

Use of the Classic Laryngeal Mask Airway Versus an Endotracheal Tube in Children Undergoing Elective Surgery in the Prone Position: A Prospective Randomized Feasibility Study

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Received date: March 05, 2018; Accepted date: April 09, 2018; Published date: April 13, 2018

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Abstract

Background: A laryngeal mask airway (LMA) has been used successfully during surgical procedures in the prone position for adults and children in some cases. In this study, we compared the use of a classic LMA versus an endotracheal tube (ETT) in children undergoing minor surgical procedures in the prone position.

Patients and methods: Forty children aged 4-8 years with an American Society of Anesthesiologists' classification of I who were undergoing elective surgery in the prone position were assigned to an airway secured by an uncuffed ETT (n=20) and or an airway secured by an LMA (n=20). SpO₂, end-tidal CO₂, heart rate, and mean arterial blood pressure were recorded before and after insertion of the LMA or ETT. The numbers of insertion attempts using the ETT or LMA were documented, along with any complications.

Results: The time taken to insert the ETT was longer than that taken to insert the LMA (15.35 ± 2.907 vs. 14.35 ± 1.843 s). No intraoperative laryngospasm was reported in either group. Bronchospasm occurred intraoperatively in 2 patients in the ETT group and in one patient in the LMA group. No device displacement was reported.

Conclusions: The classic LMA and ETT were both used successfully in spontaneously breathing children undergoing surgical procedures in the prone position. However, LMA was associated with fewer intraoperative and postoperative complications.

Keywords: Classic laryngeal mask airway; Endotracheal tube; Children; Prone position

Introduction

Insertion of an endotracheal tube requires direct laryngoscopy, which may cause sympathetic stimulation and laryngopharyngeal complications [1]. Supraglottic airway devices maintain the airway less invasively than endotracheal tubes (ETTs) [2]. The laryngeal mask airway (LMA) is a supraglottic instrument used during surgery [3]. It is widely used to maintain the airway in many surgical procedures performed under general anesthesia in children [4].

The LMA has many advantages over tracheal tubes [5], in that it is easily inserted [6], has fewer hemodynamic effects [7], and is associated with fewer complications involving the larynx and vocal cords [8,9]. Moreover, it is effective during spontaneous and positive pressure ventilation [10] and has been used successfully in adult patients requiring controlled ventilation during surgery in the prone position [11].

Maintenance of anesthesia with LMA in the prone position is controversial. Some anesthesiologists prefer LMA because of easy insertion, easy ventilation, and a low rate of dislodgement [12]. LMA has also been used to maintain the airway in spontaneously breathing patients in the prone position and to control ventilation [13]. Overall, use of LMA in surgical procedures performed with the patient in the

prone position has steadily increased [14]. In addition to its efficacy in spontaneously breathing patients in the prone position [15], it is a successful rescue device when an ETT is displaced in the prone position [16].

Ng et al. [17] reported that the LMA could be used to induce and maintain anesthesia in the prone position without any significant complications. However, there are no reports comparing the use of a classic LMA with an ETT in children undergoing elective surgery in the prone position.

In this study, we compared the use of a classic LMA versus an ETT in children undergoing minor elective surgical procedures to prove that LMA can be used safely in children in the prone position.

Patients and Methods

This study was conducted at Beni Suf University Hospital from September 2016 to April 2017 after obtaining approval from the institutional review board and university ethics committee (FM-BSU REC). The study was registered on the Pan African Clinical Trials Registry (registration number PACTR201704002105415). Written informed consent was obtained from the parents or guardians of 40 children aged 4-8 years who had an American Society of Anesthesiologists' score of I and were undergoing minor elective surgical procedures under general anesthesia in the prone position.

The exclusion criteria were as follows: 1) a head anomaly 2) Down syndrome 3) future major surgery (e.g., head and neck surgery) 4) a history or suspicion of difficult intubation or a reactive airway and 5) risk of aspiration.

Random numbers were generated by the computer for randomization and placed in sealed opaque envelopes. The patients were randomly allocated to an airway secured with an uncuffed orotracheal tube (group I; n=20) or to an airway secured using a well-lubricated LMA (group II; n=20). In group II, the LMA was of an appropriate size relative to the patient's weight; the cuff was inflated to maximum volume and absence of gas leak was confirmed. The airway was secured in both groups by an experienced anesthesiologist.

All the patients were prepared preoperatively by history-taking, examination, and routine analyses. Thirty minutes before induction of anesthesia, all patients who had taken nothing by mouth after midnight received premedication (atropine 0.01 mg/kg intramuscularly).

After transfer to the operating room, standard monitors were used, and anesthesia was induced in the supine position by inhalation of 2% sevoflurane in 100% oxygen using a facemask. Following loss of consciousness, intravenous cannulation was used. Insertion was assessed after adequate anesthesia was reached (when the pupils became central and small); if the first trial failed, a second trial was performed 30 s later.

The ETT or LMA was connected to a standard pediatric circuit, which was in turn attached to an anesthesia workstation. Correct placement of the device was confirmed by square wave capnography, adequate chest movements, chest auscultation, an end-tidal CO₂<40 mmHg, SpO₂ ≥ 95%, and absence of an audible leak. The patient was then placed in the prone position with the head turned to the lateral position; anesthesia was maintained with sevoflurane 3%-4% in 100% oxygen. Intravenous paracetamol (15 mg/kg) was administered for analgesia.

At the end of surgery, the patient was moved to the supine position and inhaled anesthetic was discontinued. After removal of the LMA or ETT (with suction in the latter case), the patient was ventilated with a facemask using 100% oxygen; after regaining consciousness, the patient was transferred to the Post-Anesthesia Care Unit

The following variables were examined:

- 1) Demographics, including age and sex, and duration and type of surgery
- 2) SpO₂, continuously monitored to detect any abnormality
- 3) End-tidal CO₂, continuously monitored to detect any abnormality
- 4) Heart rate, continuously monitored to detect any abnormality (also recorded before and after insertion of the LMA or ETT)
- 5) Mean arterial blood pressure, continuously monitored at 5-minute intervals to record any abnormality (also recorded before and after insertion of an LMA or ETT)
- 6) Number of attempts to insert an ETT or LMA
- 7) Time taken to insert the device (defined as the time interval between holding the device and successful insertion) in seconds (in the event of more than one attempt, the average time was recorded)

8) Number of episodes of coughing during insertion and after removal of the ETT or LMA (primary outcome)

9) Percentage of failed LMA insertion attempts

10) Number of patients requiring change from an LMA change to an ETT (secondary outcome).

11) Complications, including laryngospasm, bronchospasm and displacement of the device, postoperative gum injury, and blood staining on the device after removal.

Sample size and statistical analysis

The primary outcome of incidence of coughing was compared in patients after removal of an ETT and after removal of a LMA in a preliminary study to determine the sample size. Two proportions from independent samples were compared in a prospective study, using Fisher's exact test (α-error, 0.05; power, 95%); the case to control group ratio was set at 1.

According to a previous study [18], the incidence of coughing was 5% in a LMA group and 60% in an ETT group. Accordingly, the minimum sample size was 19 participants per arm. We increased the sample size to 20 per group to allow for dropout. PS Power and Sample Size Calculation version 3.0.11 (Dupont & Walton, Vanderbilt University School of Medicine, Nashville, TN, USA) was used to calculate the sample size.

The data are presented as the mean ± standard deviation, frequency (number), median and range, or percentage as appropriate. The Student's t-test was used to compare numerical variables between the groups and the chi-square test was used to compare categorical data. Alternatively, exact t-test was used if the frequency was below 5. All statistical analyses were performed using SPSS version 22 software (IBM Corp., Armonk, NY, USA). The significance level was set at 0.05.

Results

All patients completed the study (Figure 1). There were no significant differences in demographic characteristics or duration of surgery between the groups (P>0.05, Table 1).

Variables	ETT group (n=20)	LMA group (n=20)	P-value
Age (years)	6.25 ± 1.372	6.00 ± 1.451	0.579
Sex (Male/Female)	(14/6)	(12/8)	0.542
Body weight (kg)	22.67 ± 2.23	23.86 ± 2.44	0.841
Duration of surgery (min)	53.05 ± 6.353	54.20 ± 5.288	0.538
Type of surgery (release of scar, drainage of abscess, hamstring release, excision of swelling, evacuation of hematoma, burns debridement)	(2/3/4/5/2/4)	(3/4/5/4/3/1)	-

Table 1: Patient demographics and clinical characteristics. The data are presented as the mean ± standard deviation or as the number. *P ≤ 0.05 indicates a statistically significant difference. ETT: Endotracheal Tube; LMA: Laryngeal Mask Airway.

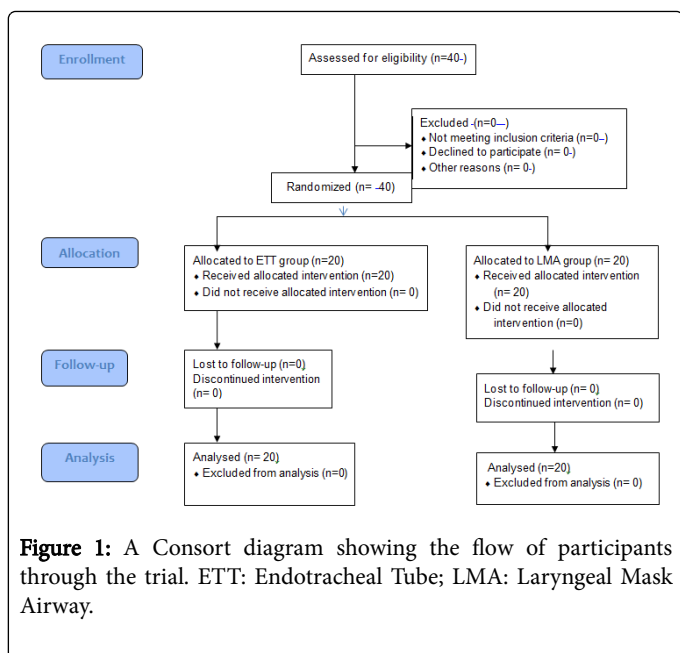


Figure 1: A Consort diagram showing the flow of participants through the trial. ETT: Endotracheal Tube; LMA: Laryngeal Mask Airway.

The SpO₂ was comparable between the LMA and ETT groups (99 ± 00 vs. 99 ± 0.1).

End-tidal CO₂ was comparable between the LMA and ETT groups (33 ± 1.3 vs. 34 ± 0.2).

There were no significant differences in heart rate or mean arterial pressure before or after the insertion of an LMA or ETT (P>0.05, Table 2).

Time	Heart rate (bpm)			MAP (mmHg)		
	ETT group (n=20)	LMA group (n=20)	P-value	ETT group (n=20)	LMA group (n=20)	P-value
Preanesthesia	115.80 ± 6.717	117.80 ± 7.245	0.371	60.80 ± 2.262	60.40 ± 3.545	0.673
After insertion	121.80 ± 5.307	121.05 ± 5.434	0.661	60.45 ± 3.086	59.50 ± 3.236	0.348

Table 2: Heart rate and mean arterial pressure. The data are presented as the mean ± standard deviation. *P ≤ 0.05 indicates a statistically significant difference. MAP: Mean arterial pressure; ETT: Endotracheal tube; LMA: Laryngeal mask airway.

The number of insertion attempts was lower for the LMA than for the ETT. Insertion of the LMA was successful in all patients on the first attempt and insertion of the ETT was successful in 17 patients on the first attempt and in the remaining 3 patients on the second attempt; no significant intergroup difference was found (P>0.05, Table 3).

The ETT took longer to insert than the LMA (15.35 ± 2.907 vs. 14.35 ± 1.843) however, no significant difference was found between the groups (P>0.05, Table 3).

Coughing was more frequent during insertion of the ETT than during insertion of the LMA (4 vs. 1), but not significantly so (P>0.05, Table 3).

No intraoperative laryngospasm was reported in either group.

Intraoperative bronchospasm was reported in 2 patients who underwent insertion of an ETT and in one patient who underwent insertion of the LMA.

	ETT group (n=20)	LMA group (n=20)	P-value
Number of attempts (1/2/3)	(17/3/0)	(20/0/0)	0.23
Time taken to insert the device (seconds)	15.35 ± 2.907	14.35 ± 1.843	0.202
Cuffing during insertion (yes/no)	(4/16)	(1/19)	0.339
Percentage of failed insertions of the device	0	0	-
Number of patients requiring exchange of the LMA for an ETT	-	0	-

Table 3: Number of attempts, time taken to insert the device, number of episodes of cuffing during insertion, percentage of failed insertion of LMA, number of patients required to exchange the LMA for an endotracheal tube. The data are presented as the mean ± standard deviation. *P ≤ 0.05 indicates a statistically significant difference. ETT: Endotracheal tube; LMA: Laryngeal Mask Airway.

No displacement of the device was reported in either group. The groups were not significantly different in this regard (P>0.05, Table 4).

Postoperative laryngospasm was reported in 2 patients who underwent insertion of an ETT but not in any of the patients who underwent insertion of the LMA

No patients in either group developed postoperative bronchospasm (P>0.05, Table 4).

	ETT group (n=20)	LMA group (n=20)	P-value
Intraoperative laryngospasm(yes/no)	(0/20)	(0/20)	-
Intraoperative bronchospasm(yes/no)	(2/18)	(1/19)	1.000
Displacement of device	0	0	-
Postoperative laryngospasm (yes/no)	(2/18)	(0/20)	0.468
Postoperative bronchospasm (yes/no)	(0/20)	(0/20)	-
Gum injury (yes/no)	(2/18)	(0/20)	0.468
Blood staining on the device after removal (yes/no)	(4/16)	(1/19)	0.339
Coughing after extubation (yes/no)	(4/16)	(1/19)	0.339

Table 4: Complications. The data are presented as the number and percentage. *P ≤ 0.05 indicates a statistically significant difference. ETT: Endotracheal Tube; LMA: Laryngeal Mask Airway.

Gum injury was reported in 2 patients who underwent insertion of an ETT but not in any of the patients who underwent insertion of the LMA.

Blood staining on the device after tube removal was observed in 4 patients who underwent insertion of an ETT and in one patient who

underwent insertion of the LMA; however, the difference was not statistically significant ($P>0.05$, Table 4).

Coughing was more common after extubation or removal of the LMA than after removal of the ETT (4 vs. 1), but not significantly so ($P>0.05$, Table 4).

Discussion

The results of this study showed that a classic LMA could be used successfully in children undergoing elective surgical procedures in the prone position and that use of this device was associated with stable hemodynamics, oxygenation and normocarbia.

In this study, no intraoperative device displacement occurred, and no patient needed to be returned to the supine position. Insertion and removal of the LMA were associated with less intraoperative bronchospasm and fewer postoperative complications (laryngospasm, bronchospasm and gum injury, blood staining on the device after removal, and coughing) than the ETT.

Different types of supraglottic airway devices are used for adult patients undergoing surgery in the prone position. Taxak et al. [19] compared i-gel and ProSeal LMA and found them to be effective. Moreover, in a study by Kang et al. [20], airway management was performed safely with i-gel and LMA in adults undergoing lumbar surgery in the prone position.

A study by López et al. [21] showed that the LMA Supreme provided adequate ventilation in adults in the prone position without airway complications. Moreover, Araújo et al. [22] used the LMA Supreme, i-gel, and Proseal in adult patients undergoing ambulatory surgery in the prone position and found them to be safe with a low incidence of complications.

Supraglottic airways are routinely used for airway management in pediatrics and emergency situations [23].

No previous study has compared the LMA and ETT in children undergoing surgical procedures in the prone position. Further, although there have been some studies of use of the LMA in adults in the prone position; the relevant literature in children is limited.

Several case reports have indicated successful application of supraglottic devices in children in the prone position [24]. Gable et al. [3] reported successful use of the LMA in a 6-year-old child who required bilateral hamstring tendon release and Achilles tendon lengthening in the prone position; the device was able to maintain spontaneous ventilation without any intraoperative complications. Moreover, Dingeman et al. [25] used an LMA for decompressive craniectomy in a 5-year-old child, who was accidentally extubated in the prone position. Similarly, Taxak and Gopinath used an i-gel in a neonate (2.65 kg) after sudden extubation in the prone position during meningomyelocele surgery [26].

A meta-analysis by Luce et al. [27] showed that the incidence of postoperative desaturation, laryngospasm, and coughing decreased when an LMA was used instead of an ETT in children.

In 2009, Saxena [18] reported that use of an ETT was significantly associated with more postoperative coughing, desaturation, laryngospasm, and reintubation than an LMA in children underwent probing of a congenitally blocked nasolacrimal duct. Coughing occurred in 12 patients in the ETT group and in one patient in the LMA group. Desaturation occurred in 9 patients and laryngospasm in

3 patients. Reintubation was required in 2 patients in the ETT group, but whether any patients in the LMA group was not reported. Blood and irrigating fluid irritate the vocal cords; however, no irrigating fluid was used in our study as because patients undergoing head and neck surgery were excluded. However, a study by Afzal [28] demonstrated that the incidence of intraoperative complications was not significantly different between the LMA and ETT groups in children undergoing lower abdominal surgery. Moreover, a systematic review by Yu and Beirne [29] showed that compared to an ETT, a LMA, which causes no vocal cord trauma, was significantly associated with a lower rate of laryngospasm (both clinically and statistically), coughing, and postoperative hoarseness. The differences between the results of the present study and the other studies could reflect the different age groups and different types of surgical procedures performed.

This study has some limitations, the main one being its small sample size, ASA I patients only were studied. Future studies are recommended in larger patient groups with controlled ventilation using the different types of supraglottic airway devices.

Conclusion

Both classic LMA and ETT were successfully used in spontaneously breathing children undergoing elective minor surgery in the prone position. However, the LMA was associated with fewer intraoperative and postoperative complications than the ETT, albeit not significantly so.

Ethics Approval and Consent to Participate

The study and recruitment was started only after obtaining an approval from the Research and Ethics Committee (Faculty of Medicine, Beni-Suef University). A written informed consent was obtained from the participants' parents or guardians.

Acknowledgements

None

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