Comparison of intubation with polyvinyl chloride tracheal tubes and silicone wire reinforced tubes through LMA CTrach^{tm}

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LMA CTrach^{TM} enables ventilation and intubation with the same device while visualising the process of intubation. The manufacturer produced silicone wire reinforced tubes are recommended for intubation through this device.

Objective: The intubation success rates with polyvinyl chloride tube and silicone wire reinforced tubes while intubating through LMA CTrach^{TM} was compared.

Study design: One hundred patients of ASA physical status 1 and 2 who were undergoing procedures under general anaesthesia were randomly allocated into two groups. In one group silicone wire reinforced tubes and in the other group polyvinyl chloride tracheal tubes were used for intubation through LMA CTrach^{TM}. The success, number of attempts, time taken and the ease of intubation along with any incidence of airway trauma were recorded.

Results: The overall success rate of intubation was 100% in both groups. The first attempt success of intubation was significantly higher in silicone tube group (98%) as compared to polyvinyl chloride tube group (84%). The ease of intubation was significantly higher in silicone tube group (98% versus 80%). The time taken for intubation was longer with polyvinyl chloride tube group by a mean of 10 seconds. The incidence of airway trauma was comparable in both groups.

Conclusion: Polyvinyl chloride tracheal tubes can be used instead of the silicone wire reinforced tubes for intubating through LMA CTrach^{TM} with a similar overall success rate and incidence of airway trauma. However, the first attempt success rate of intubation and ease of intubation were higher with the silicone wire reinforced tube.

Keywords: laryngeal mask; LMA CTrach^{TM}; intubation; endotracheal tube; silicone wire tube; polyvinylchloride tube

Introduction

The LMA CTrach^{TM} (The Laryngeal Mask Company, Singapore) is an airway device that incorporates the ability to ventilate and intubate in a single equipment.

A modification of LMA Fastrach^{TM}, it enables viewing of the glottic structures through fibreoptic bundles included in the device. The recommended tube for intubation through LMA CTrach^{TM} is the manufacturer produced silicone wire reinforced tube.[1] They claim that its malleable structure and atraumatic tip reduce the chances of airway trauma. This was based on previous studies done on LMA Fastrach^{TM}.[2,3]

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The expensive nature of the tube and its poor characteristics for prolonged ventilation make it less desirable for intubation.[4,5] We conducted a study to compare the success rate of intubation using polyvinyl chloride tracheal tubes with silicone wire reinforced tubes while intubating through LMA CTrach^{TM}.

Method

The study began after obtaining approval from the Institutional Ethics Committee. Patients were enrolled after obtaining written informed consent. Total of 100 patients aged between 18-65yrs, belonging to ASAPS 1 and 2 who were scheduled for elective surgical procedures under general anaesthesia were included. Patients with mouth opening <2.5cms, risk of regurgitation and oral, maxillofacial or laryngeal pathology were excluded from the study. All patients were evaluated during the preoperative visit and standard fasting guidelines were followed. Using computer generated random number table patients were allocated into polyvinyl chloride tube group (Group P) and silicone tube group (Group S). In group P,

Portex endotracheal tube, Smiths Medical was used. In group S, LMA Fastrach™ endotracheal tube, The Laryngeal Mask Company Limited was used. Group secrecy was protected using opaque sealed envelopes. Three anaesthetists with an experience of using LMA CTrach™ in at least 20 patients were involved in the study. The patients receiving the allocated intervention were blinded to type of tube used.

Airway intervention

In the operation theatre, patients were anesthetised as per standardised protocol with intravenous fentanyl, glycopyrrolate and propofol. After confirming ability to bag and mask ventilate, vecuronium was given for neuromuscular blockade. LMA CTrach™ of appropriate size was inserted after 3mins using manufacturer recommended guidelines and adequacy of ventilation was checked. In its absence, correctional manoeuvres like up-down manoeuvre, Chandy manoeuvre and side to side to manoeuvre were tried. If this failed reinsertion of same device or different size device was attempted. Failure of this led to abandonment of intervention in patient and tracheal intubation was done using direct laryngoscopy.

On establishing adequacy of ventilation, viewer was attached and the glottic view obtained was labelled as initial view.[6] If this initial view obtained was Grade 2 or worse, manoeuvres like up-down manoeuvre, partial withdrawal, distal manoeuvre, Chandy manoeuvre or suctioning was attempted based on the discretion of the anaesthetist. If this also failed to improve the view, a reinsertion of the device after cleaning the optics was attempted. The final view obtained was considered as the best glottic view obtained. Intubation attempt with a Grade 3 or Grade 4 view was considered as a blind attempt and one blind attempt was allowed if ventilation was adequate. The cuffed tracheal tube size for both groups was standardised as size 7mm internal diameter for LMA CTrach™ size 3 and size 8mm internal diameter for LMA CTrach™ size 4 and 5, respectively. In group P, the tube was inserted in reverse orientation with the curvature of the tube directed against the curvature of LMA CTrach™. During the visualisation of the passage of the tube into the glottis, inconsistency in the alignment of the exiting of the tube through the LMA CTrach™ was rectified using manipulations under vision. All manoeuvres performed were recorded.

An intubation attempt was defined as the tracheal tube exiting from the cuff of the LMA CTrach™ and passing into the glottic opening or hitching against any of the laryngeal structures necessitating withdrawal of the tracheal tube through the LMA CTrach™. A maximum of 3 attempts were allowed. The ease of intubation was assessed using the following scale:

Easy: Intubation was smooth without hinging on any of the laryngeal structures and no additional manoeuvres were required.

Difficult: Difficulty in intubation due to hinging at laryngeal structures and can be corrected with correctional manoeuvres or more than one attempt was required for intubation.

At all possible situations of apnoea, ventilation was maintained though LMA CTrach™ with 2% isoflurane in oxygen.

Following intubation, LMA CTrach™ was removed and tracheal tube cuff inflated, and ventilation confirmed by chest movements and capnogram. Subsequently, anaesthesia and surgery proceeded as per requirement.

Twenty-four hours following intubation, patients were interviewed and enquired about the presence of sore throat and hoarseness of voice. Patients complaining of sore throat were treated with intramuscular diclofenac 75 mg.

Data and analysis

Primary outcome measure was the successful intubation rate at first attempt which the sample size estimation was based on. The pilot study showed that the first attempt intubation success rate was 97% with silicone wire reinforced tube and 77% with polyvinyl chloride tracheal tube. Considering a difference of 20% as significant, for a power of 80% at 95% confidence interval, minimum of 44 patients were required in each group. 50 patients were enrolled in each group to account for attrition and loss to follow up. Statistical analysis was done using SPSS version 20 for Windows. Parametric data (age, weight, timings) were analysed using Independent Samples *t*-test. Non- parametric data were analysed using Chi-Square test or Fisher's Exact test. *P* value less than 0.05 was considered significant. Means and standard deviations were used to describe parametric data. Percentages were used to describe success rates.

Results

Patient characteristics are given in Table 1. All 100 patients enrolled in the study received the allocated intervention. Ventilation and intubation through LMA CTrach™ was successful in all patients enrolled in the study.

Table 1: Patient characteristics

	Group P	Group S
Age in years (Mean +/- SD)	43.78 +/- 12.71	39.58 +/- 13.054
Weight in kilograms (Mean +/- SD)	60.82 +/- 14.530	61.58 +/- 13.492

SD- Standard Deviation

The first attempt success rate of intubation in Group P and Group S was 84% and 98%, respectively. This was found to be statistically significant (P= 0.031; Fisher Exact test). The best glottic view obtained in the two groups was comparable as shown in Table 2.

Table 2: Best possible glottic view

	Grade of best possible glottic view				*P* value*
	1	2	3	4	
Group P (number of patients)	46	3	0	1	0.572
Group S (number of patients)	46	3	1	0	

* Chi square test

All patients who required a second attempt at intubation in either group except one in group P had a Grade 1 glottic view. This patient had a Grade 3 view in first attempt at intubation which failed. In the second attempt, a distal manoeuvre improved the grade of glottic view to Grade 1 and intubation was successful. The two patients who had a blind attempt at intubation in either group were successful in the first attempt and were considered easy. The most common reason for a second attempt at intubation in either group was misalignment of the LMA CTrach™ with the glottic aperture causing hinging of the tube on the soft tissues or arytenoids. This could be corrected with various manoeuvres under direct visualisations enabling success in the second attempt. In Group P, 20% patients had a 'difficult' intubation. In Group S, this was only 2% and was found to be statistically significant. The number of manoeuvres required for successful intubation was found to be significantly higher in group P as compared to the group S (Table 3).

Among these manoeuvres, realignment of LMA CTrach™ was most commonly used, followed by partial withdrawal of LMA CTrach™ (Table 4). The time taken for intubation was noted from the beginning of insertion of tracheal tube till obtaining CO_2 waveform after connecting tracheal tube to ventilator.

Table 3: Number of manipulations required for successful intubation

	Number of manipulations required for successful intubation			*P* value*
	0	1	2	
Group P (number of patients)	42	5	3	0.045
Group S number of patients)	49	1	0	

*Chi square test

The mean time taken in group P was 33.50 seconds and in group S was 22.02 seconds. This was found to be statistically significant. The incidence of sore throat and hoarseness in both groups were found to be comparable.

Table 4: Manoeuvres used for successful intubation

	Group P (number of patients)	Group S (number of patients)
Partial withdrawal	2	0
Distal manoeuver	1	0
Up and down maoneuver	1	0
Chandy manoeuver	0	1
Realignment of LMA	3	0
Rotation of ETT	1	0

Discussion

In our study, the first attempt success rate and ease of intubation were significantly higher in group S compared to group P. The overall success rate of intubation, incidence of airway trauma and presence of hoarseness of voice or sore throat were comparable.

The LMA CTrach™ has fibre optics incorporated in the LMA Fastrach™ to enable visualization of structures anterior to the cuff.[1] The preformed angle of the device was based on MRI images obtained to minimize head and neck movement during insertion of the device.[2] The polyvinylchloride tube was meant to be used for intubation with direct laryngoscopy after creating a distortion of the airway anatomy. This was the reason for the preformed curve of the tube. Brain AIJ and colleagues in their initial studies on ILMA demonstrated that the preformed curve along with the tendency of polyvinylchloride tube to retain memory of the curve of ILMA reduced the chances of successful intubation. Hence, the straight silicone tubes were developed by them.[2,3] In our study, the polyvinylchloride tube was inserted in reverse orientation. Studies done on ILMA using the two orientations of the tube have shown a higher success rate with the reverse orientation in

comparison with the normal orientation.[5-8] Studies done on LMA CTrach™, have also shown a higher first attempt success rate with polyvinylchloride tubes in reverse orientation as compared to the normal orientation.[9] A review of literature failed to show any study comparing the two types of tubes in LMA CTrach™.

A number of studies done with LMA Fastrach™ comparing polyvinylchloride tracheal tube with the silicone wire reinforced tube have shown equivocal results in the overall success rate of intubation. The first attempt success in intubation was higher in silicone wire reinforced tube. The mean number of attempts at intubation was also significantly lower with silicone wire reinforced tubes in these studies.[8, 10-12]

When the angle of emergence of the polyvinyl chloride tracheal tubes from various manufactures had been compared by Brain and his colleagues, the Portex PVC tube had an angle of emergence of 50°. The angle of emergence with a straight silicone tube was 36°.[2] The lower angle of emergence led to a better alignment between the tube and glottis aperture. Zhu T measured the angle of emergence of the conventional polyvinyl chloride tracheal tube in reverse orientation to be 20°. This corresponded more closely with the angle of emergence of the straight silicone tube.[8]

In vitro study by Joo Hs and colleagues has shown that the pressure exerted by the polyvinylchloride tracheal tube was six to seven times higher than that of the silicone wire reinforced tube.[13] In our study the incidence of sore throat, hoarseness of voice and blood on tube or LMA CTrach™ were comparable between the two groups.

The most common difficulty encountered while intubating with polyvinylchloride tracheal tubes was the hinging on the soft tissues due to its stiff nature, retained curvature and laterally directed bevel. Among the various manoeuvres used for intubation, rotation of the LMA and partial withdrawal were the most commonly used ones for bringing the tube and glottic aperture in alignment.

All initial studies with LMA CTrach™ were done using the standard silicone wire reinforced tube. Our overall success rate of ventilation was 100% which was similar to preliminary studies with LMA CTrachTM.[6,12,14-16] However, the grade of glottic view obtained with LMA CTrach™ was better in our study.[6,12,14-17] The better view in our study could be attributed to the fact that there was no limit to the time or the number of manipulations to improve the glottic view as long as oxygenation was being maintained. Previous studies had an overall success rate of intubation which was lower than our study.[6,14-16] This higher success rate could be due to the better glottic view obtained prior to intubation. Studies with ILMA using fibreoptic bronchoscope have shown that the success of intubation was directly related to the glottic view obtained.[17]

Our study has a drawback that it was conducted in a population with normal airway of Indian ethnicity. Moreover, there was a lack of operator blinding in our study as it was impractical to conceal the tube during the insertion through LMA CTrach™.

Conclusion

We conclude that the silicone wire reinforced tube has a higher first attempt success rate and ease of intubation in comparison to polyvinyl chloride tracheal tube while intubating through LMA CTrach™.

Trial Registry Number (Clinical trial registry of India): CTRI2014/01/004314

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