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A Comparative Study of Hemodynamic Response and Ease of Intubation in Patients Intubated by Direct Laryngoscopy Versus Lightwand

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Abstract

Introduction: Direct laryngoscopic endotracheal intubation is associated with varying degrees of sympathetic activity which may be detrimental in patients with coexisting conditions, such as coronary artery disease, elevated intracranial pressure and asthma. Lightwand intubation, on the other hand, by avoiding direct laryngoscopy, is expected to cause lesser hemodynamic variations. *Aim:* This randomised and prospective study intends to compare the hemodynamic response to intubation and ease of intubation by both these procedures. *Settings and design*: Prospective randomised single blind study. *Material Methods*: Hundred normotensive patients of either sex, age 18 to 60 years, ASA I & II, with normal airway scheduled to undergo elective surgeries under general anaesthesia were included in the study. They were randomly divided into two groups-DL (direct laryngoscopic intubation) & LW (lightwand intubation). Preoperatively heart rate, systolic, diastolic and mean blood pressure were recorded. Above parameters were also noted at 0, 1, 3, 5 minutes after intubation in both the groups. The time taken and the number of attempts required for successful intubation were noted. Results were statistically analysed. *Statistical analysis used:* Paired and unpaired student's t-test. *Results*: Hemodynamic response was more in DL group than in LW group which was statistically significant. Whereas, time taken for intubation was statistically significantly more with lightwand (20.08±7.07 secs) as compared to direct laryngoscopic intubation (16.94±4.55 secs). *Conclusion*: Lightwand intubation was associated with lesser hemodynamic response however the time taken for intubation by lightwand was more as compared to direct laryngoscopic intubation.

Keywords: Lightwand; Direct Laryngoscopy; Endotracheal Intubation; Time Taken for Intubation.

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Introduction

Endotracheal intubation is traditionally performed by direct vision using a laryngoscope. The success of intubation by laryngoscopy depends largely on the experience of the intubator and the patient's upper airway anatomy. Occasionally, however, even in the hands of experienced anaesthesiologist, intubation by direct vision can be difficult or impossible. At times it is not even possible to introduce the blade of the laryngoscope in patients with restricted mouth opening, tumors of the oropharynx and post burn contractures involving the face and neck. In such cases tracheal intubation has to be performed blindly. Blind intubations are often fraught with failures. Awake intubation with the help of fibreoptic bronchoscope has made dealing with such airways easy, but still many centres in India lack this facility.

Endotracheal intubation using laryngoscope is frequently associated with an increase in arterial blood pressure and heart rate. The organs involved

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in this sympathetic response to laryngoscopy and endotracheal intubation are base of tongue, epiglottis, soft palate, pharynx, epipharyngeal regions and larynx, which are extensively innervated by autonomic nervous system. Stimulation of these areas, particularly the epipharyngeal region (most sensitive area according to Tomori et al.) [1], leads to various cardiovascular changes, coughing, laryngospasm, bronchospasm, vomiting and pulmonary aspiration and increase in intracranial and intraocular pressure.

Over the years, new devices have been developed to successfully intubate the trachea and thereby provide useful alternatives to the standard technique of intubation using the laryngoscope. One of these devices is the lightwand.

The lightwand is a lighted stylet. It utilizes the principle of transillumination of the soft tissues of the anterior neck to facilitate tracheal intubation. Its use was first described by Yamura et al. [2] in 1951 for nasotracheal intubation.

Lightwand intubating device is an effective and safe aid to endotracheal intubation. The wand consists of a durable, flexible plastic shaft with a bright light bulb affixed to the distal end. Use of lightwand to intubate is expected to cause less adrenergic stimulation and sympathetic overactivity because elevation of epiglottis by laryngoscope blade is not required [3]. However, whether the haemodynamic responses to intubation with lightwand differ from those with direct laryngoscope is controversial. Also, since it is a gentle technique not involving much manipulation of the soft tissues the incidence of sore throat and mucosal injuries are also reported to be lesser than laryngoscopic intubation [4].

This study was designed to compare ease of intubation (time required for intubation) and hemodynamic response (changes in heart rate and blood pressure) to intubation by direct laryngoscopy, versus intubation with lightwand in adults with normal airways.

Material and Methods

This prospective, randomized study was conducted after approval by the Hospital Ethics Committee. Hundred patients between eighteen and sixty years of age of either sex with MPC I and II belonging to ASA grade I and II scheduled for elective surgery requiring general anaesthesia with endotracheal intubation were included in the study. Patients were labeled to be normotensive if they had no history of hypertension and their blood pressure on three occasions was less than 140/90 mm Hg.

Exclusion Criteria

1. Patients with MPC grade III and IV (anticipated difficult intubation)
2. History of previous difficult endotracheal intubation
3. Pregnant patients
4. Hypertensive patients (preoperative systolic blood pressure >140 mmHg and diastolic blood pressure >90 mmHg)
5. Patients with coexisting factors like rheumatoid arthritis, thyroid goiter and other causes of anticipated difficult intubation
6. Patients scheduled for major cardiovascular and thoracic surgery.
7. Coughing, arrhythmia or desaturation less than 90% during the procedure

Via computer generated randomization table, patients were divided into two groups-

1. Those intubated by direct laryngoscopy (DL)
2. Those intubated with lightwand (LW)

Preoperatively all patients were evaluated for history and clinical examination. Investigations according to the coexisting systemic illness and surgical procedure were done. They were also explained regarding the study and anaesthetic management. A written, valid & informed consent was obtained from each patient.

Night prior to the surgery, patients were given Alprazolam 0.25 mg P.O. and Omeprazole 20 mg P.O. Patients were fasting for atleast 6 hours before the surgery.

All patients were premedicated with Glycopyrolate 4 µg/kg intramuscularly half hour before surgery. Age and sex were noted. Inside the OT, baseline heart rate, blood pressure and oxygen saturation were recorded with multifunction monitor. Ondansetron 0.08 mg/kg i.v., Midazolam 0.03 mg/kg i.v. and Fentanyl 2 mcg/kg i.v. with supplemental oxygen were given.

The patients were positioned with standard pillow under head to achieve the ideal Chevalier Jackson position for direct laryngoscopy. For lightwand insertion, patient's head and neck were placed in neutral position.

Patients were induced with Thiopental sodium 5 mg/kg iv followed by Suxamethonium chloride 2 mg/kg iv after checking ventilation. Intubation was performed with cuffed polyvinyl chloride (Portex) endotracheal tube of optimum size (No. 7.5 for females and No.8.5 for males) by a single observer experienced in both lightwand insertion and direct laryngoscopy.

In DL group, direct laryngoscopy was performed with Macintosh blade (No. 3 for females and No. 4 for males) and the trachea was intubated with cuffed endotracheal tube. External manipulation of the larynx was used when necessary during laryngoscopy. The laryngoscope was removed after disappearance of black line on endotracheal tube. The position of the endotracheal tube was confirmed by 5-points auscultation.

In LW group, the lightwand was lubricated with water soluble K-Y jelly and introduced into the cuffed endotracheal tube. The distal end of the tube was bent to a 90 degree angle. Room lights were dimmed. The endotracheal tube with lightwand was introduced into the oral cavity after opening the jaw and advanced until midline illumination was observed in the anterior neck. The endotracheal tube was advanced until the glow disappeared behind the sternum. After the removal of the lightwand, the position of the endotracheal tube was confirmed by 5-points auscultation.

The duration of each attempt as the time from the introduction of the device (layngoscope or lightwand) into the oral cavity till its removal, was recorded with a stopwatch by an independent observer.

Three attempts were allowed for each intubating technique. Oxygenation was permitted between each attempt. Failure to intubate was defined as the inability to place the endotracheal tube into the trachea after three attempts. An alternative technique was used to intubate the trachea after a failed intubation. The total time taken for intubation (TTI) was defined as the sum of the durations of all intubation attempts (as many as three) before the use of the alternative intubating technique. Failed inubations i.e. those requiring more than three attempts were excluded from the study.

The hemodynamic changes in the form of heart rate, blood pressure and oxygen saturation at the time of intubation (0 min), at 1 minute, 3 minutes and 5 minutes following successful tracheal intubation in DL & LW group were recorded. Routine anaesthesia management was continued thereafter.

The observations were recorded, tabulated and analysed statistically by using paired and unpaired student's t-test. The results were discussed. Conclusions were drawn based on the results of statistical analysis.

Results

Demographic comparison

In group DL and group LW, the demographic profile of the patients was distributed with no significance (Table 1).The analysis was done by paired t-test.

Comparison of heart rate (beats/min)

Baseline heart rate of patients in both DL and LW groups were similar (statistically insignificant). However, the heart rate increased at 0 minute, 1 minute & 3 minutes after intubation in both the groups and the difference in heart rate was statistically significant ($p<0.05$) (Table 2). In both the groups, the mean heart rate returned to baseline at the end of 5 minutes and the difference was statistically insignificant.

Comparison of systolic blood pressure (SBP) (mmHg) in group DL and LW.

The systolic blood pressure immediately after intubation, showed a higher rise with laryngoscopic intubation at 0 minute, 1 minute & 3 minutes as compared to lightwand intubation (Table 3). Moreover, the rise in systolic blood pressure

Table 1: Demographic parameters

	Group		p-value
	DL	**LW**	
n (no. of patients)	50	50	
Age (years)	33.64 ± 9.07	37.44 ± 12.42	0.087
Gender			
Male	25	28	0.547
Female	25	22	
Weight (kg)	60.84 ± 7.46	62.62 ± 7.56	0.239
MPC			
I	34	38	0.371
II	16	12	
ASA			
I	40	38	0.629
II-	10	12	

Table 2: Comparison of heart rate in both groups

Heart rate at	Heart rate (Mean ± SD) beats/min		p-value
	DL (n=50)	LW (n=50)	
Baseline	82.60 ± 11.15	81.54 ± 10.41	0.624
0 min	109.00 ± 13.12	101.56 ± 11.73	0.004
1st min	98.82 ± 12.53	92.52 ± 12.98	0.015
3rd min	89.20 ± 10.92	85.30 ± 14.36	0.023
5th min	81.64 ± 11.45	78.20 ± 12.40	0.153

Table 3: Comparison of systolic blood pressure (SBP) mmHg in both groups

SBP at	SBP (Mean ± SD) for Groups in mmHg		p-value
	DL (n=50)	LW (n=50)	
Baseline	128.36 ± 11.71	130.14 ± 13.63	0.486
0 min	153.92 ± 26.08	144.58 ± 18.31	0.041
1st min	141.76 ± 13.59	135.10 ± 18.25	0.041
3rd min	132.76 ± 13.07	122.36 ± 16.32	0.001
5th min	117.06 ± 10.73	116.78 ± 11.41	0.900

Table 4: Comparison of Diastolic blood pressure (DBP) (mmHg) in both groups

DBP	DBP (Mean ± SD) for Groups in mmHg		p-value
	DL (n=50)	LW (n=50)	
Baseline	76.72 ± 9.44	76.02 ± 8.03	0.691
At 0 min	98.16 ± 13.56	92.78 ± 12.10	0.039
at 1st min	90.04 ± 13.66	82.78 ± 13.16	0.008
at 3rd min	78.58 ± 13.20	72.50 ± 12.00	0.018
at 5th min	68.56 ± 9.57	69.44 ± 8.10	0.621

Table 5: Comparison of Mean arterial pressure (MAP) (mmHg) in both groups

MAP at	MAP (Mean ± SD) for Groups in mmHg		p-value
	DL (n=50)	LW (n=50)	
Baseline	93.93 ± 8.22	94.06 ± 9.73	0.944
After intubation at 0 min	116.74 ± 13.53	110.04 ± 13.85	0.016
1st min	107.28 ± 11.61	100.22 ± 14.48	0.008
3rd min	95.30 ± 11.04	93.78 ± 13.90	0.016
5th min	84.72 ± 7.90	85.22 ± 9.64	0.780

normalised by 3 minutes in patients intubated with lightwand, whereas it was still on higher side at 3 minutes in laryngoscopic intubated patients. On comparing, the SBP in DL group was statistically more immediately after intubation, at 1 min and at 3 mins than LW group. However, SBP at 5 mins showed no significant difference.

Comparison of Diastolic blood pressure (DBP) (mmHg) in group DL and LW.

The diastolic blood pressure also showed an initial rise at 0 & 1 minute from baseline following intubation in both the groups (Table 4). This normalised by the end of 3 minutes after intubation in both the groups. The rise in diastolic blood pressure was lesser in LW group as compared to DL group and is statistically significant. At 5 mins again the difference in diastolic blood pressure was statistically insignificant.

Comparison of Mean arterial pressure (MAP) (mmHg) in group DL and LW.

The mean blood pressure at 0 min showed a significant rise in DL group than in LW group (Table 5). This response gradually decreased and normalised by 3 minutes in both the groups but the difference was still statistically significant ($p<0.05$). At 5 mins the difference in mean blood pressure was again found to be statistically insignificant.

Comparison of Time Taken for Intubation (seconds) in group DL and LW.

In this study, all intubations in the direct laryngoscopy group were done at the first attempt, while in lightwand group, two patients required a second attempt for intubation. The mean total time taken for intubation was 16.94±4.55 seconds for laryngoscopy group as against 20.08±7.07 seconds for lightwand intubated group. This difference was found to be statistically significant ($p<0.05$) (Table 6).

Table 6: Time taken for intubation in both groups

Group	Number of patients	Time in Secs (Mean ± SD)	p-value
DL	50	16.94 ± 4.55	0.0147
LW	50	20.08 ± 7.07	

Discussion

The present study was conducted to compare the magnitude and duration of pressor response to direct laryngoscopy guided and lightwand guided endotracheal intubation. We have also compared the time taken for intubation in both the intubation techniques.

The results showed that in DL group, the hemodynamic response was sustained for 3 minutes and normalised by 5 minutes except diastolic blood pressure which normalised by 3 minutes. All patients in DL group were intubated at the first attempt with mean intubation time of 16 secs.

In LW group hemodynamic response was of short duration (3 minutes). Forty eight patients were intubated in first attempt, while two patients required second attempt for intubation with mean intubation time of 20 secs.

When compared, it was observed that hemodynamic response after intubation was statistically significantly more in DL group than in LW group. The time taken for intubation, on the other hand, was statistically significantly more with lightwand as compared with direct laryngoscopic intubation.

Results from several authors [5-9] suggest that the sympathoadrenal response to ETT intubation arise from stimulation of the supraglottic region by tissue tension induced by laryngoscopy.

In the comparison by Hirabayashi et al. [10], the maximum mean arterial pressure changes were similar between groups. They observed that in the lightwand intubation technique since the jaw was grasped & lifted upward to clear the tongue and epiglottis off the posterior pharyngeal wall, though gentle compared with the direct vision laryngoscopy, was enough to cause hemodynamic changes similar to direct laryngosopy.

Nishikawa et al. [11] compared the effects of the lightwand technique with those of direct-vision laryngoscopy in normotensive and hypertensive patients. The results showed that the lightwand technique had significantly lower hemodynamic changes after intubation in comparison with the laryngoscopic technique in normotensive patients. However, in hypertensive patients, there was no difference in hemodynamic changes between the two techniques. They thought that a lack of direct stimuli to the mouth and larynx as one of the main explainantions for the small hemodynamc changes in normotensive patients intubated with lightwand and though it was not enough to cause a hyperdynamic response in normotensive patients, it was sufficient to produce hypertension in hypertensive patients. The lightwand technique in their study needed significantly more attempts and a longer time for intubation than the laryngoscopic technique. In hypertensive patients, they found a significant correlation between the hemodynamic changes and the number of attempts at intubation.

In another study by Takahashi et al., the hemodynamic responses to tracheal intubation were observed by dividing the groups into three [12]. The lightwand group received tracheal intubation with lightwand, the laryngoscope-intubation group received tracheal intubation with a direct-vision laryngoscope (Macintosh blade), and the laryngoscopy-alone group received laryngoscopy alone. The magnitude of hemodynamic changes associated with intubation with the lightwand were found to be almost the same as that with the direct laryngoscope and were likely to occur because of direct tracheal irritation rather than direct stimulation of the larynx.

Kihara et al. [13] compared hemodynamic responses in normotensive and hypertensive patients among three intubation devices: the Macintosh laryngoscope (LS), the Trachlight™ lightwand (LW), and the intubating laryngeal mask airway (ILM). In normotensive patients, there were no differences in any hemodynamic variables among the three devices. In hypertensive patients, blood pressure in the LS group were significantly higher than the ILM and LW groups for 2 min after intubation, but there were no differences in HR among the devices. The number of intubation attempts was similar among groups, but intubation time was longer for the ILM group. They observed that both the ILM and the LW attenuated the hemodynamic stress response to tracheal intubation compared with the LS in hypertensive patients but not in normotensive patients as this was only clinically detectable in hypertensive patients. The reduction in stimulation was related to lack of distortion of sensitive extraglottic structures by the ILM and LW. They concluded that ILM and LW may be preferable to

LS in hypertensive patients where attenuation of hemodynamic stress responses is desired.

One study assessed the cardiovascular changes after either lightwand or conventional laryngoscopic endotracheal intubation in patients with coronary artery disease [14]. The mean arterial blood pressures and heart rate increased significantly after intubation. There was a tendency for the lightwand group to have lower arterial blood pressures and slower HR. However, the differences between the two groups did not reach statistical significance. Requirements for drugs to control heart rate and mean arterial pressure were also similar in both groups. They suggested that the circulatory response to intubation was mainly due to stimulation of the trachea by the endotracheal tube rather than stimulation of the glottis by the laryngoscope. They concluded that, in patients with coronary artery disease, a lightwand intubation technique does not reduce the hemodynamic responses associated with intubation when compared to standard direct-vision intubation with a laryngoscope and in this type of patient, pharmacologic manipulations might prove more effective to control the hemodynamic changes associated with tracheal intubation.

Kanaide et al. [15] evaluated hemodynamic and catecholamine responses during tracheal intubation using lightwand in elderly patients with hypertension. They found no significant difference between groups. They concluded that lightwand has no advantage over a laryngoscope in terms of hemodynamic and plasma catecholamine responses to tracheal intubation in elderly patients with hypertension, despite a shorter intubation time.

Rhee et al. [16] compared hemodynamic responses in 40 patients with difficult airway (MPC grade 2 & 3) between the Macintosh laryngoscope and the lightwand intubating device. Mean arterial pressure increased significantly 90 seconds after intubation in laryngoscope group compared to in lightwand group ($p < 0.05$), and also remained higher than preintubation value for longer time compared to in lightwand group ($p < 0.05$).

Another study by Shrikanth Srinivasan et al. [4] compared orotracheal intubation using the Trachlight v/s Macintosh laryngoscope for: success rate; time taken for intubation; hemodynamic responses and complications encountered with either device. The success rate was comparable in both groups. Time taken for intubation was significantly longer with Trachlight (20.2sec v/s 11.8 sec). However, hemodynamic responses to intubation were significantly lesser both in magnitude and duration with Trachlight compared to laryngoscopy. They concluded that the combined stimulation of the larynx and the trachea in the laryngoscopy group, was more intense than the stimulation of the trachea alone, as in the Trachlight group.

In the same year, Byung Yoo et al. [17] compared the difference in hemodynamic responses to intubation between the lightwand and direct laryngoscope, and examined the correlation between blood pressure elevation and intubation time. They applied their results to the Hassan's equation (i.e. Blood pressure elevation = intensity of stimulation × duration time of stimulation), and found that there were no difference of blood pressure elevation and intubation time between both groups, and thus there was no difference in the intensity of stimulation between lightwand group and direct laryngoscopy group. They postulated that if there is no difference in the stimulation intensity, then the degree of blood pressure elevation would have a linear relation to the intubation time.

Naveed et al. [18] studied hemodynamic response and airway morbidity following tracheal intubation between direct laryngoscopy, video laryngoscopy and lightwand techniques and found that no benefit was achieved by using any of the 3 intubation techniques for attenuation of hemodynamic changes. There was also a higher incidence of sore throat associated with trachlight intubation than with laryngoscopy and video laryngoscopy

The results of this study showed that the lightwand intubation technique caused smaller hemodynamic changes than the direct laryngoscopy. In the lightwand technique, grasping of the jaw and lifting it upward by using the thumb and index finger to make a clear passage for the tracheal tube may be sufficient to cause hemodynamic change [11]. However, this procedure was not used in the present study. During laryngoscopy the mouth is required to be wide open, the epiglottis elevated, brought forward and lifted by the laryngoscope. As this maneuvering was not used during intubation by lightwand, there was a smaller hyperdynamic response due to stimulation of the periglottic area. Although it is not obvious how much laryngoscopy-induced stimulation directly contributes to hemodynamic changes after endotracheal intubation, a lack of direct stimuli to the mouth and the epiglottis could be one of the explanations for the small hemodynamic changes in patients intubated by the lightwand technique. Thus the results of our study are consistent with the results of Srinivasan et al. [4], Nishikawa et al. [11], Kihara et al. [13], and Lee et al. [16], while the results by Hirabayashi et al. [9], Shinji Takahashi et al. [12], Felix Montes et al. [14], Kanaide et al. [15], Byung

Yoo et al. [17] and Naveed et al. [18] showed no difference in lightwand and laryngoscopic intubation with respect to hemodynamic changes.

The time taken for intubation with lightwand was longer as direct visualization of vocal cords was not done. Instead, a well circumscribed tracheal glow of the lightwand was the only indirect guide of the position of the tube. This difference in time is partly counteracted by the time taken for insertion of tube during laryngoscopy, as the tube is already inserted over the lightwand. This could be the reason that Hung et al showed a shorter duration of intubation, while Kihara et al. [13] and Takahashi et al. [12] showed no difference in time taken for intubation between the devices. The findings of Shrikanth Srinivasan et al. [4] and Nishikawa et al. [11] with respect to time taken for intubation are comparable with the present study showing more time required for intubation with lightwand.

Conclusion

In conclusion, insertion of lightwand is associated with a lesser hemodynamic response than direct laryngoscopic endotracheal intubation. The rise in hemodynamic variables with lightwand is sustained for a shorter period of time than endotracheal intubation by laryngoscopy. This definitely can be a boon for patients with cardiovascular disease. Time taken for intubation by lightwand, however, is more as compared to direct laryngoscopic intubation, which might limit its use.

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