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Research Article

Comparing the Use of the Flexible Laryngeal Mask Airway Versus the Endotracheal Tube in Upper Airway Surgery

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Abstract

Objectives: The use of a flexible laryngeal mask (FLMA) during tonsillectomy and nasal/sinus surgery has been a controversial issue due to concerns regarding its efficacy in securing the airway and preventing potential airway complications like aspiration. This study aims at assessing the efficacy and safety of FLMA in upper airway surgery compared to the use of the standard endotracheal tube (ETT).

Method: Retrospective chart review of 229 patients who had undergone tonsillectomy alone or combined with nasal/sinus surgery, and whose airway was maintained with either a FLMA or ETT at our institution between 2016-2019. Adult and pediatric patients were included. Patient demographics, conversion rate from FLMA to ETT, LMA size modification rate, and LMA vs ETT related complications, induction time and extubation time were recorded for both groups and compared.

Results: 229 patients (128 pediatrics and 101 adults) had tonsillectomy alone or tonsillectomy combined with nasal/sinus surgery. 179 patients received FLMA, while 50 had an ETT during their surgery.

Conversion from LMA to ETT was carried out in only two adult cases (0.009%); one due to inadequate oral-pharyngeal space to perform tonsillectomy, and 1 due to an air leak after tonsillectomy requiring a larger size FLMA. None of the patients in the FLMA group developed aspiration pneumonia, bronchitis, or any other pulmonary complication. Two patients in the FLMA group developed cough 1 month postoperatively due to documented laryngeal reflux. All patients were discharged home on the same day of surgery except 1 adult patient with an ETT who was admitted overnight for monitoring due to postoperative desaturation and tachycardia.

The mean induction time and extubation time were both shorter when FLMA was used. The difference in the induction time was statistically significant (11.5 min ± 09 for ETT vs 7.8 min ± 0.3 for FLMA, $P = 0.0003$), as was the difference in extubation time (9.8 min ± 1.1 for ETT vs 7.1 min ± 0.4 for FLMA, $P < 0.05$).

Limitations: Retrospective chart review.

Conclusion: The use of a Flexible laryngeal mask airway is very safe and effective during upper airway surgery with minimal risk of pulmonary or cardiac complications and has the additional benefit of shorter induction and extubation time.

Keywords: Airway Surgery; Flexible Laryngeal Mask Airway; Endotracheal Tube

Introduction

In 1991 the Food and Drug Administration approved the use of the laryngeal mask for airway management in the USA [1]. The Flexible Laryngeal Mask Airway (FLMA) is easily inserted and forms a low-pressure seal above the laryngeal inlet with a minimal risk of dental, oropharyngeal or laryngeal trauma.

FLMA's placement in the supraglottic area, above the laryngeal inlet, avoids irritation or trauma of vocal folds or luminal surface of the trachea [2,4] and is associated with decreased intra-operative cardiac and respiratory stimulation in comparison with the Endotracheal Tube (ETT). This results in a lower heart rate and blood pressure [4] often needed for patients with cardiopulmonary disease [5], and for patients undergoing upper airway surgeries that require reduced mean blood pressure (i.e. endoscopic sinus surgery) [1,6]. Furthermore, FLMA allows awake extubation, when the patient is capable of protecting the airway resulting in shorter operating room time [7], significantly better postoperative mean oxygen saturation, less coughing [8,9] and less laryngopharyngeal spasm [5,10].

However, despite FLMA's appealing features and the growing evidence of being a safe and effective alternative to the ETT in the majority of ENT operations [11-13], adoption of the FLMA by anesthesiologists was slow. During tonsillectomy and nasal/sinus surgery, where the airway is shared between the surgeon and anaesthetist, a lot of skepticism and controversy remains. The major concern is related to the ability of the FLMA to secure the airway in the face of upper airway bleeding and a perceived increased risk of airway complications like aspiration and laryngospasm [12,13].

In addition, the otolaryngology community has concerns related to suboptimal surgical visualization in adenotonsillectomy surgery and the need to convert to an ETT due to an air leak, kinking of the flexible tube, or displacement of the FLMA upon insertion of the Davis mouth gag [12].

Our study aims at assessing the efficacy and safety of the FLMA in upper airway surgery compared to the use of the standard ETT in patients undergoing upper airway and nasal surgery, and its impact on surgical efficiency by reducing OR time.

Methods

After obtaining IRB approval, we performed retrospective chart review for all patients who had undergone tonsillectomy alone or tonsillectomy combined with nasal surgery at our institution between January 1, 2016, and December 30, 2019. All surgeries were performed by the same two attending surgeons (A and B).

Table 1 shows the medical co-morbidities for patients in each of the groups (ETT vs FLMA). Laryngeal reflux disease (LPR), atopy, and asthma were the most common. The percentage of patients with LPR in each group was 18% and 11%, respectively. For atopy, the percentages were 20% and 7%, respectively, and for asthma they were 12% and 10%, respectively.

Complications	Laryngeal Mask Patients		Endotracheal Tube Patients	
	Pediatric (122 patients)	Adult (84 Patients)	Pediatric (16 Patients)	Adult (37 Patients)
Cough	1*	1*	0	0
Aspiration Pneumonia	0	0	0	0
Post-Operative Desaturation	0	0	0	2
Post-Operative Admission	0	0	0	1

Table 1: Complications for FLMA vs ETT.

*Related to LPR in each case.

ASA category (1-4) was also reported for each patient. In the ETT vs FLMA groups, ASA 1 was present in 42% vs 50%, respectively, whereas ASA 2 was present in 52% vs 43%, respectively. ASA 3 was reported in 6% of each group and there were no patients with ASA 4 in this study.

An appropriately sized FLMA was placed according to the weight of the adult/child as recommended by the manufacturer [15], unless the patient is having tonsillectomy in which case we used an FLMA one size smaller to improve surgical visualization. In one adult case, this smaller FMLA needed to be replaced by a larger size after tonsillectomy.

Patients were divided into two groups based on whether an FLMA or ETT was used during the surgery. Based on personal experience Surgeon A used the FLMA for all cases, whereas Surgeon

B used the ETT. This decision was not based on any patient factors such as BMI, extent of surgery, tonsil size, patient age, etc. Surgeon A had been using the FLMA for the previous 12 years without incident. This eliminated any selection bias in the type of airway used as it was based solely on the surgeon's experience. Patient demographics, induction time, extubation time, conversion rate from FLMA to ETT, FLMA size modification rate, and any airway related complications including aspiration pneumonia, overnight stay for airway management, and chronic cough were reviewed.

Welch's Independent Student's test was used to determine differences in both induction and extubation time between FLMA and ETT groups.

Results

229 patients (128 pediatrics and 101 adults) had tonsillectomy alone or tonsillectomy combined with nasal surgery between 2016-2019. 179 patients out of 229 patients had an FLMA, while 50 had an ETT for airway management.

Overall, the average patient age in the FLMA group was 19 years; 63% were <18 years and 48% were male. The ETT group had an average age of 28 years; 30% were <18 years and 47% were male.

Conversion from FLMA to an ETT occurred in two adult cases (0.009%), one due to failed ventilation and one due to inadequate oral space to perform tonsillectomy. LMA size modification was only needed in 2 cases (0.009%). In one case the LMA was downsized for better fitting and ventilation and one was upgraded after tonsillectomy due to an air leak.

Table illustrates ETT and FLMA airway related complications. None of the patients in the FLMA group developed post-operative desaturation or aspiration pneumonia and only 1 patient (1/206) developed cough 1 month postoperative due to laryngo-esophageal reflux. No one in the ETT group developed cough. All patients in our study were discharged home on the same day of the surgery except for 1 adult patient in the ETT group who was admitted for monitoring because of postoperative desaturation and tachycardia.

The mean induction time and extubation time for surgery were consistently shorter when FLMA was used (Figure 1). The difference in the induction time was statistically significant for all surgeries combined (11.5 min ± 09 for ETT vs 7.8 min ± 0.3 for FLMA, P = 0.0003). The mean extubation time was also consistently shorter when using FLMA (9.8 min ± 1.1 for ETT vs 7.1 min ± 0.4 for FLMA, P < 0.05) (Figure 1).

Figure 1: Airway complications related to FLMA and ETT.

Tonsillectomy alone was performed in 29 patients; 14 were in the FLMA group and 15 in the ETT group. The indication for tonsillectomy was chronic tonsillitis in 53% (FMLA) and 56% (ETT), respectively, with the remainder in each group being done for sleep disordered breathing. Nasal and sinus surgery with tonsillectomy was performed in 111 children and 54 adults in the FLMA group and 15 children and 20 adults in the ETT group. Septoplasty was performed in 83% of all patients, endoscopic sinus surgery in 81%, and turbinate reduction in all those undergoing nasal surgery.

Discussion

The safety of FLMA during ENT upper airway surgery has been extensively studied and compared to the ETT. There have been two primary concerns that have hindered widespread FLMA use. The first is the risk of airway soiling with blood produced during surgery, and the second is the risk of aspiration from acid reflux.

However, the literature shows that the risk of aspiration from acid reflux is similar between patients receiving the FLMA vs the ETT [14,15]. During nasal surgery, the head is slightly elevated - a favorable position - and provides extra-protection against the regurgitation of gastric contents and allows easier diaphragm movement [15]. In 1991, John., *et al*. performed a study on 64 patients undergoing surgery using an LMA. The placed a fiberoptic laryngoscope through the LMA lumen to view the laryngeal inlet, while at the same time placing methylene blue dye into the pharynx

of the patients. The larynx was viewed at various points during the surgery, but there was no evidence of dye in the larynx or on the inner surface of the FLMA [16].

The FLMA is designed to protect the airway by isolating it from the pharynx and directing any blood and secretions into the pyriform fossa. Coupled with the ability to perform an "awake" extubation (meaning the patient has regained their protective airway reflexes), and the ability to suction all secretions from the superior surface of the FLMA prior to extubation, makes use of the FLMA extremely safe [6,17,18].

In contrast, blood pooling around the ETT would seep into the subglottic area above the endotracheal cuff, an area that is inaccessible to the suction and difficult to visualize, jeopardizing the lower airway upon deflation of the cuff during extubation [17].

None of our study patients developed aspiration pneumonia. An essential routine practice at our institution is suctioning of secretions and blood from the oropharynx by the surgeon at the end of the surgical procedure, and prior to extubation, using a soft tip suction catheter.

Another area of concern upon selecting the best anesthetic airway is the incidence of cough during emergence from anesthesia or in the immediate postoperative period. This may increase venous congestion in the head and neck and consequently exacerbate postoperative bleeding [10]. A meta-analysis of 19 studies comparing the LMA to the ETT in pediatrics demonstrated that cough may actually be lower among FLMA patients [19].

Our study has shown that both induction time and extubation time is statistically shorter when FLMA is used. The FLMA is usually removed when the patient is able to open their eyes and mouth [23]. The vast majority of our patients were moved safely to the post anesthesia care unit with the FLMA still in place, allowing for quicker room turnover and more efficient use of the OR. This was not possible with an ETT.

The shorter extubation time is possible because the level of anesthesia can be lessened toward the end of surgery as the FLMA is not as stimulating to the airway as the ETT. For this same reason, the FLMA does not require neuromuscular blocking agents. Thus, OR time can be reduced and OR utilization increased when compared to using the ETT [6,10]. Doksrod., *et al*. showed in their study on adenotonsillectomy in children [21], and Webster., *et al*. also showed that during intranasal surgery in adults and children [22], a decrease in time from the end of surgery to OR exit in patients receiving an LMA in comparison to those with an ETT. In both studies, the anesthesia team was able to move LMA patients to recovery room with the LMA still in place, while ETT patients had to be kept in the OR to ensure a safe extubation [21,22].

Conflicted data is available regarding the impact of the FLMA on tonsil visualization during tonsillectomy, which might indicate that surgical field visualization is surgeon dependent. After performing 206 tonsillectomies alone, or tonsillectomy combined with nasal surgery, we believe the surgeon's experience using the FLMA plays a crucial rule in placing a Crowe-Davis mouth gag without causing FLMA displacement or compromising surgical visualization.

Additionally, the authors recommend the usage of an FLMA that is a one size smaller to improve surgical visualization during tonsillectomy, and not securing the FLMA to the face to provide maximum flexibility to the surgeon for adjusting its location for better visualization. Proper communications between the ENT team and anesthesia team during this time in required.

Five patients out of 54 enrolled in Webster's study had their LMA converted to an ETT, as 3/5 developed airway obstruction upon opening the Boyle-Davis gag. All cases of induced airway obstruction happened early in their study, most likely due to inadequate anesthesia causing laryngospasm, a problem that was later solved by increasing the depth of anesthesia [22].

The conversion rate from FLMA to ETT, and FLMA size modification rates were very low in this study and likely reflects the experience between the anesthesia and surgical teams.

Some airway device experts recommend that anesthesiologists develop experience with the FLMA first in non-otolaryngic surgery, before proceeding to upper airway surgery where the airway is shared between the ENT team and anesthesia team [22].

The medical co-morbidities in our patient population are very common and did not adversely affect patient outcomes or surgical risks. Only 1 patient developed a cough a few days AFTER surgery that was diagnosed secondary to LPR. One other patient in the

ETT group developed some desaturation and tachycardia in the PACU requiring 23-hour observation. She had no pre-operative co-morbidities and was discharged home the next day without incident. While there were some differences in the incidence of medical co-morbidities between groups, complications or adverse events related to them were absent, therefore rendering them less significant in terms of airway management than one might have expected.

Given the previously mentioned advantages of the FLMA, in our experience, the FLMA is the airway of choice in upper airway surgery.

Conclusion

When compared to the ETT, use of the Flexible LMA is very safe and effective during upper airway surgery and allows for shorter induction and extubation times with minimal risk of pulmonary or cardiac complications.

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