Original Research Article

Indian Journal of Anesthesia and Analgesia
November – December 2020;7(6)
DOI: http://dx.doi.org/10.21088/ijaa.2349.8471.7620.70

A Comparative Evaluation of Respiratory Parameters Spo_2 and $Etco_2$ with Paediatric I-Gel, Proseal LMA Vs Endotracheal Tube

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How to cite this article:

Uma B R, Sridhara. A Comparative Evaluation of Respiratory Parameters Spo_2 and $Etco_2$ with Paediatric I-Gel, Proseal LMA Vs Endotracheal Tube. Indian J Anesth Analg. 2020;7(6):1359–1364.

Abstract

Introduction: Supra Glottic Airway devices have set a new trend in airway maintenance since their invention. Availability of these devices in the paediatric sizes has revolutionized their use. Endo Tracheal Tubes have always been considered "Gold Standard" owing to their ability of maintaining stable respiratory parameters and in prevention of aspiration. We have compared the repiratory parameters achieved with Paediatric I-Gel, Proseal -LMA and Endo Tracheal Tube.

Description: 120 children aged 2 to 12 years, both sex, ASA 1 and 2, posted for elective surgery were included in the study. They were divided into 3 groups of 40 each - Endo Tracheal Tube (E), Proseal LMA (P-LMA) and I-GEL respectively. The device was inserted after induction of anaesthesia and the respiratory parameters namely SpO_2 and $EtCO_2$ were recorded at various time intervals.

Result: All values were analysed and expressed as mean +/– SD. Statistical comparison was done by unpaired student "t"- test and chi square test. The values obtained for various time intervals were found to be statistically insignificant for all the three devices.

Conclusion: PaediatricProseal LMA (P-LMA) and I-GEL are very much comparable with Endo Tracheal Tube (E) with regard to respiratory parameters and hence can be safely used as an alternative airway in the paediatric population.

Keywords: Airway; Endotracheal Tube; I-GEL; Paediatric; Proseal LMA.

Introduction

Supraglottic airway devices (SAD) have formed a revolution in the art of airway maintenance. These devices are designed in such a way that they maintain a clear airway while sitting above the larynx and creating a seal around it.[1] The " First – Generation " SAD are simple airway tubes. ex: Laryngeal Mask Airway – LMA Classic. The " Second – Generation" SAD contain a suction port and integral bite-block.[2] ex: Proseal LMA (P-LMA) and I-Gel. P-LMA is considered a premier supraglottic airway device in children. The I-Gel seal is made of thermoplastic elastomer and overcomes the cuff related problems of second generation devices.[3] The P-LMA allows a higher seal pressure than LMA Classic due to its drainage tube for the same intra-cuff pressure and permits drainage of gastric secretions and access to the alimentary tract.[4] The Endo-Tracheal Tube (ETT) has always

been a gold standard in maintaining the airway due to its control over respiratory parameters namely Saturation (SpO_2) and End tidal CO_2 ($EtCO_2$). Maintaining these parameters throughout the intra-operative period in the paediatric population is all the more important as they have very minimal reserves. This study was conducted to compare the respiratory parameters namely SpO_2 and $EtCO_2$ at various time intervals after the insertion of Proseal LMA and I-Gel in paediatric population with respect to the performance of ETT.

Materials And Methods

This clinical study was undertaken at a tertiary care hospital on 120 children aged 2 to 12 years, both sex belonging to ASA physical status 1 and 2 undergoing elective surgery under general anaesthesia.

After obtaining Institutional Ethical Committee clearance, an informed verbal and written consent was obtained from parent/ guardian. Children with airway anomaly, doubtful Nil Per Oral (NPO) criteria, head and neck surgery were excluded from the study.

A thorough pre-anaesthetic evaluation was performed and necessary investigations were done. Fasting guidelines were advised. On the day of surgery, children were premedicated according to Institutional protocol and an appropriate IV canula was secured. Fluid administration was calculated according to Holiday and Segar formula.[5]

On arrival into the operation theatre, children were connected to standard monitors like pulse oximetry, ECG, NIBP and parameters were noted. The study population was divided into 3 groups of 40 each namely, Endo Tracheal Tube (E), Proseal LMA (P-LMA) and I-GEL through computer generated randomization table. After the children were allocated into one of the 3 groups, General Anaesthesia (GA) was induced with Sevoflurane, Oxygen, Nitrous Oxide and Fentanyl 2 mcg/kg, relaxed with Scholine 1.5mg/kg iv. After achieving adequate muscle relaxation, airway was secured with the device to which the child was randomly allocated.

For children allocated to the ETT group, laryngoscopy was performed and appropriate size cuffed/ uncuffed ETT was used to secure the airway.

For P-LMA and I-GEL group, appropriate size device was inserted. The cuff was inflated in the P-LMA group.

Once the device was inserted, correct placement was confirmed with bilateral chest rise, air entry on auscultation and $EtCO_2$ tracing (curve). The SpO_2 and $EtCO_2$ recording at this point was taken as baseline or "0" minute value. The airway device was secured with adhesive tapes and an appropriate size gastric tube was placed through the drain tube of P-LMA and I-GEL. Anaesthesia was maintained with O_2(40%) + N_2O(60%) + Isoflurane + Non-Depolarising muscle relaxant + IPPV with paediatric circle absorption system. The SpO_2 and $EtCO_2$ readings were recorded every 10 minutes upto 60 minutes or completion of surgery which ever was earlier.

At the end of surgery, children were reversed with neostigmine + glycopyrrolate and extubated after return of spontaneous ventilation, adequate muscle power and when they were fully awake.

After the insertion of the airway device in case of P-LMA and I-GEL, if satisfactory $EtCO_2$ curve was not obtained or the chest lift was not adequate, then the device was removed and changed over to an ETT of appropriate size. Such children were excluded from the study.

Results

Statistical Analysis: All values were analysed and expressed as mean +/– SD. Statistical comparison was done by unpaired student "t"- test and chi square test. A "p" value less than 0.05 was regarded as statistically significant whereas "p" value more than 0.05 was considered statistically insignificant.

The values of SpO_2 and $EtCO_2$ with the 3 airway devices were recorded every 10 minutes. The values for all the children at particular time intervals are expressed as mean +/– SD. The values obtained in ETT group was kept as a standard. The values obtained in P-LMA ang I-GEL group are compared with that of ETT group.

The comparison of SpO_2 and $EtCO_2$ values at different time intervals in ETT and P-LMA group is shown in Table 1 and Graph 1 and 2.

The comparison of SpO_2 and $EtCO_2$ values at different time intervals in ETT and I-GEL group is shown in Table 2 and Graph 3 and 4.

The p values obtained for the SpO_2 and $EtCO_2$ values at different time intervals was statistically not significant.

Table 1: SpO_2 and $EtCO_2$ values: P-LMA vs ETT.

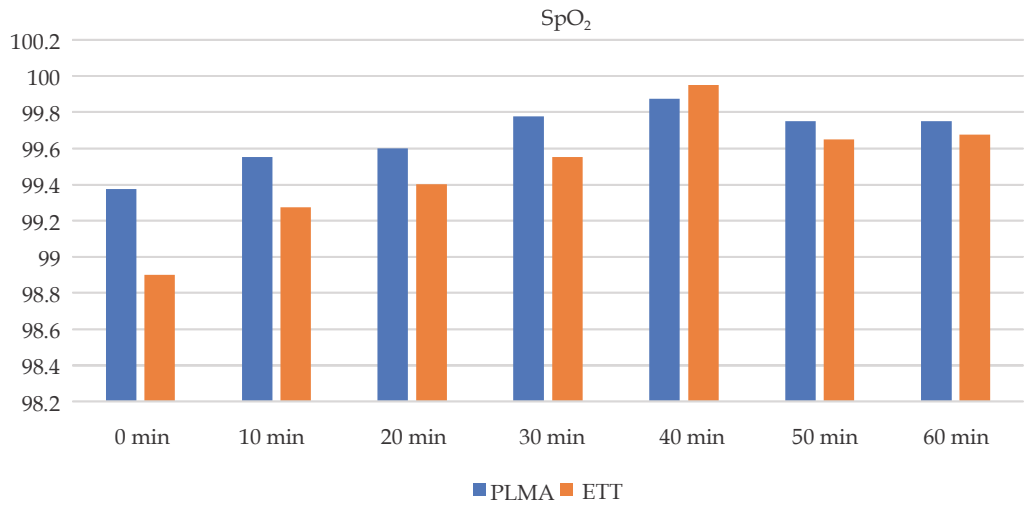
Time	$EtCO_2$			SpO_2		
	PLMA	ETT	P – Value	PLMA	ETT	P - Value
0	31.15 ± 4.142	30.775 ± 2.093	0.6108	99.375 ± 0.925	98.9 ± 1.335	0.068
10	31.275 ± 3.98	31.2 ± 1.963	0.9152	99.55 ± 0.749	99.275 ± 1.131	0.2036
20	31.2 ± 3.736	31.625 ± 1.674	0.5134	99.6 ± 0.708	99.4 ± 1.032	0.3153
30	31.525 ± 3.162	31.85 ± 1.888	0.578	99.775 ± 0.479	99.55 ± 0.714	0.1019
40	30.775 ± 2.759	31.325 ± 1.456	0.2683	99.875 ± 0.404	99.95 ± 0.316	0.3611
50	30.925 ± 3.253	30.975 ± 1.51	0.93	99.75 ± 0.543	99.65 ± 0.579	0.428
60	30.425 ± 3.265	30.3 ± 1.042	0.8182	99.75 ± 0.630	99.675 ± 0.764	0.633

P value not significant.

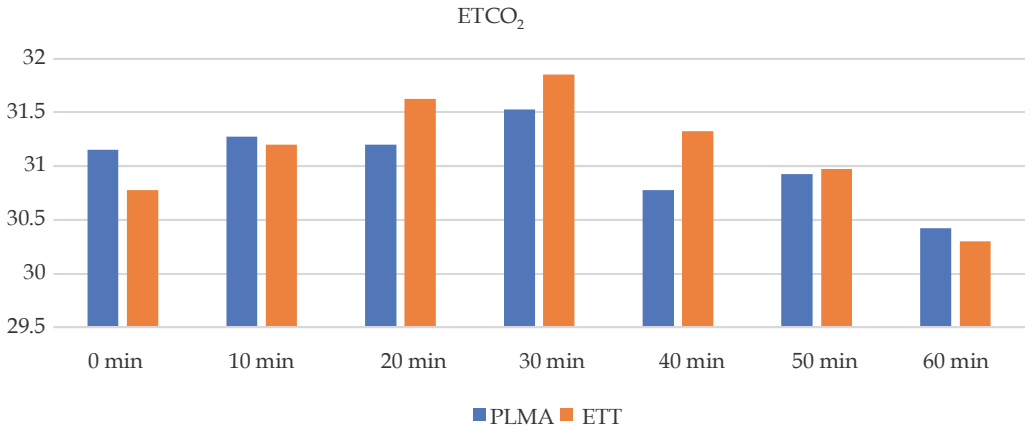
Table 2: SpO_2 and $EtCO_2$ values: I-GEL vs ETT.

Time	$EtCO_2$			SpO_2		
	I-GEL	ETT	P - Value	I-GEL	ETT	P - Value
0	30.9 ± 1.9	30.775 ± 2.093	0.7719	99.15 ± 1.122	98.9 ± 1.335	0.3674
10	31.15 ± 1.657	31.2 ± 1.963	0.9023	99.525 ± 0.933	99.275 ± 1.131	0.2842
20	31.2 ± 1.62	31.625 ± 1.674	0.2521	99.55 ± 0.875	99.4 ± 1.032	0.4853
30	31.35 ± 1.672	31.85 ± 1.888	0.2136	99.725 ± 0.598	99.55 ± 0.714	0.2383
40	31.1 ± 1.41	31.325 ± 1.456	0.4847	99.925 ± 0.349	99.95 ± 0.316	0.7379
50	30.75 ± 1.315	30.975 ± 1.51	0.4794	99.8 ± 0.464	99.65 ± 0.579	0.2048
60	30.5 ± 1.432	30.3 ± 1.042	0.4772	99.7 ± 0.648	99.675 ± 0.764	0.875

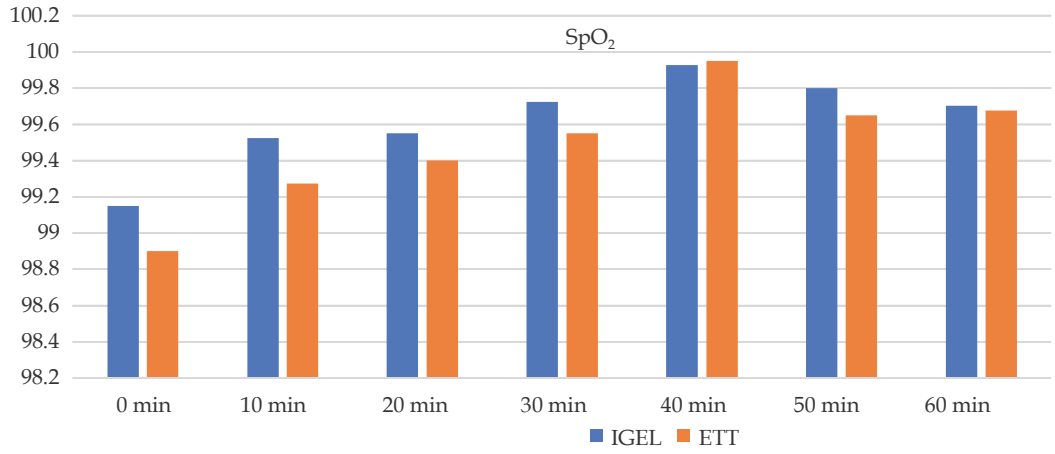
P value not significant.



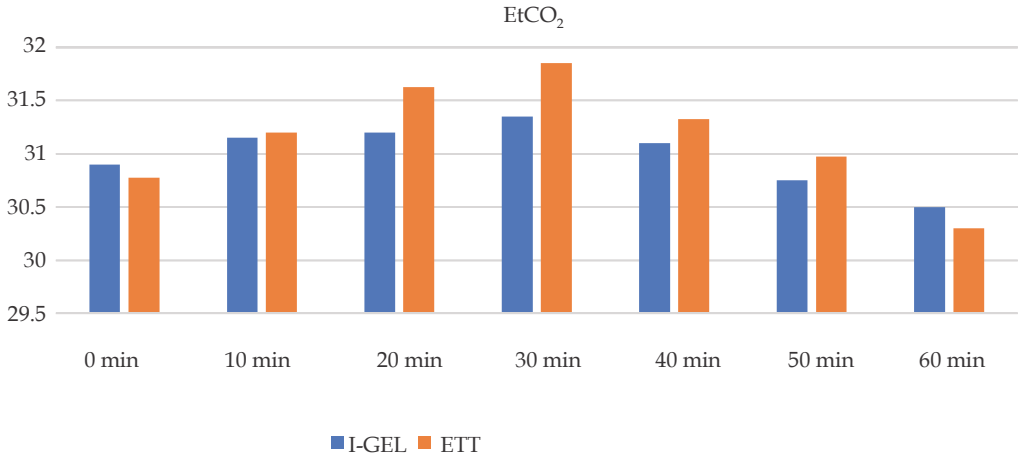
Graph 1: SpO_2 values: P-LMA vs ETT.



Graph 2: $EtCO_2$ values: P-LMA vs ETT.



Graph 3: SpO_2 values: I-GEL vs ETT.



Graph 4: $EtCO_2$ values: I-GEL vs ETT.

Discussion

ETT have been a standard technique of securing the airway in paediatric population since many years. It no doubt provides a secure airway for ventilation and protects against aspiration of gastric contents when an adequate size ETT is used. Maintenance of respiratory mechanics and their monitoring has been very reliable with ETT. Use of ETT in paediatrics have their own disadvantage namely (1) Expertise (2) Size selection – smaller tubes cause resistance to ventilation, air leak, gastric distension leading to regurgitation and aspiration whereas a larger tube is difficult to pass beyond the sub-glottis and causes post-operative airway oedema, stridor and obstruction due to narrow sub-glottic anatomy. When cuffed ETTs are used, inadvertant high cuff pressures may further compromise perfusion of pharyngeal mucosa.

Many of the above mentioned disadvantages have been successfully over come by the availability and use of paediatric P-LMA since 2007[6] and I- Gel since later part of 2009 and early 2010.[2]

Most of the available literature on Supra Glottic Airway Devices (SAD) have studied and compared parameters like ease of insertion, oropharyngeal leak pressures, ease of insertion of gastric drain tube etc,.The success of insertion of SAD were mainly assessed based on the appearance of square wave capnography trace along with adequate chest-lift, auscultation of breath sounds.[3,7]

We recorded the SpO_2 and $EtCO_2$ values of I-Gel, P-LMA and ETT at various time intervals. On comparison of SpO_2 and $EtCO_2$ values of ETT and I-Gel at various time intervals, they were statistically insignificant with p-value more than 0.05.

Similarly, the comparison of SpO_2 and $EtCO_2$ values of ETT and P-LMA were statistically insignificant.

Various causes can be attributed to changes in SpO_2 and $EtCO_2$ values. During placement of the device, if longer time is taken for insertion, there may be desaturation and hence low SpO_2 recordings. The I- Gel for instance is quicker to insert than the LMA Classic or P-LMA as there is no cuff to inflate.[2]

Upon insertion of the device, improper placement, dislodgement and/ or disconnections can lead to abnormal values of SpO_2 and $EtCO_2$.

Lighter planes of anaesthesia combined with Pre-existing infections may be disastrous with laryngospasm, bronchospasm, desaturation and increasing $EtCO_2$ values.

Proper fixation of any airway device is of prime importance after its insertion. Some have even recommended technique of fixation of SAD with adhesive tapes from maxilla to maxilla. If the SAD is not fixed properly, chances of dislodgement is high as they are bulkier compared to ETT.

Selection of appropriate size of SAD reduces the time of insertion or in other words minimizes the time of securing the airway. Availability of different sizes of paediatric SAD minimizes the time required to change the device in case of inadequate ventilation. Adhering to the flow chart of size selection based on body weight recommended by the manufacturer in most of the cases overcomes this problem. In conditions where the body weight cannot be measured as in emergency scenario, bed ridden children etc, many authors have recommended pinna or auricle size based selection criteria.[8,9]

Knowledge and prior experience of the anaesthesiologist regarding SAD plays an important role in many situations dealing the airway. However White MC and colleagues concluded that an effective airway can be provided even without prior experience using P-LMA.[1] There is more than 90% success rate of first time insertion of I-Gel as observed by P. Smith and C. R. Bailey.[2] In our study, the insertion of SAD was successful in all children and we have used the standard insertion technique recommended by the manufacturer. Various other techniques like introducer and gum elastic bougie have been compared by many authors.[10] The anaesthesiologist inserting the device was experienced and had thorough knowledge of SADs and airway maintenance. None of the children in our study had any airway complications requiring change of SAD to ETT.

The end-point of cuff inflation or assessing oropharyngeal leak pressure (OPL) of P-LMA was left to the individual anaesthesiologist. They used one of the 4 techniques of determining the OPL pressure namely (1) Detection of audible noise (2) Determination of $EtCO_2$ in oral cavity (3) Airway pressure monitoring (4) Audible noise by neck stethoscopy. M Lopez-Gil and colleagues have concluded in their study that all the above mentioned techniques are accurate and reliable with regard to OPL pressure assessment.[11] Maintenance of appropriate OPL pressure avoids post -operative complications of SAD. We however did not notice any complications in our study group.

With the extensive availability and use of 2nd generation SAD in paediatric population, anaesthesiologist may have to select between I-GEL and P-LMA. I- Gel has added advantages over P-LMA. I-Gel can be used in difficult airway scenario likes burns contracture,[12] syndromic children with airway abnormality.[13] Since the I-Gel is devoid of an inflatable cuff, it is quicker to insert.[2] I-Gel promotes easy passage of fiberoptic scope and also an ETT as it has a wide bore stem and lacks epiglottic bars.[2]

P-LMA insertion is easier due to the absence of a rear cuff. The side by side presence of the airway tube and drainage tube prevents its rotation during insertion. This is in contrast to the cuff in LMA classic which folds on itself when deflated and makes its insertion theoretically difficult.[7]

Conclusion

Paediatric supraglottic airway devices like I-Gel and P-LMA are novel approach of securing the airway with adequate control of respiratory parameters like SpO_2 and $EtCO_2$. They are very much comparable to the stable respiratory parameters provided by ETT and hence are a suitable alternative airway devices.

Acknowledgement: We are grateful to all the surgeons, OT staff, patients', their parents/ guardian without whom this study would not have been possible.

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