15.86	117.92 $\pm$ 19.17	0.46	72.92 $\pm$ 14.5	76.92 $\pm$ 12.73	0.305	84.28 $\pm$ 14.31	88.68 $\pm$ 13.09	0.262	99.92 $\pm$ 0.289	99.72 $\pm$ 0.74	0.214
T 1	92.08 $\pm$ 11.61	89.12 $\pm$ 15.06	0.44	111.52 $\pm$ 15.65	114.92 $\pm$ 17.13	0.467	70.08 $\pm$ 14.06	74.64 $\pm$ 12.48	0.312	82.08 $\pm$ 14.01	86.48 $\pm$ 14.16	0.276	99.84 $\pm$ 0.47	99.76 $\pm$ 0.6	0.602
T 2	92.2 $\pm$ 2.28	87.96 $\pm$ 14.61	0.272	108.48 $\pm$ 9.6	113.04 $\pm$ 16.83	0.247	67.88 $\pm$ 12.01	72.36 $\pm$ 13.89	0.229	79.36 $\pm$ 10.56	85.4 $\pm$ 14.52	0.099	99.72 $\pm$ 0.61	98.88 $\pm$ 3.99	0.304
T 3	91.36 $\pm$ 10.63	87.12 $\pm$ 17.61	0.31	112.4 $\pm$ 11.37	104.08 $\pm$ 12.33	0.17	77.2 $\pm$ 10.64	69.2 $\pm$ 12.33	0.017	88.93 $\pm$ 8.63	80.83 $\pm$ 11.61	0.009	99.6 $\pm$ 0.71	99.88 $\pm$ 0.44	0.1
T 4	90.6 $\pm$ 1.47	83.6 $\pm$ 14	0.05	109.4 $\pm$ 15.6	101.32 $\pm$ 10.14	0.03	75.48 $\pm$ 10.06	67.8 $\pm$ 10.63	0.012	86.79 $\pm$ 10.56	78.97 $\pm$ 9.79	0.009	99.68 $\pm$ 0.56	99.52 $\pm$ 0.77	0.404
T 5	90.44 $\pm$ 11.83	83.12 $\pm$ 14.1	0.05	114.44 $\pm$ 13.09	101.72 $\pm$ 6.92	0.02	78.88 $\pm$ 8.5	69.8 $\pm$ 10.2	0.001	89.73 $\pm$ 8.93	79.91 $\pm$ 6.83	<0.001	99.88 $\pm$ 0.33	99.8 $\pm$ 0.41	0.451

*Group D (Values are presented as mean $\pm$ SD)

†Group V (Values are presented as mean $\pm$ SD)

‡ P- p value (<0.05 significant)

T0=base line in OR , T1= Immediately before laryngoscopy, T2=Immediately after laryngoscopy, T3= 2 minutes after laryngoscopy, T4=5 minutes after laryngoscopy ,T5=10 minutes after laryngoscopy

Discussion

The indications for surgery were comparable in both the groups of our study but we excluded any patient with known or anticipated difficult airway to maintain uniformity. Data of 49 patients out of 50 were included in the study and analysed statistically. One patient had to be excluded from group V as more than two attempts were required to intubate and Spo2 fell to 88% transiently. This patient was intubated orally in the 3rd attempt with the help of McCoy laryngoscope as the Cormack Lehane grade was 3b. We consider it as a limitation of our study that no difficult airway patients were included whereas NTI is required in many difficult airway situations such as cervical spine trauma/instability and facial trauma. Also no postoperative evaluation was done to assess complications such as sore throat and airway trauma in our study.

Demographic profile of our patients such as age, sex, BMI, and ASA physical status were comparable. As far as time to intubation is concerned, both the groups showed no statistical differences ($p = 0.638$).

One probable reason could be that no known or unanticipated difficult airway patient was included either group. One important finding seen in our study was that the cases done using VL during the initial phase of the study showed longer time to intubate. This was probably related to the steep learning curve for using the device. Aggarwal H et al concluded that the McCoy laryngoscope provided better attenuation of hemodynamic responses to laryngoscopy and intubation than the Macintosh DL and C-Mac VL whereas better Cormack and Lehane score Class I was seen with the C-MAC VL. Furthermore, the time taken to perform endotracheal intubation was the longest with the C-MAC VL in their study [8]. In our study the number of attempts was lesser in group D even though the difference was not significant ($p=0.11$). A study by Kumari M et al also showed similar results with similar number of intubation attempts even though visualisation was better with VL. This study compared C-MAC and Macintosh DL whereas our study compared Tuoren™ VL and Macintosh DL [9].

Ease of insertion was assessed by using Likert's Scale where very hard, hard, neutral, easy, or very easy insertion were assigned numbers 1, 2, 3, 4 and 5 respectively [7]. On statistical analysis by Fisher's exact test and Independent t test, the difference between the two groups was significant ($p=0.041$) in our study. The mean Likert score for ease of insertion was 4.16 ± 0.64 for Group D and 4.08 ± 1.10 for Group V, showing no significant difference ($P=0.764$). The percentage reporting insertion as "Hard" and "Easy" showed distinctions between the two groups, suggesting a nuanced perception of ease of insertion.

Magill's forceps was used in 23 (92%) cases out of 25 cases in group D whereas in group V it was used in 15 (62.50%) cases out of 25 cases. This is significant as Magill's forceps usage may lead to cuff tear in many cases. The study by Brett J King, et al also concluded that use of Magill's forceps was significantly increased in DL group ($p=0.007$) [3]. No cuff tear was seen in either group, so both the laryngoscopes seems to be similar in this aspect.

In our study hemodynamic parameters were observed up to 10 minutes after laryngoscopy and NTI. There was no significant difference with respect to oxygen saturation and heart rate between both the groups at any point after intubation. There was lesser increase in systolic, diastolic and mean arterial pressures in the videolaryngoscope group (group V) noted 3,5,10 minutes after intubation, thereby showing a better hemodynamic profile. Previous studies comparing DL and VL of different makes have given contrasting results with the VL showing a better stress response profile than DL, as seen through hemodynamic monitoring, in some studies and vice versa. Our results differ from a similar study by Buhari FS et al who compared three groups; namely, Group A - Macintosh direct laryngoscopy (control group), Group B - laryngoscopy with McCoy laryngoscope and Group C - laryngoscopy with CMAC video laryngoscope. They found that the HR was significantly higher in the C-MAC group than the Macintosh group at 3 min after intubation, whereas SBP, DBP, and MAP were significantly higher at 1 min. McCoy group showed a similar response compared to Macintosh group at all time intervals. Hence they concluded that C-MAC video laryngoscope has a comparatively greater hemodynamic response than Macintosh laryngoscope [10]. Various studies have compared ease of intubation and hemodynamics between different video laryngoscopes and the Macintosh laryngoscope with varying results [11-16].

To conclude, the Tuoren™ videolaryngoscope showed better ease of insertion with lesser use of Magill's forceps during NTI in patients undergoing GA in our study. There was no significant difference as far as time to intubate was concerned. The haemodynamic response at 2 min, 5 min and 10 min after intubation, as shown by NIBP readings, was also better in the videolaryngoscope group. The mean number of attempts were however lesser in Macintosh direct laryngoscopy group. Both the group showed no ETT cuff tear in any of the patients.

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