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Original research article

A STUDY TO EVALUATE AND COMPARE THE EASE OF INTUBATION BETWEEN WIRE ENFORCED SILICONE ENDOTRACHEAL TUBE THROUGH INTUBATING LARYNGEAL MASK AIRWAY AND POLYVINYL CHLORIDE TUBE THROUGH THE INTUBATING LARYNGEAL MASK AIRWAY

[1]Shaji Thadathil Valappil, [2]K. Karunakara Adappa
[1]Specialty Doctor in Anaesthesia, Broomfield Hospital, Broomfield, England
[2]Professor and HOD, Department of Anesthesiology, A.J. Institute of Medical Sciences and Research Centre, Mangalore, Karnataka, India

Corresponding Author:
K. Karunakara Adappa

Abstract

The aim of this study was to evaluate the level of difficulty in inserting a standard PVC endotracheal (ET) tube using the intubating laryngeal mask airway (ILMA) and compare it with the ease of inserting a silicone ET tube. The objective was to ascertain the feasibility of using the PVC endotracheal tube in conjunction with the intubating laryngeal mask airway (ILMA).
Keywords: ET, ILMA, PVC-ET, Wire enforced silicone endotracheal tube, polyvinyl chloride tube through the intubating laryngeal mask airway

Introduction

Challenging tracheal intubation continues to be a significant factor contributing to death and illness in anaesthesia. The invention of the laryngeal mask airway (LMA) in 1985 by Brain [2] was a significant advancement in managing problematic airways. However, its ability to assist with tracheal intubation is restricted. The Intubating Laryngeal Mask Airway (ILMA) was developed to address this constraint. Since its introduction, there have been several documented instances of successful intubation with the ILMA in both expected and unexpected challenging airway cases [3-6].

The intubating laryngeal mask airway is a medical device that allows for tracheal intubation to be performed without the need for laryngoscopy. The intubating laryngeal mask airway is a flexible metal tube coated with soft silicone, designed with an ergonomically curved shape and a guiding handle.

The LMA-Fastrach™ not only facilitates lung ventilation but also serves as an excellent pathway for blind or fiberoptically guided tracheal intubation in challenging airway situations.

ISSN:0975 -3583,0976-2833 VOL 11, ISSUE 03, 2020

It is recommended to use a specialised silicone endotracheal tube with wire reinforcement for intubation through the LMA-FastrachTM. This tube possesses distinctive features including a linear arrangement, wire reinforcement, and the inclusion of a conical Touhy-like tip, which is less damaging than traditional endotracheal tubes. Nevertheless, the tube's low volume, high-pressure cuff renders it less appropriate for extended usage, and it is both costly and not readily accessible. Furthermore, the use of wire reinforcement can be problematic since it may impede ventilation if the patient bites on the tube and causes distortion of the lumen. In addition to being disposable, a typical Polyvinylchloride (PVC) endotracheal tube (ETT) is cost-effective, readily accessible, and equipped with a high-volume low-pressure cuff, making it particularly appropriate for extended periods of ventilation.

The aim of this study was to evaluate the level of difficulty in inserting a standard PVC endotracheal (ET) tube using the intubating laryngeal mask airway (ILMA) and compare it with the ease of inserting a silicone ET tube. The objective was to ascertain the feasibility of using the PVC endotracheal tube in conjunction with the intubating laryngeal mask airway (ILMA).

Materials and Methods

The study was a prospective study conducted on patients aged between 18-60 years, ASA grade I/II posted for elective surgeries under general anaesthesia in A. J. Institute of Medical Sciences, Mangalore between December 2013 and May 2015 chosen by randomized sampling method using the below set inclusion and exclusion criteria.

Inclusion Criteria

1. Patients belonging to ASA grade I and II scheduled for elective surgery under general anaesthesia.
2. Mallampatti grade I and II patients.
3. Patients of either sex, between the age group 18-60 years.
4. Interincissor distance more than 2 cms on pre-anesthetic assessment.
5. Thyro-mental distance greater than 6 cms.

Exlusion Criteria

1. Patients belonging to ASA grade III or IV.
2. Patient refusal.
3. Patients with loose dentures.
4. Patients with enlarged thyroid gland.
5. Patients with hypertrophied tonsils (grade 3 and 4).
6. Patients with morbid obesity.
7. Patients with respiratory tract pathology.
8. Patients with previous upper gastrointestinal (GI) surgery like gastroeseophageal reflux disease or Hiatus Hernia.

Method of Collection of Data

Selection Criteria

Written informed consent was taken from patients, for willingness to participate in the study, for pre-anesthetic assessment, intubation and postoperative evaluation of any complications.

ISSN:0975 -3583,0976-2833 VOL 11, ISSUE 03, 2020

60 patients aged between 18-60 years posted for elective surgeries under general anaesthesia, in A. J. Institute of Medical sciences, Mangalore, were divided into two groups (Group I and Group II) of 30 patients each, by random sampling method.

- **Group I:** Were intubated using wire enforced silicone endotracheal tube through intubating laryngeal mask airway (LMA-Fastrach).
- **Group II:** Were intubated using Polyvinyl chloride tube through the intubating laryngeal mask airway (LMA-Fastrach).

In all patients the appropriate size LMA was used-

: Size 3-for patients weighing < 50 kgs.

: Size 4-for patients weighing between 50 and 70kgs.

All patients were instructed to abstain from eating or drinking overnight. The patient was administered a 150mg tablet of Ranitidine on the evening before to the surgery and again in the morning of the procedure. In the operating room, the following monitors were connected: pulse oximeter, noninvasive blood pressure monitor, ECG leads, and $ETCO_2$ monitor. The intravenous line has been properly secured and the administration of normal saline solution has been commenced. The patient received premedication with intravenous administration of Inj. Glycopyrrolate (0.005mcg/kg) and Inj. Fentany (1mcg/kg). The patients underwent preoxygenation with 100% oxygen for a duration of 3 minutes. The patient was administered intravenous injection of Propofol at a dose of 2 mg/kg and intravenous injection of Vecuronium at a dose of 0.1 mg/kg to induce anaesthesia.

After a duration of 3 minutes, when the patient achieved complete relaxation, an appropriately sized Intubating Laryngeal Mask Airway (ILMA) was introduced with the cuff in a deflated state. Subsequently, the cuff was inflated with air, using a volume of 20ml for size 3 and 30ml for size 4. Proper positioning is verified by the capacity to provide ventilation without any air leakage at an airway pressure of 20 mm Hg. Next, the cuff was inflated and a square wave capnograph trace is observed during mild ventilation. If the patient cannot be ventilated, various adjustments can be made. These include pulling the handle back towards the intubator (extension manoeuvre), withdrawing the ILMA by 5 cms with the cuff inflated and then reinserting it (up-down manoeuvre), adjusting the position of the ILMA until an optimal seal is achieved, as determined by audible leak with the expiratory valve closed (optimisation manoeuvre), and flexing the neck and extending the head (head-neck manoeuvre). Additionally, rotation in the sagittal plane or lifting away from the posterior wall (Chandy manoeuvre) may be performed.

Afterwards, a properly lubricated endotracheal tube (ETT) with an internal diameter (ID) of either 7.0, 7.5mm, or 8.0mm, and a cuffed design, made of wire-reinforced silicone (WRS) or prewarmed polyvinyl chloride (PVC), is inserted into the metal tube of the intubating laryngeal mask airway (ILMA). The choice of tube size and material depends on the specific group assignment. Prior to insertion, the tube is soaked in sterile water at a temperature of 40 degrees Celsius for a duration of 1 minute. The tube was inserted to a depth of 16cm. The ETT was inserted into the trachea with care, without exerting excessive pressure. The cuff was then inflated and the ETT was connected to the Bain circuit. The accuracy of tube installation was verified by the

ISSN:0975 -3583,0976-2833 VOL 11, ISSUE 03, 2020

presence of symmetrical breath sounds on auscultation and capnography. The ILMA was thereafter deflated and extracted use the designated stabilising rod to ensure the tube's stability, which was then reattached to the Bain circuit.

The patient is receiving a combination of oxygen, nitrous oxide, halothane (at a concentration of 0.2%), and occasional intravenous bolus injections of vecuronium.

Post operatively patients were observed/monitored over 24 hours and any complications like sorethroat, horseness, airway trauma and esophageal intubation will be noted in every patient.

Parameters to be studied

1) Ease of intubation by.

i) Number of attempts.

ii) Time taken for intubation (the time from disconnection of breathing circuit from the ILMA to the time to successful tracheal intubation as confirmed by the presence of bilateral breath sounds and capnography).

iii) Manoeuver employed to accomplish tracheal intubation.

2) Overall success rate for oxygenation and ventilation with the ILMA was considered as a primary airway, success rate for tracheal intubation using the ILMA.

Results

Demographic data

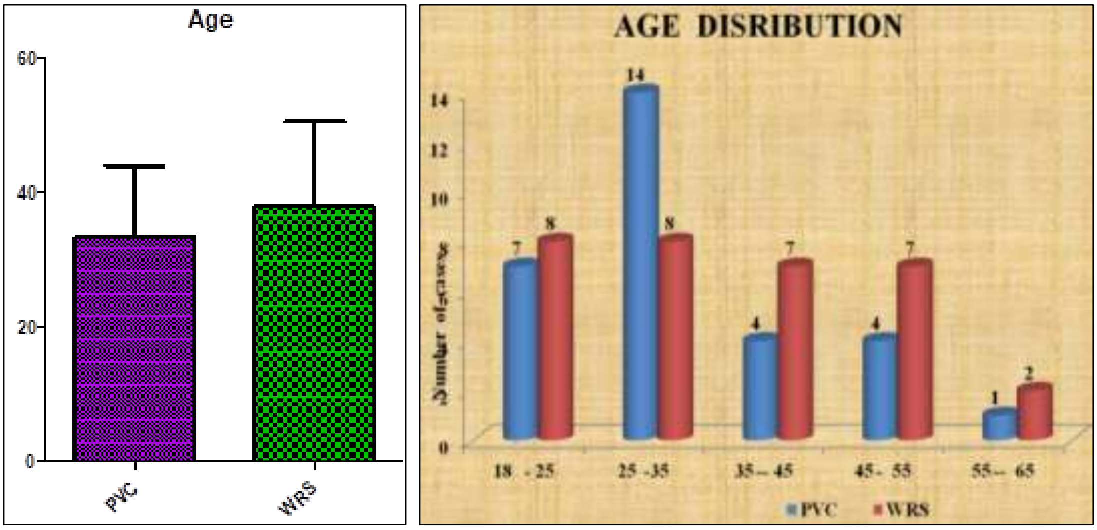
Age Distribution

Table 1: Age Distribution

	Group	**n**	**Mean**	**Std. Deviation**	**t**	**p**
Age	PVC	30	33.400	10.650	1.540	0.129
	WRS	30	38.033	12.577		

Age group	**PVC**	**WRS**
18-25	7	8
25-35	14	8
35-45	4	7
45-55	4	7
55-60	1	2

ISSN:0975 -3583,0976-2833 VOL 11, ISSUE 03, 2020



Graph 1: Age Distribution

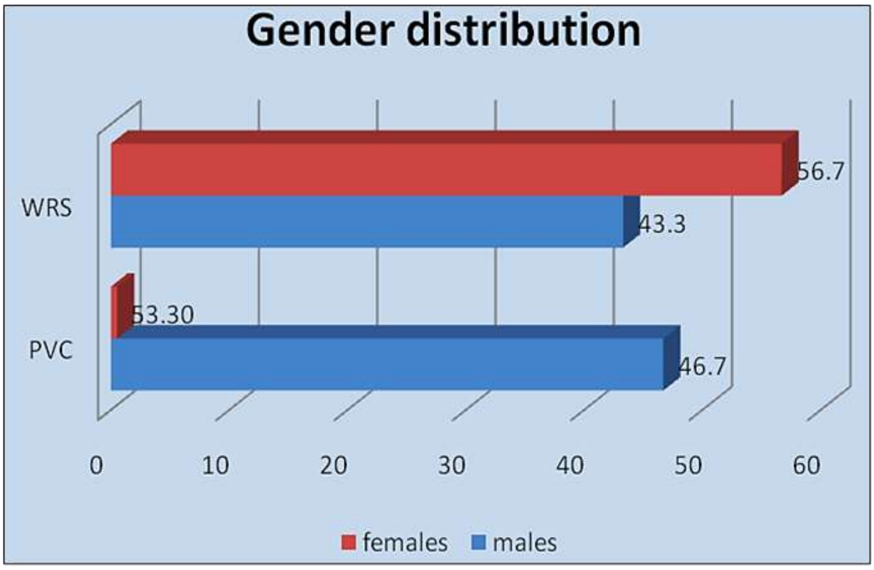
On evaluation of the age distribution in the study groups, we found that the mean age in the PVC group was 33.4 years and the 38.03 years. Most patients belonged to the age group 25-35 years. There was no statistically significant with a p value of .129 using the independent samples of t test 2 tailed significance.

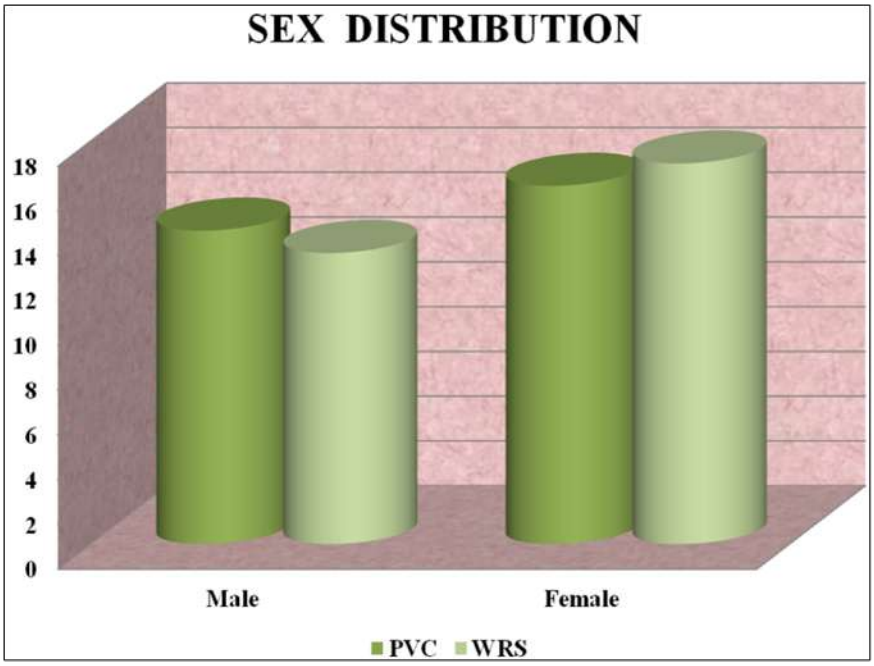
Gender Distribution

Table 2: Gender Distribution

Tube type			Frequency	Percent	Valid Percent	Cumulative Percent
PVC	Valid	Male	14	46.7	46.7	46.7
		Female	16	53.3	53.3	100.0
		Total	30	100.0	100.0	
WRS	Valid	Male	13	43.3	43.3	43.3
		Female	17	56.7	56.7	100.0
		Total	30	100.0	100.0	

ISSN:0975 -3583,0976-2833 VOL 11, ISSUE 03, 2020





Graph 2: Gender Distribution

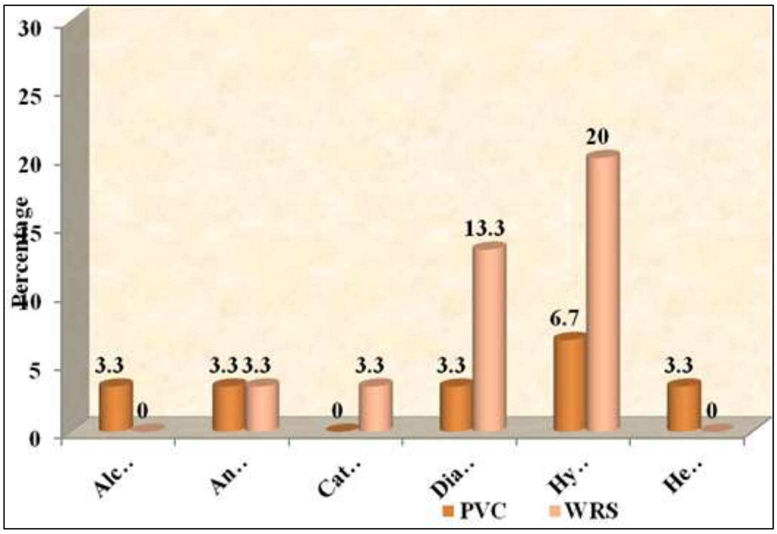
On evaluation of the gender distribution in the study groups, we found that the mean in the PVC group males made up 46.7% of the population and females 53.3% and in the WRS group males made up 43.3% of the population and females 56.7%.

ISSN:0975 -3583,0976-2833 VOL 11, ISSUE 03, 2020

Clinical Data

Risk Factors

	PVC	**WRS**
Alcoholic	3.3	0
Anaemia	3.3	3.3
Cataract	0	3.3
Diabetes	3.3	13.3
Hypertension	6.7	20
Hernia	3.3	0
	PVC	WRS
Alcoholic	3.3	0
Anaemia	3.3	3.3
Cataract	0	3.3
Diabetes	3.3	13.3
Hypertension	6.7	20
Hernia	3.3	0



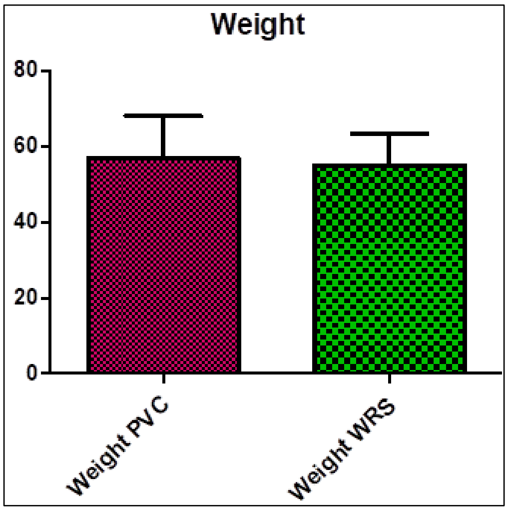
In both the test and the control groups the most common associated co-morbidity was Hypertension followed by diabetes mellitus.

Weight Characteristics

Table 3: Weight Characteristics in Both Groups

Weight	PVC	30	56.77	11.337	2.070
	WRS	30	55.03	8.236	1.504

ISSN:0975 -3583,0976-2833 VOL 11, ISSUE 03, 2020



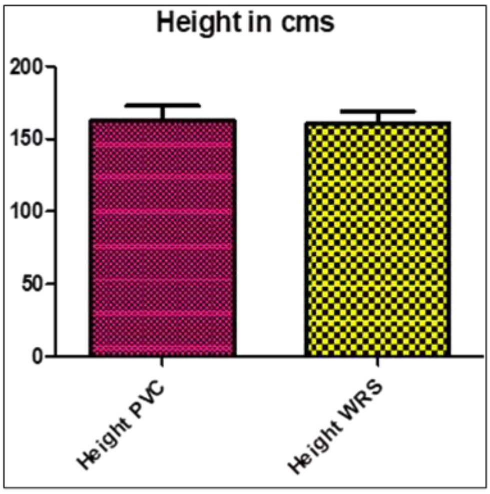
Graph 3: Weight Charecteristics in Both Groups

There was no statistically significant with a p value of .501 using the independent samples of t test 2 tailed significance. The mean weight in the PVC group was 56.7 kgs and the WRS group was 55.3kgs.

Height Charecteristics in Both Groups

Table 4: Height Charecteristics in Both Groups

Height	PVC	30	162.47	10.500	1.917
	WRS	30	160.20	9.087	1.659



Graph 4: Height Charecteristics in Both Groups

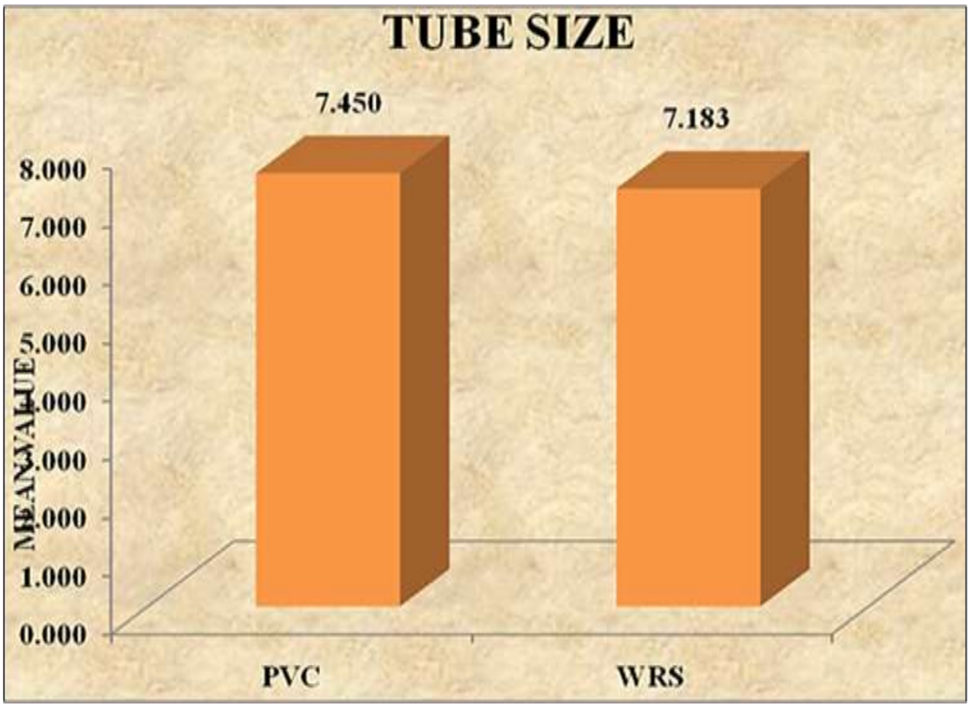
There was no statistically significant with a p value of .375 using the independent samples of t test 2 tailed significance, the mean weight in the PVC group was 162.47cms and the WRS group was 160.2cms.

ISSN:0975 -3583,0976-2833 VOL 11, ISSUE 03, 2020

Ilma Size

Table 5: Ilma Size

	PVC	WRS
ILMA Size	3.57	3.57



Graph 5: Ilma Size

There was no statistically significant with a p value of .200 using the independent samples of t test 2 tailed significance. the mean size of the tube used in both the groups was 3.57.

Man Overs Employed

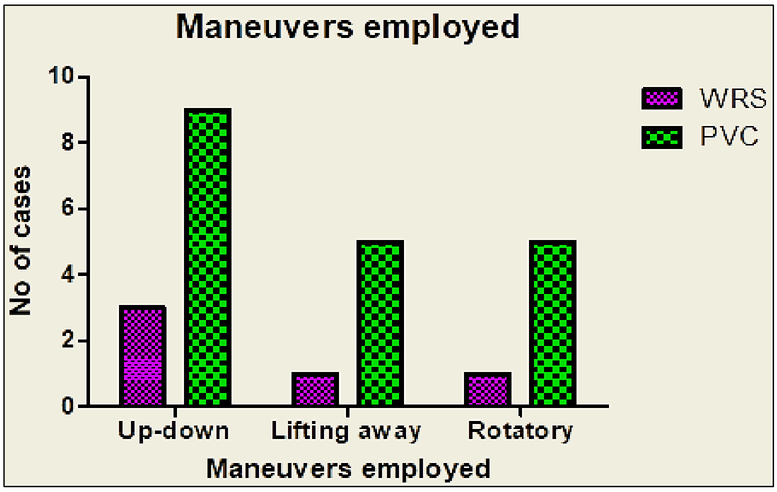
Table 6: Man Overs Employed

Tube type * Manoeuver Crosstabulation

			Manoeuver			
			None	Up-down	Rotatory	Lifting away
Tube type	PVC	Count	11	8	4	5
		% within Tube type	36.7%	26.7%	13.3%	16.7%
	WRS	Count	25	3	1	1
		% within Tube type	83.3%	10.0%	3.3%	3.3%
Total		Count	36	11	5	6
		% within Tube type	60.0%	18.3%	8.3%	10.0%

ISSN:0975 -3583,0976-2833 VOL 11, ISSUE 03, 2020

In our study in the PVC group we had to do up down maneuver in 8, rotatory maneuver in 4, lifting away maneuver in 5 and in the WRS group we had to do up down maneuver in 3, roatory maneuver in 1, lifting away maneuver in 1.



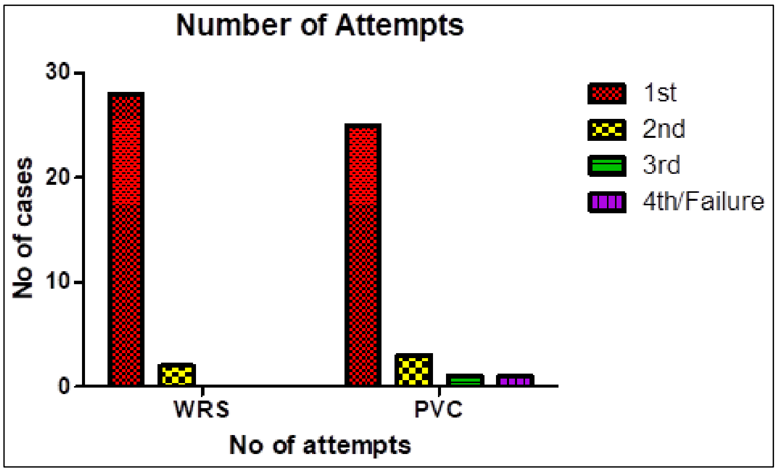
Graph 6: Man Overs Employed

Number of Attempts

Table 7: Number of Attempts

Tube type * No of attempts Crosstabulation

			No of attempts			
			1st Attempt	2nd Attempt	3rd Attempt	Failure
Tube type	PVC	Count	25	3	1	1
		% within Tube type	83.3%	10.0%	3.3%	3.3%
	WRS	Count	27	3	0	0
		% within Tube type	90.0%	10.0%	0.0%	0.0%
Total		Count	52	6	1	1
		% within Tube type	86.7%	10.0%	1.7%	1.7%



ISSN:0975 -3583,0976-2833 VOL 11, ISSUE 03, 2020

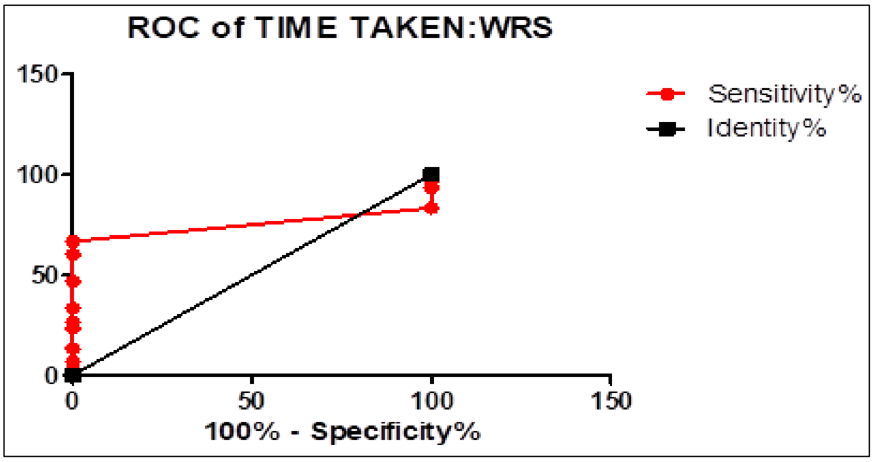
Graph 7: Number of Attempts

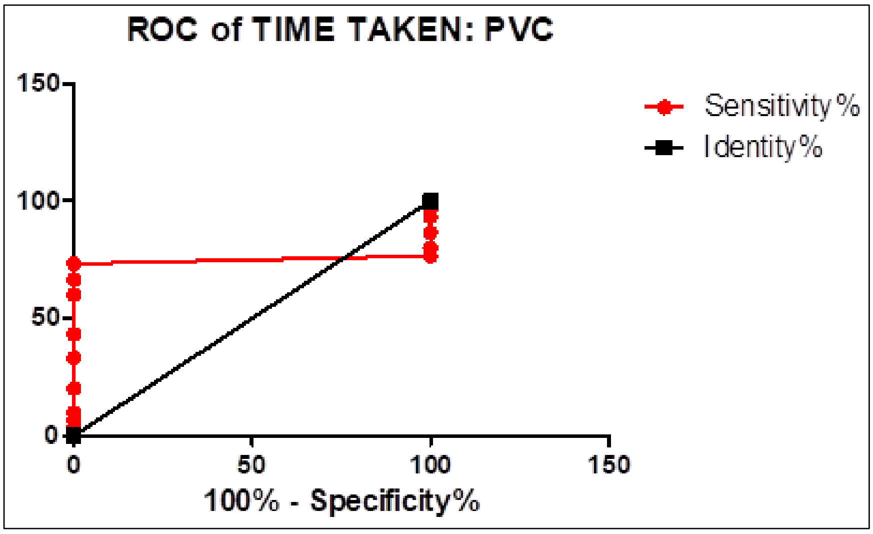
In the present study we found that there was statistically significant difference in the number of attempts between the WRS and the PVC tube with a p value of .001 using the independent samples of t test 2, tailed significance. The number of attempts that were needed for the ET tube to be in place was significantly lesser in the WRS group.

Time Taken

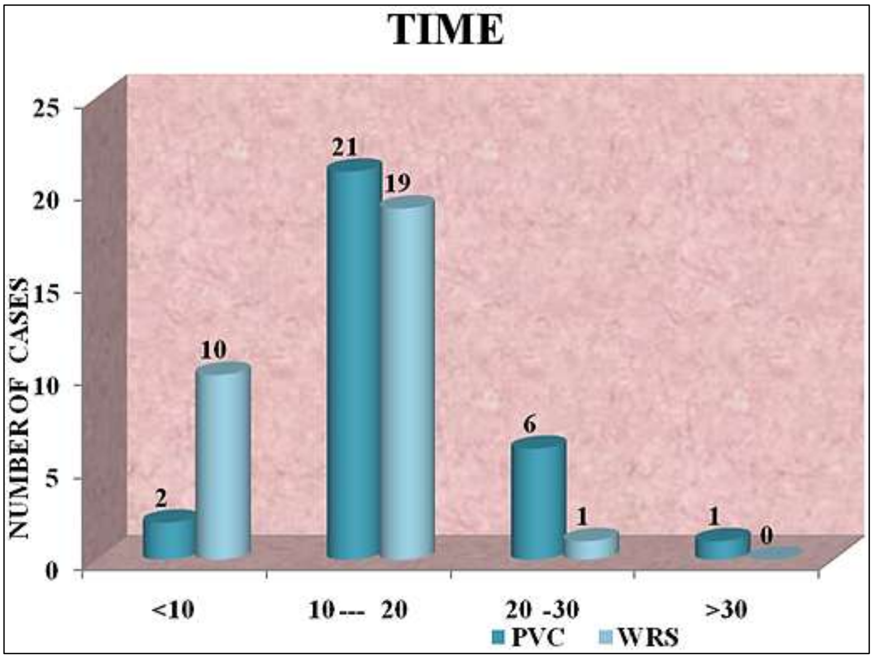
Table 8: Time Taken

Time taken	PVC	30	18.00	6.215	1.135
	WRS	30	13.00	4.864	.888





ISSN:0975 -3583,0976-2833 VOL 11, ISSUE 03, 2020



Graph 8: Time Taken

In the present study we found that there was statistically significant difference in the time between the WRS and the PVC tube with a p value of .001 using the independent samples of t test 2, tailed significance. The duration that were needed for the ET tube to be in place was significantly lesser in the WRS group.

SPO_2

Table 9: SPO_2

SPO2	PVC	30	99.13	1.456	.266
	WRS	30	99.53	1.224	.224

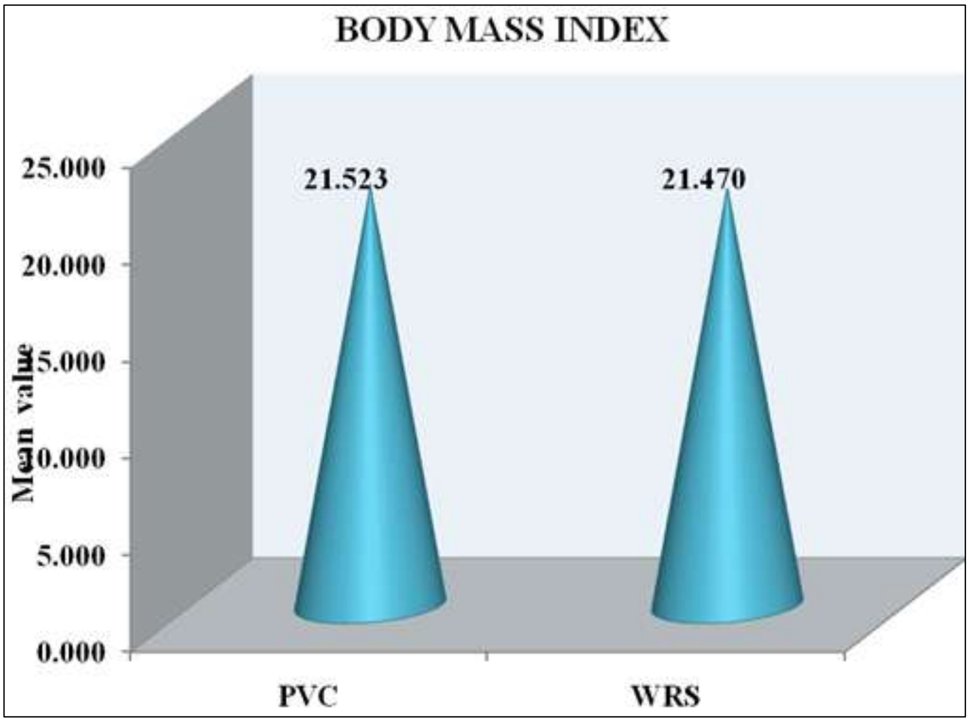
In the present study we found that there was no statistically significant difference in the SPO2 between the WRS and the PVC tube with a p value of .254 using the independent samples of t test 2, tailed significance.

BMI

Table 10: SPO_2

Body Mass Index	PVC	30	21.5234	3.99110	.72867
	WRS	30	21.4702	2.90952	.53120

ISSN:0975 -3583,0976-2833 VOL 11, ISSUE 03, 2020



Graph 9: BMI

In the present study we found that there was no statistically significant difference in the SPO2 between the WRS and the PVC tube with a p value of .953 using the independent samples of t test 2, tailed significance.

Discussion

The Classic LMA was suboptimal for blind tracheal intubation. The main objective in designing a new intubating LMA was to create a device that would minimise the requirement for anatomical distortion and avoid the need for manipulation of the head and neck. This would boost its usefulness in patients with cervical spine pathology [7].

The LMA-Fastrach™ silicone wire-reinforced tube (FTST) was specifically created for tracheal intubation using the intubating LMA (ILMA) [47]. It is both reusable and costly. The design of the device prevents it from maintaining the curved shape it acquires when passing through the shaft of the ILMA. The polyvinyl chloride (PVC) tracheal tube is rigid and protrudes from the ILMA with its far end directed too far forward to successfully enter the glottis. Nevertheless, although the FTST has been praised for its benefits, both traditional PVC [3] and PVC-reinforced [8, 9] tracheal tubes have also been effectively utilised for blind tracheal intubation through the ILMA. A polyvinyl chloride endotracheal tube (PVC ETT) is equipped with a cuff that operates at high volume and low pressure, making it particularly well-suited for extended periods of ventilation.

This study aimed to compare the success rates of intubation using the traditional PVC tube and the WRS tube given with the ILMA set for intubation in Mallampati [MP] 1 and 2 patients. The comparison was based on the success rate, ease of tracheal intubation, and complication rate. In addition to being disposable, a PVC endotracheal tube (ETT) is cost-effective and readily accessible. The purpose of this study was to assess the practicality of utilising this type of tube.

ISSN:0975 -3583,0976-2833 VOL 11, ISSUE 03, 2020

The study found that the success rate with PVC tubes was 83.3% overall. Specifically, the success rates for the first, second, and third efforts were 83.3%, 10%, and 3.3% respectively. However, the success rate dropped to 3.3% for the fourth try, resulting in failure. The success rate with the WRS tube was 90% on the first attempt and 10% on the second attempt. In a comparable study, Sharma *et al*. [10] achieved a success rate of 90% for the first category, 5% for the second category, and 1% for the third category using PVC tubes. Additionally, 4% of their cases were classified as failures. They attained a success rate of 95% for the first attempt, 2% for the second attempt, and 0% for the third attempt with WRS tubes. Additionally, 3% of the attempts resulted in failure. In a study conducted by Shah *et al*. [11], the success rates of the first, second, and third attempts with PVC tube were 82.14%, 10.71%, and 7.14%, respectively. The success rates with WRS tube were 86.20%, 10.34%, and 3.44%, respectively. These results are equivalent to our work. Kundra *et al*. [12] reported a 96% overall success rate and an 86% first-attempt success rate using both FTST and PVCT techniques, attributed to the prewarming of the tube to 40 °C. Kanazi *et al*. [13] found that the total success rate of FTST was 90%, but the success rate of PVCT was just 57%. The decreased success rate was ascribed to the obstruction caused by the contact between the endotracheal tube (ETT) tip and the tubercle of the epiglottis. Lu *et al*. [14] found that using a Sheridan PVC tube resulted in a success rate of 96.7% (with 75% success on the first attempt), whereas Kapila *et al*. [15] attained a success rate of 93% (with 72% success on the first attempt) using a Portex PVC tube.

The observed increased success rate on the initial attempt using a PVC tube, as opposed to earlier researchers, could potentially be attributed to the tube being softened through prewarming to a temperature of 40 °C. The success of tracheal intubation is significantly influenced by the angle at which the tracheal tube emerges from the distal aperture of the ILMA. The PVC tube has a pronounced curve and the ILMA exits at an angle greater than 45 degrees. The WRS tube included in the ILMA set is positioned at an angle of 35 degrees.

In our study, the average duration for tracheal insertion was 18 seconds for the PVC tube and 13 seconds for the WRS tube. While the statistical significance was evident, we do not consider it clinically relevant when compared to the expected laryngoscopic intubation time of 15 seconds. As controlled subjects were not included, 15 seconds were used as the control time. Sharma *et al*. [10] recorded a duration of 14.71s and 10.04s for the PVC and WRS groups, respectively. The shorter time was due to the implementation of adjustment manoeuvres prior to the insertion of the ETT. The study conducted by Shah *et al*. [11] found that the average time for intubation was 22.42 ± 8.5 seconds in the PVC group and 18.6 ± 6.8 seconds in the WRS group. The absence of adjustment movements likely resulted in an extended intubation time in their study. However, Kundra *et al*. did not find any notable disparity in the average insertion time among the study groups.The number 12 is enclosed in square brackets. The study found that the insertion time was shorter in the PVC group (11.8s) compared to the silicone tube (12.9s), which can be attributed to the prewarming of the PVC tube prior to insertion. In their study, Joo *et al*. [3] found that the ILMA blind group had a longer median insertion time of 23 seconds, with a range of 18 to 35.8 seconds. This may be attributed to the upward-facing reverse curvature of the PVC. The implementation of various adjustment techniques and preheating the tube would have resulted in a shorter

ISSN:0975 -3583,0976-2833 VOL 11, ISSUE 03, 2020

period in our investigation. The total duration for inserting the tracheal tube is shorter with WRS compared to PVC, which aligns with previous research findings.

In this work, we utilised many adjustment manoeuvres, including the up-down manoeuvre and the Chandy manoeuvre. The Chandy manoeuvre involves two steps: a rotational movement in the sagittal plane (Chandy step 1) and a modest lifting from the posterior pharyngeal wall (Chandy step 2). We found a statistically significant disparity in the number of attempts between the WRS and the PVC tube. The WRS group required fewer attempts to install the ET tube, and in the second phase, they used the technique of lifting away from the posterior pharyngeal wall just before tracheal intubation. The use of manoeuvres during PVC tube insertion was much higher (63.3%) compared to WRS tube (16.7%), potentially because to the increased angulation when a PVC tube exits the ILMA, resulting in contact with the tubercle of the epiglottis.

In their work, Kihara *et al*. [16] utilised a series of techniques, including extension manoeuvre, up-down manoeuvre, extension manoeuvre, and head-neck manoeuvre, for the insertion of ET. Sharma *et al*. [10] similarly used similar techniques prior to inserting the tube.

Conclusion

In the present study we found that there was statistically significant difference in the number of attempts and time taken between the WRS and the PVC tube with a p value of .001 using the independent samples of t test 2, tailed significance.

References

1. Brandt L. "The first reported oral intubation of the human trachea". Anesthesia & Analgesia. 1987;66(11):1198-1199.
2. Pratt, Loring W, Alfio Ferlito, Alessandra Rinaldo. Tracheotomy: historical review. The Laryngoscope. 2008;118(9):1597-1606.
3. Carroll CM, Pahor A. The history of tracheotomy. Journal of the Irish Colleges of Physicians and Surgeons. 2001;30(4):237-238.
4. Sittig E, Pringnitz JE. Tracheostomy: Evolution of an Airway. AARC Times, 2001.
5. Castellengo, Michèle. Manuel Garcia Jr: A clear-sighted observer of human voice production. Logopedics Phoniatrics Vocology. 2005;30(3-4):163-170.
6. Stemple, Joseph C, Leslie E Glaze, Bernice K. Gerdeman. Clinical voice pathology: Theory and management. Cengage Learning, 2000, pp. 3-8.
7. Adnet F, Borron SW, Lapostolle F, Lapandry C. The three axis alignment theory and the “sniffing position”: perpetuation of an anatomic myth? Anesthesiology. 1999 Dec;91(6):1964-5.
8. Greenland KB, Eley V, Edwards MJ, Allen P, Irwin MG. The origins of the sniffing position and the Three Axes Alignment Theory for direct laryngoscopy. Anaesth Intensive Care. 2008 Jul;36(1):23-7.
9. Greenland K. The ramped position and its relationship to the 2-curve theory. Anesth Analg. 2011 Dec;113(6):1524-5, 1525.
10. Booth, John B. Tracheostomy and tracheal intubation in military history. Journal of the Royal Society of Medicine. 2000;93(7):380.
11. Greenland KB, Edwards MJ, Hutton NJ, Challis VJ, Irwin MG, Sleigh JW. Changes in airway configuration with different head and neck positions using

ISSN:0975 -3583,0976-2833 VOL 11, ISSUE 03, 2020

magnetic resonance imaging of normal airways: a new concept with possible clinical applications. Br J Anaesth. 2010 Nov;105(5):683-90.

12. Lee LC. Two curves theory does not clearly explain laryngoscopy and intubation. Br J Anaesth. 2011 Jun;106(6):909-10; author reply 910-1. PubMed PMID:
13. Varon J, Fromm RE. Airway Management. In Varon J(ed): Practical Guide to the Care of the Critically Ill Patient. 1st Ed, St. Louis; Mosby-Year Book, Inc, 1994, pp. 321-339.
14. Widdicombe, John, Lu-Yuan Lee. Airway reflexes, autonomic function and cardiovascular responses. Environmental health perspectives. 2001;109(4):579.
15. Scott J. Oral Endotracheal Intubation. In Dailey RH, Simon, B, Young GP, Stewart RD (eds): The Airway: Emergency Management, 1st Ed., St Louis; Mosby-Year Book, Inc. 1992, pp. 73-91.
16. Widdicombe, John G. Reflexes from the upper respiratory tract. Handbook of physiology: the respiratory system. Bethesda, Md: American Physiological Society, 1986, pp. 363-394.
17. Young GP. Clinical Airway Anatomy. In Dailey RH, Simon, B, Young GP, Stewart RD (eds): The Airway: Emergency Management, 1st Ed, St Louis; Mosby-Year Book, Inc., 1992, pp. 3-13.