Original Article

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Anaesthesia Section

Evaluation of the Effect of Tracheal Tube Orientation on Success of Intubation through Intubating Laryngeal Mask Airway

SWATI CHHATRAPATI[1], ANJANA SAHU[2], SUBHHASH SADASHIV AUTI[3], SWAPNIL GANESH ASWAR[4]

ABSTRACT

Introduction: Polyvinyl Chloride Endotracheal Tube (PVC ETT) can be used as an alternative to Fastrach Silicone Wire-Reinforced Tube (FTST) for intubation through Intubating Laryngeal Mask Airway (ILMA) as the latter is expensive and has low volume high pressure cuff.

Aim: To evaluate the effects of orientation of PVC ETT (normal curve and reverse curve) on the success of intubation through ILMA, haemodynamic response and postoperative sore throat.

Materials and Methods: Sixty healthy adult patients of ASA physical status I & II scheduled for elective surgery under general anaesthesia requiring endotracheal intubation were randomly divided into two groups. In Normal (N) group (n=30), the tracheal tube was inserted with its natural curve following the 90° curvature of ILMA. In Reverse (R) group (n=30), the tracheal tube was inserted with its natural curve directed opposite to the curvature of ILMA. The time taken to intubate, number of attempts, and maneuvers required for successful endotracheal intubation along with haemodynamics and oxygen saturation were noted. Postoperative sore throat was evaluated using a Verbal Analogue Scale (VAS) (0-10).

Qualitative data was analysed by Chi-Square test and Fisher's exact test. Quantitative data was analysed by unpaired t-test and Mann-Whitney test.

Results: Placement of ILMA was successful in all patients. Total Intubation Time (mean±SD) in Group N was 12.53±1.78 seconds and in Group R was 11.97±1.33 seconds (p>0.05). Tracheal intubation through ILMA was successful in all patients. First attempt success rate in R Group (26 patients, 86.7%) was higher than N Group (22 patients, 73.3%) (p>0.05). Four patients (13.3%) in R Group and 8 patients (26.7%) in N Group required 2nd step of Chandy's maneuver during second attempt for successful intubation. Incidence of sore throat 6 hours postoperatively was statistically significant (median value 2.00 in N Group vs. 0.00 in R Group) between two groups.

Conclusion: PVC ETT with reverse orientation increases first attempt success rate of intubation through ILMA with less immediate postoperative laryngeal morbidity.

Keywords: Fastrach silicon wire-reinforced tube, Normal curve, Reverse curve, Polyvinyl chloride endotracheal tube

INTRODUCTION

Tracheal intubation through Intubating Laryngeal Mask Airway (ILMA) is usually carried out by reusable Fastrach Silicone wire-reinforced tube (FTST) [1]. Special features of these tubes are straight alignment with wire reinforcement, flexibility which helps in negotiating anatomical curves of the airway, and presence of a conical-Touhy-like tip made up of silicone, which produces less trauma than conventional endotracheal tube. It has low volume and high pressure cuff system, which makes it less suitable for prolonged use. Being very expensive and not so readily available, other alternatives to replace it in case of difficult airway should be considered. A conventional, Polyvinyl Chloride Endotracheal Tube (PVC ETT) is not only cheaper, easily available and disposable, but has an added advantage of high volume low-pressure cuff which makes it a better option for prolonged ventilation. However, insertion with normal curvature facing anteriorly makes it too difficult to be negotiated through the vocal cords, but the reverse curve makes it easy [2-4]. Hence, we studied the effects of orientation of PVC tube (normal curve and reverse curve) on the success of intubation through ILMA, haemodynamic response, and postoperative sore throat.

AIM

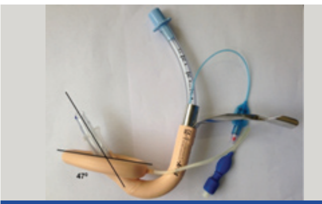
Aim of the present study was to evaluate the effect of tracheal tube orientation on the success of intubation through ILMA in mallampati 1 and 2 patients.

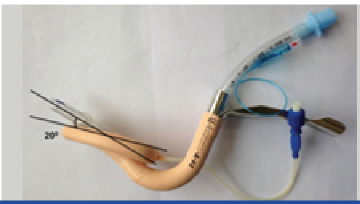
MATERIALS AND METHODS

A randomized, prospective, single blinded, comparative trial was conducted in the anaesthesia department of a tertiary medical center after obtaining Institutional Ethics Committee approval and patient's written and informed consent over a period of two years from November 2011 to November 2013. The exclusion criteria were negative consent, Mallampati grade 3 and 4, morbid obesity, any factor predicting difficult intubation and risk of aspiration. It was carried out in 60 patients, 30 patients in each group posted for various types of elective surgical procedures requiring endotracheal intubation under controlled ventilation. All patients were randomly assigned to one of the two study groups i.e. normal group (N) or reverse group (R) depending on the orientation of tracheal tube at the point of insertion into ILMA using computer generated randomization table. In N group, the tracheal tube was inserted with its natural curve following the 90° curvature of ILMA [Table/Fig-1]. In R group, the tracheal tube was inserted with its natural curve directed opposite to the curvature of ILMA [Table/Fig-2].

On the day of surgery after confirming starvation and consent, IV access was secured and ringer lactate was started at 2ml/kg/hr. In the operating room, patient's heart rate, arterial blood pressure, oxygen saturation and ECG were monitored. The equipments required for management of difficult intubation were kept ready.

Patient was premedicated with IV glycopyrrolate 0.002 mg Kg^{-1}, IV midazolam 0.03 $mgkg^{-1}$ and IV fentanyl 2 $\mu gmKg^{-1}$. After





[Table/Fig-1]: Angle of emergence of conventional endotracheal tube through Intubating laryngeal mask airway in normal orientation.
[Table/Fig-2]: Angle of emergence of conventional endotracheal tube through Intubating laryngeal mask airway in reverse orientation.

pre-oxygenation with 100% oxygen for 3 minutes using circle-absorbing system with capnograph attached, patient was induced with injection propofol 2 mg kg^{-1} till loss of eyelash reflex. After confirming ventilation, vecuronium 0.1$mgkg^{-1}$ was given IV. Size 3 ILMA and 7 mm TT was chosen for female patients and size 4 ILMA and 7.5 mm TT was chosen for male patients. After ventilating the patient with oxygen, air (33:66%) and sevoflurane for 3 minutes ILMA was inserted with head-neck in neutral position. Cuff was inflated with maximum recommended volume i.e. 30 ml in size 3 ILMA & 45 ml in size 4 ILMA. Adequate ventilation was assessed by chest wall movement, auscultation of breath sounds and square wave Capnograph trace. If adequate ventilation could not be attained, ILMA was readjusted in situ by using the 1st step of Chandy's Maneuver [5]. The PVC ETT was softened by immersing in sterile water heated to 40ºC for 1 minute before insertion. After lubrication the tracheal tube was inserted into ILMA with orientation according to randomization. If resistance was encountered during the passage of TT, 2nd attempt was made after performing 2nd step of Chandy's maneuver. An intubation attempt was considered as a failure if tracheal tube could not be negotiated the full distance, if after negotiating the full distance capnograph trace was not visible, or if the patient was desaturated with $SpO_2 < 90\%$ and hence intubation attempt was abandoned. In each patient, intubation via ILMA was allowed up to 3 attempts. After 3 attempts if intubation was not successful, tracheal intubation was performed using direct laryngoscopy.

The ease of tracheal intubation was determined by time taken to intubate the trachea (time from dis-connection of breathing circuit of ILMA to confirmation of placement of ETT by auscultation and display of a square – wave capnograph trace) and the number of maneuvers required for successful endotracheal intubation. Patients' Heart Rate (HR), systolic (SBP), Diastolic (DBP), Mean Arterial (MAP) Blood Pressure and oxygen saturation were monitored continuously and values were noted preoperatively, after premedication, after induction, at intubation and 7 min after intubation. The primary end point was to compare 1st attempt intubation success rate, and secondary objectives were to compare number of oesophageal intubations/failed intubations, incidence of trauma as evidenced by blood on tracheal tube after removal and postoperative sore throat at 6 hours and 24 hours after surgery using a verbal analogue scale (VAS) (0-10). A verbal analogue scale > 3 was considered positive [3].

STATISTICAL ANALYSIS

Qualitative data was represented in the form of frequency and percentage. Association between qualitative variables was analysed by Chi-Square test with continuity correction and Fisher's-exact test where p-value of Chi-Square test was not valid due to small counts. Quantitative data was represented in the form of mean±SD and median and IQR (Interquartile range). Analysis of quantitative data between two groups was done using unpaired t-test if data passes "Normality test" and by Mann-Whitney test if data fails "Normality test". The p-value less than or equal to 0.05 was considered to be statistically significant. SPSS version 17.0 was used for analysis.

RESULTS

The demographic variables such as age, sex, weight, height and BMI were comparable in both groups. HR, SBP, DBP, MAP, SpO_2 were also comparable at all times in this study [Table/Fig-3].

Total Intubation Time (TIT) (mean ± SD) in N group was (12.53±1.78) seconds and that in R group was (11.97±1.33) seconds. This was statistically not significant [Table/Fig-4].

Placement of ILMA was successful in all patients and none of the patients required 1st step of Chandy's maneuver for successful ventilation. Overall, rate of successful tracheal intubation via ILMA in both groups was 100%. None of the patients required direct laryngoscopy for successful intubation. First attempt success rate in R group (26 patients, 86.7%) was higher than N group (22 patients, 73.3%) (p>0.05). Four patients (13.3%) in R group and 8 patients (26.7%) in N group required 2nd step of Chandy's

Variables	Normal Group	Reverse Group	p-value	Difference/ Association
Age (mean±SD)yrs	27.50±6.78	28.10±6.09	0.609	Not significant
Weight(mean±SD) kg	57.00±5.01	57.00±5.27	1.000	Not significant
Height (mean±SD) m	159.60±7.49	160.73±6.45	0.533	Not significant
BMI(mean±SD) kg/m^2	22.42±2.16	22.13±2.09	0.745	Not significant
Sex number (%)				
Female	16(53.3%)	16(53.3%)	1.000	Not significant
Male	14(46.7%)	14(46.7%)	1.000	Not significant
HR (mean±SD)/min				
Pre-operative	76.07±7.09	79.57±8.14	0.609	Not significant
Post induction	73.30±5.79	69.40±3.84	0.00321	Significant#
At Intubation	86.30±6.70	81.33±6.28	0.00443	Significant#
SBP (mean±SD)mmHg				
Pre-operative	121±9.27	119.60±11.55	0.468	Not significant
Post induction	121.80±8.60	116.47±10.94	0.082	Not significant
At Intubation	131.70±5.82	110.47±8.05	0.00605	Significant #
DBP (mean±SD)mmHg				
Pre-operative	80.47±6.53	76.20±6.40	0.874	Not significant
Post induction	72.13±4.75	72.33±3.93	0.235	Not significant
At Intubation	78.67±6.96	76.33±5.41	0.235	Not significant
MAP (mean±SD)mmHg				
Pre-operative	95.87±6.55	90.67±6.52	0.610	Not significant
Post induction	88.69±4.42	87.04±4.14	0.129	Not significant
At Intubation	96.13±4.42	92.53±4.38	0.002	Significant #
SpO_2 (%)	99.03±0.67	99.03±0.56	0.986	Not significant
Blood on tracheal tube number(%)	5(16.7%)	1(3.3%)	0.197	Not significant
Sore throat (VAS, median value)				
At 6 hrs	2.00	0.00		Significant
At 24 hrs	0.00	0.00		Significant

[Table/Fig-3]: Comparision of demographic data, ASA grade, MPC, haemodynamics and complications between normal and reverse groups.
BMI indicates body mass index, ASA American Society of Anaesthesiologist, MPC mallampati class, HR heart rate, SBP systolic blood pressure, DBP diastolic blood pressure, MAP mean arterial pressure, SPO2 oxygen saturation. Wherever data failed 'Normality' test, Mann-Whitney test applied. Chi-Square test and Fisher's-Exact test applied wherever applicable and "unpaired 't' test" was applied to compare haemodynamic parameters. p-value<0.05 was considered statistically significant. # statistically significant but clinically not significant.

Variable	Normal subject				Reverse Subjects				Unpaired t-test		
	Mean	SD	Median	IQR	Mean	SD	Median	IQR	t-value	p-value	Difference is-
TIT (Sec)	12.53	1.78	13.00	3.00	11.97	1.33	12.00	2.00	1.400	0.167	Not significant

[Table/Fig-4]: Comparision of TIT (sec) between normal and reverse groups.

maneuver during second attempt for successful intubation [Table/Fig-5]. None of the patients had failed intubation /oesophageal intubation.

No. of attempts for successful intubation	Maneuver required		Normal group	Reverse group	Total
1	No maneuver	No. (%)	22 (73.3%)	26 (86.7%)	48 (80.0%)
2	2ndstep of Chandy's maneuver	No. (%)	8 (26.7%)	4 (13.3%)	12 (20.0%)
Total		No. (%)	30 (100.0%)	30 (100.0%)	60 (100%)
Chi-Square tests		**Value**	**Df**	**p-value**	**Association**
Pearson Chi-Square		1.667	1	0.1967	Not significant
Continuity Correction		0.9375	1	0.3329	Not significant
Fisher's Exact Test				0.3334	Not significant

[Table/Fig-5]: Comparison of the number of attempts and Maneuvers required for successful intubation in normal and reverse groups.

Five patients (16.7%) in normal group and 1 patient (3.3%) in reverse group had blood on tracheal tube [Table/Fig-3]. All patients who had blood on tracheal tube needed two attempts for successful intubation. This was statistically not significant.

In our study, incidence of sore throat measured by VAS score 6 hours postoperatively was statistically significant (median value 2.00 in N group vs. 0.00 in R group) between two groups and it was statistically not significant 24 hours after surgery (median value 0.00 N group vs. 0.00 in R group) [Table/Fig-3].

DISCUSSION

Difficult airway has been a challenge to anaesthesiologists and ILMA is a very important and useful armamentarium in the difficult intubation kit [6-10]. FTST is designed for intubation through ILMA [1]. It is expensive, not readily available and has low volume high pressure cuff. Hence, search for an alternative to FTST like PVC ETT is under trial. Brain, the inventor of the ILMA, did not recommend conventional PVC ETT usage for intubation through ILMA owing to its stiffness, lateral opening bevel and potential difficulties in its passage through the glottis which can cause trauma and an increased incidence of failed intubation [2]. This can be attributed to the impingement of the tip of the endotracheal tube against the anterior portion of the upper airway as the tube has a steep curvature and the angle of emergence from ILMA is higher than 45 degrees [4]. The additional curvature imposed by the metal shaft of the ILMA prevents the ETT from reversing its curvature from the point of exit from ILMA, further increasing the chance of difficult intubation [1]. Despite these limitations, PVC tubes are being used for blind tracheal intubation through ILMA by using certain modifications in the technique of insertion. In most studies, the PVC tube has been inserted either with reverse curve anteriorly, pre-warmed to make it more flexible, or under fiberoptic guidance [11,12]. It has been demonstrated that intubation success is higher if PVC tracheal tubes are inserted in a reverse orientation compared with normal orientation [2-4,12].

An important factor that determines the success of tracheal intubation is the angle at which the tracheal tube emerges from the distal aperture of the ILMA [1,4,12]. Brain et al., and Kundra et al., have demonstrated that difference in success rates of tracheal intubation is due to difference in the angle of emergence [1,12]. L Ye et al., in their invitro study concluded that the angle of emergence of PVC tube with normal orientation was 47°, and with reverse orientation was 20° [4]. They further highlighted that the angle of emergence of 47° may cause impingement of the tip of the endotracheal tube against the anterior portion of the upper airway such as larynx, cricothyroid membrane or trachea, resulting in failure of tracheal tube advancement [Table/Fig-1]. However, an emergence angle of 20° with reverse orientation may allow the tube to follow a more anatomical direction and approach the larynx at a more optimal angle, resulting in higher intubation success rates [Table/Fig-2].

In our study, HR, SBP, DBP and SpO_2 between the two groups were comparable at all times. SpO_2 did not fall below 95% at any time in either group. TIT in N group was 12.53±1.78 seconds and that in R group was 11.97±1.33 seconds. This was statistically not significant. Joo et al., reported intubation time with median value of 23 seconds (Range of 18-35.8 sec) in their ILMA blind intubation group where PVC tube was inserted with reverse orientation [2]. Kundra et al., found that insertion time for successful intubation (mean±SD) was 12.9±3.7 seconds in group FTST, and 11.8±3.3 seconds in group PVCT and it was clinically not significant [12].

In our study, overall rate of successful tracheal intubation via ILMA in both groups was 100%. But the overall success rate of endotracheal intubation in the study of L Ye et al., was lower as compared to our study (91.5%) as their patients belonged to Mallampati class 3 and 4 [4].

First attempt success rate in reverse group (26 patients, 86.7%) was higher than normal group (22 patients, 73.3%) (P>0.05). Four patients (13.3%) in R group and 8 patients (26.7%) in N group required second attempt for successful intubation. These results are comparable with Lu and colleagues and L. Ye and colleagues who demonstrated that first attempt success rate in reverse group was higher than in normal group. Changing the tracheal tube curve to the opposite direction at the third attempt increased the success of intubation in normal group [3,4].

In our study, placement of ILMA was successful in all patients in the first attempt and none of the patients required 1st step of Chandy's maneuver for successful ventilation. 8 (26.7%) patients in N group and 4 (13.3%) patients in R group required 2nd step of Chandy's maneuver after failure of first attempt of intubation for successful endotracheal intubation. In a study by Lu PP et al, placement of ILMA was successful in all patients and there were no immediate adverse airway events [3]. Following each failed intubation, the position of ILMA was adjusted, if necessary. Various maneuvers were used such as rightward or leftward rotation maneuver, pull-up or push-down maneuver, neck flexion or extension to obtain an optimal ILMA position for successful intubation. In another study by Sharma MU et al., a combination of several adjustment maneuvers were used [11] as described by several authors such as Chandy's maneuver, Ferson et al., and Kihara et al., for successful intubation [5,13]. When there was resistance to tracheal tube insertion, maneuvers were employed according to the level at which resistance was felt, as described by Brain et al., [6].

In our study, none of the patients required direct laryngoscopy for successful intubation. None of the patients had failed intubation /oesophageal intubation. Lu and colleagues in their study found that incidence of failed intubation was 0.04% and major causes of failure included poor ILMA-larynx alignment, suspected subglottic stenosis, and elongated and downfolded epiglottis [3]. Kundra et al., found 1.8% incidence of esophageal intubation with PVCT [12]. In LYe et al., study, in 17 (8.5%) patients out of 200 patients, intubation was accomplished by using direct laryngoscopy [4].

In our study, we found that 5 patients (16.7%) in N group and 1 patient (3.3%) in R group had blood on tracheal tube. Kundra et al., found that 14% patients in PVCT group had blood on tracheal tube after extubation [12]. In their study, PVCT was passed with normal orientation, which can explain increased incidence of trauma.

In our study, incidence of sore throat measured by VAS score 6 hours postoperatively was statistically significant (median value-

2.00 in N group vs. 0.00 in R group) between two groups and it was statistically not significant 24 hours after surgery (median value-0.00 in N group vs. 0.00 in R group). L. Ye et al., found that incidence of sore throat in normal group (22%) was higher than that in reverse group (12%) [4]. In a study by Lu et al., it was found that incidence of sore throat was 14.2% and was higher in normal than in the reverse group (p=0.042) [3]. The average number of intubation attempts was higher in those with sore throat. The incidence of hoarseness did not differ between two groups (p=0.497). Kundra et al., too found incidence of sore throat in PVCT group with normal orientation as 12% [12]. The sore throat was mostly mild, self-limiting, did not require any medical interventions and resolved within 2-3 days.

The minor difference in incidence of sore throat may be attributed in part to the subjective nature of the visual analogue scale, type and curvature of tracheal tube used, and the number of intubation attempts. Joo et al., examined the maximal invitro forces and pressure exerted by the tip of various tracheal tubes as they exit the ILMA and found that the PVC endotracheal tube exerted 7-10 times higher force and pressures than the silicon and armoured ETT as PVC tubes are more stiffer [14]. Softness of PVC tube warmed to 40 degree is preserved only over a brief period of 40 seconds. Hence to reduce incidence of trauma and sore throat with PVC tube, intubation has to be accomplished within 40 seconds of prewarming and by avoiding excessive force during intubation [15].

LIMITATION

There are certain limitations to our study. First, the results of our study are applicable only to patients with normal airway. Secondly, a good laryngeal mask-larynx relationship was ascertained only clinically and not with fiberoptic bronchoscope.

CONCLUSION

Overall tracheal intubation was successful in 100% of patients through ILMA with a conventional PVC tracheal tube in MPC 1 and 2 patients. The first-attempt success rate was higher in reverse group compared with the normal group, but overall success rate was similar between two groups. The incidence of trauma as evidenced by blood on tracheal tube and postoperative sore throat was higher in normal group as compared with reverse group but it was statistically not significant. Although heating and introduction with reverse curvature increase the success rate of intubation of PVC tubes, they do not decrease the pressure exerted by the endotracheal tube on the distal objects. This can contribute to increased morbidity to the patient's airway. Therefore, caution must be used with the passage of the PVC conventional tube into the ILMA and use of excessive force must be avoided to prevent airway trauma.

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PARTICULARS OF CONTRIBUTORS:
1. Professor, Department of Anaesthesiology, B.Y.L Nair Ch. Hospital & Topiwala National Medical College, Mumbai, India.
2. Assistant Professor, Department of Anaesthesiology, B.Y.L Nair Ch. Hospital & Topiwala National Medical College, Mumbai, India.
3. Senior Registrar, Department of Anaesthesiology, B.Y.L Nair Ch. Hospital & Topiwala National Medical College, Mumbai, India.
4. Senior Resident, Department of Anaesthesiology, Tata Memorial Hospital, Mumbai, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Anjana Sahu,
13, 7th floor, Sky-Scraper Building, Mumbai Central Station Campus, Mumbai Central-400008, India.
E-mail: dranjanasahu@gmail.com

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