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Original Scientific Paper

COMPARISON OF FLEXIBLE LARYNGEAL MASK INSERTION AND ENDOTRACHEAL INTUBATION IN ADENOTONSILLECTOMY SURGERY

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SUMMARY – This study compared the effectiveness of flexible laryngeal mask (F-LMA) insertion and endotracheal intubation in pediatric patients undergoing adenotonsillectomy surgery. A total of 60 patients aged 2-12 years were included in the study. Patients were divided into the F-LMA group (n=30) and endotracheal tube (ETT) group (n=30). The groups were compared according to intubation time, heart rate, SpO_2, $EtCO_2$, airway pressure, surgical field of view, and recovery time. Both the insertion time and recovery time were shorter in the F-LMA group than in the ETT group (16.93±4.84 s *vs.* 23.93±8.74 s; and 10±2 min *vs.* 14.5±3 min; p<0.001 both). The airway pressure measurements at 5-min intervals were significantly lower in the F-LMA group than in the ETT group (p<0.001). F-LMA may be a useful alternative to ETT for adenotonsillectomy surgery because it is safe, provides shorter induction and recovery times, reduces intraoperative airway pressure, and provides an adequate operative field of view.

Key words: *Adenotonsillectomy; Endotracheal tube; Flexible laryngeal mask airway; Airway pressure; Operative field of view*

Introduction

Adenotonsillectomy is one of the most common surgeries performed in childhood around the world. Endotracheal intubation (ETT) is considered the standard procedure in this surgery, as it allows control and protection of the patient's airway and provides a good surgical field of view, especially when the patient is under general anesthesia[1]. In anesthesia for pediatric adenotonsillectomy, increased infectious and inflammatory hyper-reactivity and the presence of secretions and blood in the oropharynx significantly increase the rates of respiratory complications such as bronchospasm and laryngospasm.

General anesthesia with a laryngeal mask airway (LMA) has some advantages over ETT, including fewer complications, better hemodynamic stability, quicker insertion time, and shorter recovery time. Due to these advantages, the use of LMA anesthesia in one-day anesthesia has been increasing[1,2]. However, comparisons in the literature showed no difference in the rate of laryngospasm between LMA and ETT. Nevertheless, the time required for extubation was significantly reduced in patients in whom LMA was used, and LMA was determined to be an effective alternative to ETT in pediatric adenotonsillectomy[3,4].

In adenotonsillectomy, there is continuing controversy regarding classic LMA use. Specifically, the use of an LMA presents challenges in terms of safe airway management and airway complications. More-

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over, LMA dislocation and gas leakage can occur during positioning of the patient's head and flexion can occur during the operation[5,6]. However, we believe that a flexible LMA (F-LMA) will provide adequate ventilation, reduce respiratory complications, offer an adequate surgical view, and provide rapid recovery in adenotonsillectomy surgery.

This study compared the effectiveness of F-LMA insertion with ETT in pediatric patients undergoing adenotonsillectomy surgery.

Patients and Methods

Approval was obtained from the Ethics Committee of the Faculty of Medicine, Adıyaman University, Adıyaman, Turkey (2015/3-15) prior to commencement of the study.

Power analysis was performed using G* Power 3.1 to calculate sample sizes for the F-LMA and ETT groups[7]. In a previous study, power analysis was performed based on differences in heart rate (HR) detected between ETT and LMA groups, and the effect size was calculated as 0.8[8]. With an effect size, calculated at the 95% confidence level, of 0.8 and power taken as 80%, it would be necessary to include 26 patients in each group. Taking into account possible dropouts and data loss for various reasons, we planned to include 30 patients in each group.

A total of 60 patients aged 2-12 years in the American Society of Anesthesiologists (ASA) classes 1 and 2 undergoing elective adenotonsillectomy surgery were included in the study. Patients with airway anomalies, difficulty with intubation, allergies to anesthetic drugs, gastroesophageal reflux, upper respiratory tract infections, and body mass index (BMI) >30 were excluded from the study.

Study groups

After obtaining informed consent, patients were divided into the F-LMA group (n=30) and ETT group (n=30) using the sealed envelope method.

Preoperative preparation

Children fasted for 6 h for solid foods, 4 h for breast milk and 2 h for clear liquids before the intervention. Patients were pre-medicated with 0.3 mg/kg of oral midazolam for 30 min in the preoperative room before undergoing the intervention. Electrocardiogram (ECG), HR, peripheral oxygen saturation (SpO_2) and noninvasive blood pressure monitoring were performed once the patient was taken into the operating theater.

General anesthesia

All patients were pre-oxygenated with 100% oxygen at a flow rate of 3 L/min before the induction of anesthesia. Anesthesia was induced by descending administration of sevoflurane (from 8% to 2%) in a mixture of 50% N_2O and 50% O_2. After intravenous administration, 2 mg/kg of propofol and 1-1.5 μg/kg of fentanyl were added.

In the F-LMA group, controlled manual ventilation was performed until further deepening of anesthesia and loss of the eyelash reflex occurred. The recommendations of the manufacturer based on the patient's weight were considered while selecting which F-LMA size to use. The laryngeal mask cuff was inflated and connected to the ventilator circuit. Interventions that could not be performed despite a second attempt were considered unsuccessful insertions. These patients were intubated and excluded from the study.

In the ETT group, an additional 0.6 mg/kg of rocuronium was administered for induction. After waiting for 120 s, the patient was intubated with direct laryngoscopy using an appropriately sized spiral intubation tube which was connected to the ventilation circuit. After listening to bilateral lung sounds, bilateral chest wall expansion monitoring and determination of end-tidal carbon dioxide ($EtCO_2$) traces by capnography were conducted in both groups of patients. Moreover, volume-controlled ventilation (breath volume of 8 mL/kg, inspiratory/expiratory ratio of 1:2 and respiratory rate of $EtCO_2$ of 30-35 mm Hg) was applied. Anesthesia maintenance was provided with 2%-3% sevoflurane in a 50% O_2/N_2O mixture. The time between removal of the surgical mask and monitoring of the first $EtCO_2$ wave was recorded as the insertion time.

Procedures

The HR, SpO_2,$EtCO_2$ and airway pressure values were recorded in the preoperative period and after intubation at 1st, 5th, 10th and 15th minutes. Surgical field of view (1: bad; 2: moderate; 3: good; 4: very good) was recorded after consultation with the surgeon. The operation was terminated after removal of adenotonsillar tissues by curettage, maintenance of homeostasis, and aspiration of the oral cavity. Paracetamol was admin-

istered (10 mg/kg, i.v.) for postoperative analgesia. Complications (cough, hiccough, laryngospasm, stridor, bronchospasm, desaturation, and traumatic hemorrhage) that occurred during insertion were recorded.

At the end of the operation, 0.05 mg/kg of neostigmine methyl sulfate and 0.02 mg/kg of atropine sulfate were administered in the intubation group for neuromuscular antagonism. Mask ventilation was initiated when the spontaneous breathing effort was sufficient in both groups. Recovery times were recorded as the time in minutes between extubation and admission to the post-anesthetic care unit (PACU). Patients were monitored postoperatively in the PACU. In addition, patients were closely monitored for side effects such as bleeding, hoarseness, sore throat, nausea, vomiting, and agitation.

Statistical analysis

The mean, standard deviation, minimum and maximum values were used for descriptive statistics of continuous variables, and the number and percentage were used for categorical variables. Differences between the groups and correlations between variables were investigated with the Kruskal-Wallis test, χ^2-test, and analysis of variance. Results were assessed at a 95% confidence level and $p<0.05$ was taken to indicate statistical significance. Statistical analyses were performed using SPSS (version 18; SPSS Inc., Chicago, IL, USA).

Results

A total of 60 pediatric patients aged 2-12 years, i.e., 28 (47%) boys and 32 (53%) girls (30 in each group) were included in the study. There were no differences between the two groups according to age (p=0.929), sex (p=1.0), weight (p=0.610) and ASA class (p=0.500) (Table 1).

The intubation time was significantly shorter in the F-LMA group (16.93±4.84 s) than in the ETT group (23.93±8.74 s) (p=0.001). The recovery time was significantly shorter in the F-LMA group (10.07±1.63 min) than in the ETT group (14.53±2.99 min) (p=0.001). There was no difference between the two groups in terms of surgical field of view, which was classified as good in both groups (p=0.090) (Table 1).

Table 1. Demographic and operative data

	F-LMA group (n=30)	ETT group (n=30)	p value
Age (years)	7.30±2.80 (7)	6.5±2.7 (6)	0.929
Gender (F/M) (n)	16 (53%)/14 (47%)	16 (53%)/14 (47%)	1.000
Weight (kg)	20.77±6.25	22.27±8.20	0.610
ASA (1/2) (n/%)	28 (93%)/2 (7%)	29 (97%)/1 (3%)	0.500
Intubation time (s)	16.93±4.84	23.93±8.74	**0.001**
Recovery time (min)	10.07±1.63	14.53±2.99	**0.001**
Duration of surgery (min)	25.07±5.19	25.23±5.44	0.429
Surgical view (3/4) (n/%)	22(73%) / 8(27)	16(53%) / 14(47%)	0.090
Complications	1 (3.3%)	2 (6.6%)	0.500

Data are presented as mean ± standard deviation (SD) or numbers and percentages; significant values are given in bold (p<0.05); F-LMA = flexible laryngeal mask airway; ETT = endotracheal tube; ASA = American Society of Anesthesiologists Classification

No clinical difference was found in HR, $SpO_2$and $EtCO_2$values at 1st, 5th, 10th, and 15th minute of intubation between the two patient groups (Table 2).

Endotracheal intubation was begun after inserting mouth openers in two patients (6.25%) in the F-LMA group. During the postoperative period in both groups,

Table 2. Comparison of hemodynamic data between the groups

		F-LMA group (n=30)	ETT group (n=30)	p value
HR	Preoperatively	111.97±15.27	121.33±10.31	**0.007**
	After int.1th min	114.17±16.17	123.23±20.57	0.063
	After int.5th min	113.73±27.51	124.37±15.42	0.700
	After int.10th min	114.17±17.37	122.10±13.17	0.510
	After int.15th min	110.47±15.66	121.60±11.71	**0.003**
SpO_2	Preoperatively	99.37±0.92	99.47±0.86	0.667
	After int.1th min	99.77±0.50	99.03±0.92	**0.001**
	After int.5th min	99.57±0.97	99.07±1.11	0.069
	After int.10th min	99.73±0.58	99.27±0.78	**0.011**
	After int.15th min	99.50±1.19	99.17±1.02	0.250
$EtC0_2$	After int.1th min	36.83±3.13	36.73±5.55	0.932
	After int.5th min	37.80±3.17	37.10±5.68	0.558
	After int.10th min	38.20±3.12	38.13±4.93	0.950
	After int.15th min	36.87±3.21	37.83±4.55	0.346

Values are mean ± SD; significant values are given in bold (p<0.05); F-LMA = flexible laryngeal mask airway; ETT = endotracheal tube; HR = heart rate; SpO_2 = percutaneous saturation percentage of oxygen; $EtCO_2$ = end-tidal carbon dioxide; After int. = after intubation

The airway pressure measurements at 5-min intervals were significantly lower in the F-LMA group than in the ETT group (p<0.001) (Table 3).

each patient developed laryngospasm and one patient in the ETT group developed bronchospasm. All three patients were successfully treated with medical ap-

Table 3. Comparison of airway pressures between the groups

	F-LMA group (n=30)	ETT group (n=30)	p value
After int.1th min	13.23±1.98	16.40±2.60	**<0.001**
After int.5th min	12.96±2.88	16.22±2.90	**<0.001**
After int.10th min	13.50±2.06	16.33±3.55	**<0.001**
After int.15th min	13.36±1.92	16.43±3.40	**<0.001**

Values are mean ± SD; significant values are given in bold (p<0.05); F-LMA = flexible laryngeal mask airway; ETT = endotracheal tube; After int. = after intubation

proach. Demographic features including age, weight, sex, ASA class, intubation time, recovery time, duration of surgery and development of complications are shown in Table 1.

Discussion

This study compared two different airway instruments in patients undergoing adenotonsillectomy under general anesthesia. Our findings indicated the use of F-LMA in pediatric adenotonsillectomy surgery to be safe, shorten induction and recovery times, decrease intraoperative airway pressures, and be similar to ETT in terms of complication rates and surgical field of view.

The use of F-LMA under general anesthesia is frequently preferred in short- and medium-term surgeries in children[9,10]. F-LMA is a good alternative to ETT, especially in outpatient surgeries. The use of F-LMA shortens the duration of stay in the operating theater and eliminates the need for muscle relaxants. Therefore, the use of choline esterase inhibitors, which have side effects such as bradycardia, bronchoconstriction and hypersalivation, is not required[2,11]. In a comparative study, Peng *et al*.[4] report that there was no difference between F-LMA insertion and ETT in terms of the rate of laryngospasm, the extubation time was significantly shorter in patients receiving F-LMA than in those with ETT, and F-LMA was an effective alternative to ETT in pediatric adenotonsillectomy. Lalwani *et al*.[12] report that appropriate patient selection, careful insertion and controlled ventilation in F-LMA use can decrease the incidence of complications.

In addition, Kretz *et al*.[13] report that F-LMA can be used safely in adenotonsillectomy surgeries when it provides better coordination with the surgeon. The complication rates in our study were similar in the two groups. During the postoperative period in both groups, each patient developed laryngospasm and one patient in the ETT group developed bronchospasm. Consistent with previous reports, our results showed that F-LMA could be used safely in adenotonsillectomy surgery, being a good alternative to ETT.

Bağuş *et al*.[14] report that the insertion time for different LMAs ranged from 19.80 to 20.28 s in pediatric patients. Similarly, Lardner *et al*.[15] report an average insertion time for classic and ProSeal LMAs of 45 s in pediatric patients. In the present study, the F-LMA insertion time was 16.93 s, which is shorter than in previous studies. This may have been due to different LMA models used in other studies.

Peng *et al*.[4] compared ETT and LMA insertion and report that the extubation time was by 4.06 min shorter in patients treated using LMA compared to ETT. Joshi *et al*.[16] report lower intraoperative narcotic requirements and reduced time spent in the PACU in patients receiving LMA as compared with ETT. Similar to Peng *et al*.[4], we found that the extubation time was shorter in the F-LMA group than in the ETT group. This may have been associated with the shorter extubation time in the F-LMA group, as muscle relaxants were not used.

Lalwani *et al*.[12] report an F-LMA failure rate of 6.8%. Other studies report success rates for F-LMA insertion ranging from 67% to 99% in children[17-19]. In the present study, failed F-LMA insertion occurred in two patients, yielding a failure rate of 6.25%, which is consistent with the literature.

Mahdavi *et al*.[20] report that the peak inspiratory pressure was lower during the use of F-LMA in children under mechanical ventilation than during the use of ETT. Özden *et al*. compared F-LMA use with non-cuffed ETT in terms of postoperative airway complications and found lower airway pressures in the F-LMA group. They conclude that F-LMA is a more appropriate airway tool than endotracheal tube for use in infants[21]. Consistent with the literature, we found that the airway pressure was lower in the F-LMA group than in the ETT group. In the present study, the SpO_2 values at 1st and 5th min were lower in the ETT group than in the F-LMA group, but these differences were not clinically significant.

To our knowledge, there are few studies prospectively comparing LMA and ETT in terms of perioperative adverse events and operative, anesthesia and recovery times in pediatric adenotonsillectomy.

The strength of the current study is that it included a standardized anesthesia protocol. This study had a few limitations. It was carried out in a tertiary medical center. Therefore, results cannot be generalized to a community hospital setting or an outpatient center. Lastly, more research is needed to determine cost analysis of LMA and ETT in adenotonsillectomy.

Conclusion

The results presented here suggest that the use of F-LMA in pediatric adenotonsillectomy surgery is safe and provides shorter induction and recovery times than ETT. F-LMA also reduces intraoperative airway pressure and is similar to ETT in terms of complication rates and surgical field of view. Therefore, F-LMA use may be a useful alternative to ETT in pediatric adenotonsillectomy surgery.

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Sažetak

USPOREDBA UČINKOVITOSTI FLEKSIBILNE LARINGEALNE MASKE I ENDOTRAHEALNE INTUBACIJE KOD ADENOTONZILEKTOMIJE

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U ovom istraživanju usporedili smo učinkovitost postavljanja fleksibilne laringealne maske (F-LMA) i endotrahealne intubacije (ETT) u pedijatrijskih bolesnika podvrgnutih adenotonzilektomiji. U studiju je bilo uključeno ukupno 60 bolesnika u dobi od 2-12 godina. Bolesnici su podijeljeni u dvije skupine, F-LMA i ETT, od po 30 bolesnika. Ove dvije skupine uspoređene su prema sljedećim parametrima: trajanje intubacije, srčani ritam, SpO_2, $EtCO_2$, tlak dišnih putova, kirurško vidno polje i vrijeme oporavka. Vrijeme postavljanja kao i vrijeme oporavka bili su kraći u skupini F-LMA nego u skupini ETT (16,93±4,84 s prema 23,93±8,74 s, p=0,001; 10±2 min prema 14,5±3 min, p<0,001). Tlak dišnih putova mjeren u 5-minutnim razmacima bio je značajno niži u skupini F-LMA u usporedbi sa skupinom ETT (p<0,001). F-LMA mogla bi biti korisna alternativa za ETT kod adenotonzilektomije, jer je sigurna, omogućava kraće vrijeme indukcije i oporavka, snižava intraoperacijski tlak u dišnim putovima te osigurava odgovarajuće operativno vidno polje.

Key words: *Adenotonzilektomija; Endotrahealna intubacija; Fleksibilna laringealna maska; Tlak dišnih putova; Operativno vidno polje*