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"Comparison Of Efficacy Of Tuoren Video Laryngoscope, Airtraq And Macintosh Laryngoscope For Intubation In Adult Patients: A Randomized Controlled Trial".

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Abstract
Background*: Since its introduction, Macintosh laryngoscope has proved to be inefficient in many situations of difficult airway. Video and optical laryngoscopes showed great success in many situations. So, we have compared the efficacy of Tuoren video laryngoscope, Airtraq optical laryngoscope and Macintosh laryngoscope in terms of number attempts of successful intubation and time taken to intubate adult patients.*
Materials and Methods: *Ninety adult patients undergoing elective surgery were divided into three groups to achieve tracheal intubation with Tuoren video laryngoscopes (Group T), Airtraq (Group A) and Macintosh (Group M). The primary objective was number of attempts required for successful intubation with three devices. Secondary objectives were laryngoscopy and intubation time, ease of tracheal intubation, number of adjustment maneuvers required and airway complications. SPSS version 20.0 software was used for statistical analysis. Intergroup and intragroup mean comparisons were made using ANOVA and Post Hoc Tukey statistical analysis. Frequencies were compared using Fischer exact test, keeping level of significance at P-value<0.05.*
Results*: There was no significant difference in the number of attempts to intubate by the three devices. Tuoren Video laryngoscope took less time(13.8±3.24 seconds) to intubate compared to other two devices (P=0.004) and showed lesser in rise in heart rate and mean arterial blood pressure just after intubation which gradually declined to normal. The number of adjustment maneuvres was also significantly less with Tuoren video laryngoscope*
Conclusion: *The number of attempts was similar but time taken to successfully intubate was less with Tuoren Video Laryngoscope as compared to Airtraq and Macintosh Laryngoscope*
Key Words: *Intubation; Laryngoscopes; Anesthesia; Heart rate; Blood pressure.*

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I. Introduction

Managing a difficult airway has always been a challenging task for an Anaesthesiologist, as at times it is life threatening.[1] The curved laryngoscopic blade which was described by Macintosh in 1943, is the most popular device for tracheal intubation till date.[2] Some of the disadvantages of direct laryngoscopy include the need for an optimal line of sight for glottic visualization, greater cervical spine movement during laryngoscopy, lack of visual feedback for other healthcare providers during resuscitation, for novices undergoing training in laryngoscopy and lack of image archiving capability.[3-4] So, alternative techniques and equipments must always be readily available for managing such cases.

Video laryngoscopy is relatively recent development that improves the success of tracheal intubation. Visualization of vocal cords with these devices is achieved indirectly either through an optical or a video system.[5] The purpose of the study is to compare the number of attempts for successful intubation using Video laryngoscope (Tuoren Video laryngoscope), Optical laryngoscope (Airtraq) and Macintosh laryngoscope in elective adult surgical patients.

The new Tuoren video laryngoscope is a unique piece of equipment with a non-channelled blade which helps anaesthesiologist to intubate using video system. It is used like a conventional Macintosh laryngoscope. The tip of its blade has a video camera recording system by which one can see the epiglottis live on the screen which is present on the side of the handle and record the intubation procedure.

We hypothesised that because of the constructive characteristics of the videolaryngoscope, it would prove to be a better intubating device as compared to the Macintosh and Airtraq laryngoscope. The study was conducted with primary objective of assessing the total number of attempts required for successful intubation. The secondary objectives of our study were laryngoscopy and intubation time; ease of tracheal intubation; haemodynamic alterations and number of adjustment maneuvers required along with airway complications. Thus

the present study was conducted to assess and compare the success of intubation using Video laryngoscope with the optical laryngoscope and conventional laryngoscope.

II. Materials And Method

Study design & settings:

The present randomized prospective study was conducted in the Department of Anesthesiology, from the period August 2018 to December 2019. The study was approved from Institutional ethical committee and was then registered in Clinical Trial Registry; before enrollment of first patient.

Inclusion & exclusion criteria:

90 adult ASA Grade I & II patients, of both sexes, aged 20-65 years, weighing between 40-75 kg undergoing elective surgery under General anaesthesia, having any class of mallampati grades, basal metabolic index <30 kg m−2, thyromental distance >6 cm were included in the study. Patients with previous history of multiple or failed intubation, predicted difficult laryngoscopy, any pathology of oral cavity that may obstruct the insertion of device, patients with mouth opening <2.5 cm, potentially full stomach patients, trauma, morbid obesity, pregnancy, history of gastric regurgitation and heart burn, or patients at risk of esophageal reflux (hiatus hernia) were excluded from the study.

After explaining the purpose of study, a written informed consent was obtained from all included patients, and then they were randomly allocated into three groups of 30 each, based on computer generated random number table.

Procedure:

Patients (n=30 each) were intubated using Tuoren video laryngoscope (Group T); Airtraq (Group A) and Macintosh laryngoscope (Group M). Blinding of the attending laryngoscopist was not possible as the three intubating devices were quite different. To avoid observer bias, the same anaesthesiologist did all the endotracheal intubations. The anaesthesiologist had sufficient clinical experience and was well aware of using videolaryngoscopes (**Figure 1**).

After shifting the patient inside the operating room Standard monitors such as pulse oximeter, non-invasive blood pressure, electrocardiogram, temperature probe and capnography were applied. Pre-oxygenation was done for 3 minutes following which balanced anaesthesia technique through intravenous route was used to anaesthetize the patient. Anaesthetic technique comprised of premedication with injection (inj.) midazolam 0.03 mg/kg, glycopyrrolate 0.01 mg/kg, and fentanyl 1.5 mcg/kg of body weight. Anaesthesia was induced with propofol 2.0 mg/kg. After adequate muscle relaxation with Inj. Rocuronium 1.2 mg/kg, intubation was done depending on the group to which the patient was assigned.

Oropharyngeal devices were used if tongue fall was detected after patient had gone unconscious. Intubation Difficulty Scale (IDS) score was used for quantitative determination of intubation complexity.[6] Adjusting maneuvers like readjustment of head position, external laryngeal manipulation, jaw thrust and /or a bougie was used whenever a need was accounted. A maximum of three attempts with a device were allowed, a supraglottic airway device (I-gel) was to be used as a rescue device in the event of failure of intubation even after three attempts. Surgery was allowed to commence, only after the collection of the last hemodynamic data at 5 minutes post-intubation. Following successful intubation, circle circuit was attached to the tube and anaesthesia was maintained with 60% N_2O in oxygen with vecuronium bromide and isoflurane.

Data collection

As per the primary and secondary objectives, we assessed total number of attempts for successful intubation; intubation time; ease of tracheal intubation; number of adjustment maneuvers required, hemodynamic parameters (blood pressure and heart rate) and airway complications. Intubation time was calculated from the introduction to the removal of device between the two incisors. Heart rate (HR) was recorded by the pulse oximeter and blood pressure (BP) was recorded using non-invasive multi-channel monitor. Ease of intubation was graded as Grade I when no extrinsic manipulation of larynx was required; Grade II if external manipulation of the larynx is necessary to intubate; and Grade III in failed intubation. Immediate pre-induction value was recorded and considered as control value for all the groups. Thereafter, HR and BP were recorded after 1, 3 and 5 minutes.

Any trauma during intubation was assessed by presence or absence of blood on blade after its removal from the oral cavity. Postoperatively sore throat was assessed by an independent observer blinded to the nature of laryngoscopy. Presence of an unpleasant sensation in the throat (which was not previously present) just prior to discharge from the recovery room and 24 hours later was recorded as evidence of sore throat.

Statistical analysis

The data obtained was subjected to the statistical analysis using SPSS version 20.0 software (IBM, Chicago) for Windows at a significance level of P-value<0.05.

Sample size calculation

Taking expected proportion (p)[5] of 0.121, confidence interval of 95% with precision (d) 5%, sample size was calculated as 82.69, using formula: $N= [Z^2 p(1-p)] / d^2$

Considering 10% drop outs/loss to follow up/attrition, sample size was enhanced to 90. Total 90 selected cases were then randomly divided into three groups (n=30) of different intubation techniques, using computer based randomisation system.

III. Results

A total of 99 patients were assessed for the eligibility, out of which four patients declined to participate and five patients were excluded because of other reasons (**Figure 2:** Consort Flow Diagram). Patients of all three groups were compared in relation to demographic profile like age, sex, weight, BMI, Thyromental distance and Mallampati Classification. Statistically all the three groups were found to be comparable, showing an insignificant difference in relation to demographic profile **(Table no. 1).** We observed that as compared to conventional techniques, more number of patients (96.67%) were intubated in one attempt using Tuoren Video laryngoscope, but statistically the difference was found to be insignificant (P-value=0.692). The mean intubation time was significantly (P-value=0.004) lesser with Tuoren video laryngoscope (12.5±1.38 seconds) as compared to the other two devices (Group A: 13.8±3.48 seconds; Group M: 15.06±3.48 seconds) **(Table no. 2).** We also recorded the outcomes of all three devices. It was found that more number of cases in Group A required adjustment maneuvers, showed ease of intubation and sore throat, as compared to other two groups; although difference between all devices was insignificant (P-value=0.064, 0.667, 0.374, 0.136) statistically. Maximum cases (93.3%) in Group T showed blood staining and maximum (83.3%) showed Cormack Lehane grade 1, as compared to other two groups; although difference between all the devices was insignificant (P-value=0.096) statistically (**Table no. 2**).

Change in heart rate and mean arterial blood pressure (MABP) was observed from pre-intubation to 1, 3 and 5 minutes post intubation periods. It was observed that both hemodynamic parameters were significantly (P-value=0.001, 0.001, 0.002 after 1min, 3min, 5min respectively for heart rate; P-value=0.000, 0.006 after 1min, 3min respectively for MABP) lower in Tuoren video laryngoscope as compared to the other two devices (**Table no. 3**). For both heart rate and blood pressure, intergroup comparison between the groups revealed that at all post-intubation periods; a significant difference was seen between Group T with either Group A (P-value=0.022, 0.003, 0.001 after 1min, 3min, 5min respectively for heart rate; P-value=0.000, 0.001, 0.043 after 1min, 3min, 5min respectively for MABP) and M (P-value=0.001, 0.001, 0.003 after 1min, 3min, 5min respectively for heart rate; P-value=0.000, 0.007 after 1min, 3min respectively for MABP); whereas statistically difference was found to be insignificant between Group A and M (except for mean arterial pressure at 1min; P-value=0.021), (**Table no. 4**).

IV. Discussion

After the invention of laryngoscope, anesthesiologists have been working for development of improved and sophisticated version of laryngoscopes. The new Tuoren video laryngoscope (Henan Tuoren Kingtaek Medical Device Company, Ltd., China) is unique equipment which helps anaesthesiologist intubate and record it. It has a video camera and an LCD monitor. This camera when introduced with the blade goes inside mouth and shows the tracheal opening on the monitor. It has rechargeable battery that can be used for 5 years. At a time more than one person can see procedure on the screen making it a suitable equipment even for teaching /demonstration. The software is very user friendly with recording facility. As per convenience of operator, the monitor can also be tilted and rotated. It is a recently introduced videolaryngoscope, so only few studies are available comparing its efficacy as an intubating device. Thus, we compared the features and uses of Tuoren video non-channelled laryngoscope with optical channelled laryngoscopes and conventional Macintosh non-channelled laryngoscope in cases of difficult airway.

We found that with Tuoren video laryngoscope, more number of patients got intubated in one attempt but there was statistically insignificant difference (p-value>0.05) with other conventional groups, in relation to the number of attempts. All patients were either intubated in first or second attempt and no patient required rescue supraglottic devices. Similar to our study, I**tai J et al.,[7] Murphy LD et al.,[8] and Jarvis JL et al.[9]** have demonstrated that video laryngoscope helps in improving the laryngeal view and in first attempt one can achieve successful intubation as compared to Macintosh laryngoscope.

In our study laryngoscopy time was calculated from introduction to the removal of laryngoscope (Macintosh, Airtraq, Tuoren) from the mouth and subsequent confirmation of correct placement of endotracheal tube (ETT). We found that order of intubation time taken by devices was Group T<Group A<Group M. Tuoren

group showed lesser time to intubate than Macintosh group and Airtaq group; and Airtaq took lesser time than Macintosh laryngoscope. **Ali QE et al.,[10]** also found that Kings vision video laryngoscope was associated with lesser time for successful intubation than optical laryngoscope.

In our study, the effects of laryngoscopy and tracheal intubation on the mean arterial blood pressure and on heart rate showed significant changes from pre induction values in all the three groups but inter group variations were relatively modest. Heart rate increased in all the groups, after tracheal intubation, but gradually returned to baseline value within 5 min. Both hemodynamic parameters were significantly (p-value<0.05) lower in Tuoren video laryngoscope as compared to the other two devices; with a significant difference (p-value<0.05) was seen between Group T with either Group A and M. Group A showed lesser values of hemodynamic parameters, showing an insignificant (p-value>0.05) difference between Group A and M.

Similar to our study, **Maharaja CH et al.[11]** found that Airtraq reduced hemodynamic stimulation as compared to Macintosh laryngoscopes. Similar to our study, **Riad W et al.[12]** found that Airtraq showed lesser alteration in the heart rate as compared to Macintosh laryngoscope. **Nishikawa K et al.[13]** compared haemodynamic changes between PENTAX-AWS Video Laryngoscope and Macintosh. They found that haemodynamic changes were more in the Macintosh group as compared to Video Laryngoscope.

In our study, it was found that more number of cases in Group A required adjustment maneuvers, showed ease of intubation and sore throat, as compared to other two groups. Maximum cases (93.3%) in Group T showed blood staining and maximum (83.3%) showed Cormack Lehane grade 1, as compared to other two groups. Difference between all the devices in relation to outcomes was insignificant (p-value>0.05) statistically. Similar to our study, **Riad W et al.[12]** found that Airtraq required lesser optimization maneuvers than standard Macintosh laryngoscope. Similar to our study, **Elhadi SM et al.[14]** compared Macintosh laryngoscope with a King vision video laryngoscope for endotracheal intubation and found that video laryngoscope required less number of optimization maneuvers.

Video laryngoscopy produces larger and brighter resolution images, making it easier for the clinician to intubate patients. Moreover, the video version is said to exert less force and less trauma than direct laryngoscopy, which is vital when patients have already been subjected to a physically distressing situation. **Nakstad AR et al.[15]** demonstrated the advantages of video laryngoscopy in airway management in simulated entrapped patients. **Sakles J et al.[16]** found that emergency department intubations were more successful with video laryngoscopy than with direct laryngoscopy. **Rabiner JE et al.,[17]** reported a decrease in dental trauma using video laryngoscopy as compared to direct laryngoscopy.

Raimann FJ et al.[18] compared four video laryngoscopes with one optical laryngoscope and Macintosh laryngoscope. They demonstrated that VL improves the view of glottic structures, but good view was not associated with a successful intubation depending on the angulation of the blade. Findings of our study were in consonance with this study by as Tuoren video laryngoscope and Airtraq laryngoscope both revealed a better glottic view than Macintosh laryngoscope.

Till date there are few studies being conducted comparing Tuoren video laryngoscope with other conventional laryngoscopes.[19-22] But till date there is no study comparing three different types i.e. Tuoren video laryngoscope, Macintosh laryngoscope and Airtraq optical laryngoscope. Thus the results of present study can help to give an insight regarding the use of video laryngoscope in comparison to optical and conventional laryngoscope.

Besides the strength, our study also has few limitations. The anesthesiologist was not blinded about the device being used; this could have led to observer bias. Sample size of the study was less, thus further comparative studies should be conducted on larger sample size. The present study was conducted in a tertiary hospital, thus results of study couldn't be generalized for whole population.

V. Conclusion

The present study revealed that Tuoren Video Laryngoscope was found to be the most efficient device in terms of least intubation time and comparatively lesser hemodynamic derangements as compared to optical and conventional Laryngoscope. Thus findings of our study advocate the use of Video Laryngoscope for better outcomes and ease of intubation.

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Table no. 1: Demographic Data

Parameters assessed	Group T	Group A	Group M
Age in years (Mean ±SD)	40.5±4.24	40±7.0	39.9±6.68
Male:Female ratio	15:15	14:16	13:17
MP Classification I/II/III/IV	12/12/5/1	11/14/4/1	14/11/4/1
Thyromental distance	7.1±0.4	6.9±0.8	7.4±0.7
Weight in Kg (Mean±SD)	61.5±5.45	58.8±6.43	60.6±4.64
BMI (kg/m^2)	24.2±4.2	24.6±3.8	23.8±4.6

Table no. 2: Number of attempts, intubation time and outcome in three groups of patients

Parameters		GROUP M		GROUP A		GROUP T		p-value
		N	%	N	%	N	%	
Number of attempts	1 Attempt	29	96.67	27	90	27	90	0.692†
	2 Attempts	1	3.33	3	10	3	10	
Intubation time in seconds (Mean ±SD)		12.5±1.38		13.8±3.24		15.6±3.48		**0.004*‡**
No. of adjusting maneuvers	0	26	86.67	0	0	0	0	0.064†
	1	2	6.67	23	76.67	28	93.33	
	≥2	2	6.67	7	23.33	2	6.67	
Ease of intubation	Grade 1	24	80	27	90	25	83.33	0.667†
	Grade 2	6	20	3	10	5	16.67	
Blood Staining	No	24	80	26	86.67	28	93.33	0.374†
	Yes	6	20	4	13.33	2	6.67	
Sore Throat	No	24	80	29	96.67	28	93.33	0.136†
	Yes	6	20	1	3.33	2	6.67	
Cormack Lehane grading	1	17	56.67	20	66.67	25	83.33	0.096†
	2	11	36.67	10	33.33	5	16.67	
	3	2	6.67	0	0	0	0	
	4	0	0	0	0	0	0	

***p-value<0.05 is significant; † Fischer exact test; ‡ ANOVA statistical analysis**

Table no. 3: Haemodynamic parameters at different time intervals

Groups	Heart rate (per minute)				Mean arterial blood pressure (mm hg)			
	Pre intubation	After 1 minute	After 3 minutes	After 5 minutes	Pre intubation	After 1 minute	After 3 minutes	After 5 minutes
Group T	77.8±7.78	94.36±7.78	86.8±6.64	79.53±6.35	77.73±3.81	88.6±4.35	85.63±3.83	82.1±3.83
Group A	81.6±8.59	99.2±7.82	92.4±7.05	85.66±7.29	78.6±4.02	92.26±3.23	89.3±4.04	84.4±4.36
Group M	78.67±7.99	103.9±11.78	95.33±10.6	85.7±8.54	78.1±9.068	97.66±8.98	90.46±8.48	84.73±8.11
p-value†	0.167	**0.001***	**0.001***	**0.002***	0.862	**0.000***	**0.006***	0.189

***p-value<0.05 is significant; †ANOVA statistical analysis**

Table no. 4: Intergroup comparisons between all three groups in relation to haemodynamic parameters at different time intervals

Haemodynamic parameters	Time intervals	Group A vs M (p-value)	Group M vs T (p-value)	Group A vs T (p-value)
Heart Rate (per minute)	**Pre Intubation**	0.171	0.675	0.078
	After 1min	0.079	**0.001***	**0.022***
	After 3 Min	0.222	**0.001***	**0.003***
	After 5 Min	0.975	**0.003***	**0.001***
Mean arterial blood pressure(mm Hg)	**Pre Intubation**	0.784	0.840	0.408
	After 1min	**0.021***	**0.000***	**0.000***
	After 3 Min	0.506	**0.007***	**0.001***
	After 5 Min	0.846	0.129	**0.043***

***p-value<0.05 is significant; †Post HOC Tukey statistical analysis**

Figure 1: Tuoren Video Laryngoscope

Figure 2: Consort Flow Diagram