REVIEW ARTICLE

THE IMPACT OF ENDOTRACHEAL TUBE VS. LARYNGEAL MASK AIRWAY ON THE INCIDENCE OF POSTOPERATIVE NAUSEA AND VOMITING: A SYSTEMIC REVIEW AND META-ANALYSIS

JAHAN PORHOMAYON*, SINA DAVARI FARID**, ALI A. EL-SOLH***, GHAZALEH A DLPARVAR**** AND NADER D. NADER*****

Abstract

Objective: To investigate the impact of Endotracheal tube (ETT) vs. Laryngeal Mask Airway (LMA) on postoperative nausea and vomiting (PONV) in patients undergoing surgery with general anesthesia.

Methods: Key words searching from databases such as Medline, Embase, and Cochrane library provided 14 studies focusing on the use of EET vs. LMA for general anesthesia. Pooled estimate of relative risk with 95% confidence interval using random effect model was conducted.

Results: 14 studies were selected for meta-analysis with a total of 1866 patients. 9 studies focused on the outcome of PONV in adult patients. It showed incidence of PONV with of LMA and ETT in adult of about 204/690 (30%) and 145/725 (20%) respectively with [Odds Ratio (OR) = 1.69, 95% CI, 0.76-3.75, P = 0.20]. Heterogeneity was high (I² = 87%). Five studies focused on the outcome of PONV in pediatric patients with PONV in LMA and ETT group of 85/229 (37%) and 72/222 (32%) respectively with (OR = 1.30, 95% CI, 0.61-2.76, P = 0.50). Heterogeneity was moderate at (I² = 53%). When all patients were combined heterogeneity was high at 81% with OR = 1.56, 95% CI, 0.87-2.79, P = 0.14.

Conclusion: Risk of PONV shows an increase trend toward the use of LMA. Larger randomized trials are needed to assess the impact of airway devices on PONV.

Keywords: Postoperative, Nausea and Vomiting, Endotracheal Tube, Laryngeal Mask Airway.

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Introduction

PONV remain a common problem occurring in 20-30% of surgical population, and can be as high as 70-80% in the high risk population. It increases cost, and delays discharge, and decreases patient satisfaction. In this analysis, nausea is defined as uncomfortable feeling of stomach which might lead to the eagerness to vomit, while vomiting refers the actual motion of throwing up.

PONV could lead to pulmonary aspiration of gastric content and may lead to aspiration pneumonia with potentially fatal consequences. Our current knowledge outlines several well-established risk factors for the occurrence of PONV. These risk factors include: patient, anesthesia and surgical risk specific risk factors. The patient specific risk factors include, female gender, history of PONV or motion sickness, non-smoking status, age greater than or equal to three, and family history of PONV in children. Anesthesia related risk factors include volatile anesthetics, use of Nitrous oxide, and opioid use. There is also a dose relation between volatile anesthetics and opioids. Surgical risk factors include duration of surgery and type of procedure, in particular strabismus correction in children and laparoscopic procedures.

In addition to these well-established risk factors, there are other etiologies for development of PONV such as, the lower American society of anesthesiology (ASA) classification, the use of large doses of neostigmine (>2.5mg), restrictive vs. liberal intraoperative fluid strategy, ventilation mode, starvation nausea, heartburn, anxiety, depression, Hepatitis C, P450 inducers/suppressors (medications and food), migraines, and ethnicity. However, the role of airway devices and its impact on the incidence of PONV remains controversial. Therefore, the following systematic review was conducted to study the influence of airway devices on the incidence of PONV.

Materials and Methods

We conducted databases searches from Embase, Cochrane, Medline with the term “Laryngeal mask AND Endotracheal tube AND Post-operative AND Nausea AND Vomiting”. Abstracts were reviewed and only prospective RCTs included. A total of 6568 articles were identified. 5967 were excluded because it was not related to risk factors or airway device. 601 relevant articles related to PONV risk factors and airway device were screened. 584 were excluded because they were either review, duplicate and non-relevant duplications. 17 articles were assessed for eligibility with additional 3 articles excluded due to its retrospective nature and low quality. Finally, 14 articles included for final analysis [Figure 1].

Compared to Yu, we included newer studies published since, as well as pediatric studies. We also included RCTs with the use of non-depolarizers muscle relaxant and Neostigmine usage in the ETT group. RCTs with regional techniques were also excluded.

Data Extraction

Timing of PONV reporting varied among studies. Some studies reported PONV in the post-anesthesia

Fig. 1
recovery unit (PACU) while others reported PONV on the first postoperative day. When confronted with multiple data points, data extracted for analysis with earliest time for PONV was reported. This was an effort to reduce confounding factors such as, rescue anti-emetics given after surgery. Furthermore, PACU treatment for PONV was not always standardized and was often based on individual patient variables and anesthesiologist preference. Characteristics of each study was extracted, which included last name of first author, publication year, patient age range, procedure type, usage of anesthetics and prophylactic anti-emetics. The following outcomes were also extracted including the incidence of PONV for both ETT and LMA group. After data searching and study selection, 14 studies were included in our meta-analysis. Study characteristics and demographics were shown in Table 1. 12 studies reported postoperative vomiting as the primary outcome and 10 reported postoperative nausea as the primary outcome. One study did not differentiate between nausea and vomiting. Results were shown in Table 2.

**Table 1**

*Studies Included*

<table>
<thead>
<tr>
<th>Study</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joshi 1997</td>
<td>Adult ASA 1 or 2; Succinylcholine or non-depolarizer + Neostigmine sometimes used in ET group; Higher overall fentanyl dose in intra-op ET group; post-op pain management unstated</td>
</tr>
<tr>
<td>Patel 2010</td>
<td>Age 3-10; ProSeal LMA vs ETT; lower abdominal procedures; no opioids given intraop; caudal injection with GA with Sevo + N2O; universal OG tube use</td>
</tr>
<tr>
<td>Klockgether 1996</td>
<td>Age 4-14, strabismus surgery, identical induction (Propofol, Vecuronium, Alfentanil), identical maintenance (67% N2O, Propofol, Alfentanil). PONV incidence by 24 hours reported</td>
</tr>
<tr>
<td>Doksrød 2010</td>
<td>Age 3-16 tonsillectomy &amp; adenoidectomy; prophylactic Dexamethasone used; nausea and vomiting not reported separately</td>
</tr>
<tr>
<td>Gulati 2004</td>
<td>Age 1-12 ophthalmologic procedures; greater duration of surgery and more strabismus procedures in LMA group</td>
</tr>
<tr>
<td>Hohlrieder 2007a</td>
<td>Adult 18-75, standardized induction and maintenance with oral midazolam, propofol, fentanyl, and Neostigmine in both groups. ProSeal LMA used along with ETT; Universal use OG tube placement and decompression; No prophylactic anti-emetics</td>
</tr>
<tr>
<td>Cork1994</td>
<td>Adult outpatient peripheral orthopedic procedures; Non-depolarizers and Neostigmine used in both groups; no sig differences in patient population or duration or opioids intra-op; greater morphine post-op in ET group</td>
</tr>
<tr>
<td>Hohlrieder 2007b</td>
<td>Adult female 18-75 for laparoscopic gynecological surgery; iv induction after oral midazolam, ProSeal LMA used along with ETT; Universal OG placement + Dexamethasone 4mg + Tropisetron 2mg prophylactic dose administered</td>
</tr>
<tr>
<td>Quinn 1996</td>
<td>Adult 18-64; Nasal ET with Mivacurium vs. none for LMA group; no prophylactic anti-emetics</td>
</tr>
<tr>
<td>Swann 1993</td>
<td>Adult laparoscopic gynecological surgeries; ASA 1-2 single blinded RCT LMA vs ET. Atracurium and Neostigmine 2.5mg given in ET group only; controlled ventilation with ETT vs intermittent manual assistance to maintain ETCO2 in LMA group</td>
</tr>
<tr>
<td>Griffiths 2013</td>
<td>Adult ASA 1-2 Laparoscopic gynecological procedures. Single blinded RCT ProSeal LMA vs ET: same induction; Dexamethasone prophylaxis; universal reversal with Neostigmine 2.5mg</td>
</tr>
<tr>
<td>Idrees 2000</td>
<td>Adult ASA 1-2 Limb surgery. Single blinded RCT ProSeal LMA vs ETT; Standardized induction + maintenance; Dexamethasone prophylaxis;</td>
</tr>
<tr>
<td>Gul 2012</td>
<td>Age 1-12 strabismus surgery; ProSeal LMA vs. ETT; inhaled induction, 50% N2O, Atracurium in both groups. Universal OG tube and gastric decompression</td>
</tr>
<tr>
<td>Porhomayon†</td>
<td>Adult, mostly male, undergoing general anesthesia with N2O in knee surgery</td>
</tr>
</tbody>
</table>
Meta-analysis of subgroups

In terms of PONV in subgroups of adults and pediatric patients, the incidence of PONV was higher in adults’ patients. PONV in adult with the use of LMA and ETT was about 204/690(30%) and 145/725(20%) respectively with (OR = 1.69, 95% CI, 0.76-3.75, P = 0.20). In pediatric population PONV in the LMA and the ETT group was 85/229(37%) and 72/222 (32%) respectively with (OR = 1.30, 95% CI, 0.61-2.76, P = 0.50). Overall, LMA was associated with higher incidence of PONV. Statistical heterogeneity for adult and pediatric patients was 87% and 53% respectively. Test for subgroup difference was not statistically significant with p value of 0.64 and I² = 0.

Discussion

The impact of the airway device on PONV remains unresolved. Previous models included the influence of airway devices on development of PONV,

<table>
<thead>
<tr>
<th>Author</th>
<th>Postoperative Vomiting</th>
<th>Postoperative Nausea</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ETT</td>
<td>LMA</td>
</tr>
<tr>
<td>Joshi 1997¹⁷</td>
<td>8/174 (4.6%)</td>
<td>15/207 (7.2%)</td>
</tr>
<tr>
<td>Patel 2010¹¹</td>
<td>1/30 (3.3%)</td>
<td>0/30 (0)</td>
</tr>
<tr>
<td>Klockgether 1996¹⁴</td>
<td>24/50 (48%)</td>
<td>16/50 (32%)</td>
</tr>
<tr>
<td>Doksrod 2010¹⁵</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Gul 2012¹¹</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Gulati 2004¹⁶</td>
<td>2/30 (6.7%)</td>
<td>5/30 (16.7%)</td>
</tr>
<tr>
<td>Hohleried 2007a²</td>
<td>18/100 (18%)</td>
<td>4/100 (4%)</td>
</tr>
<tr>
<td>Cork1994¹⁰</td>
<td>1/22 (4.5%)</td>
<td>1/22 (4.5%)</td>
</tr>
<tr>
<td>Hohleried 2007b⁸</td>
<td>6/50 (12%)</td>
<td>1/50 (2%)</td>
</tr>
<tr>
<td>Quinn 1996¹⁸</td>
<td>3/50 (6%)</td>
<td>2/50 (4%)</td>
</tr>
<tr>
<td>Swann 1993²¹</td>
<td>4/30 (13.3%)</td>
<td>8/30 (26.7%)</td>
</tr>
<tr>
<td>Griffiths 2013²⁰</td>
<td>27/57 (47.4%)</td>
<td>28/59 (47.5%)</td>
</tr>
<tr>
<td>Porhomayon¹²</td>
<td>25/157 (15%)</td>
<td>12/157 (7%)</td>
</tr>
<tr>
<td>Idrees¹⁹</td>
<td>50/3 (1.6%)</td>
<td>50/12(4%)</td>
</tr>
</tbody>
</table>

Table 2
Outcomes on Postoperative Vomiting and Nausea

Statistical Analysis

RevMan 5.2 was used to calculate the odds ratio for the incidence of PONV. Subgroup analysis including only adult or pediatric patients was also performed. I² was used to assess heterogeneity with a value below 30% standing for low heterogeneity, a value between 30% and 50% standing for moderate heterogeneity and a value above 50% standing for high heterogeneity. Random effect model was used in all analyses. A p value of <0.1 was significant.

Results

A total of 1899 patients were included. The incidence of PONV with of LMA and ETT was 289/919 (31%) and 217/947 (22%) respectively. In all patients heterogeneity was high at 81% with OR = 1.56, 95% CI, 0.87-2.79, P = 0.14 [Figure 2, 3].
and children. This systematic review and meta-analysis includes 14 total studies focusing on the incidence of PONV comparing the different airway devices including eTT and LMA. Overall, no statistically significant difference was noted between airway devices, although a trend towards higher incidence was noted with the use of LMA group. Subgroup analysis included only children and adult, showed similar trend with stronger association in adult patients.

Compared with previously meta-analysis by Yu, we included 3 newer studies and 5 pediatric RCTs. Therefore, our final analysis was more reliable. Of the studies included, only the four by Holhreider, Quinn, Idrees and Klockgether-Radke showed a

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>LMA</th>
<th>ETT</th>
<th>Odds Ratio</th>
<th>Odds Ratio</th>
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<tbody>
<tr>
<td></td>
<td>Events</td>
<td>Total</td>
<td>Events</td>
<td>Total</td>
</tr>
<tr>
<td>Adult</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cork</td>
<td>4</td>
<td>22</td>
<td>6</td>
<td>22</td>
</tr>
<tr>
<td>Griffiths</td>
<td>27</td>
<td>57</td>
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<td>59</td>
</tr>
<tr>
<td>Hohlrieder</td>
<td>63</td>
<td>100</td>
<td>17</td>
<td>100</td>
</tr>
<tr>
<td>Hohlrieder1</td>
<td>16</td>
<td>50</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>Joshi</td>
<td>12</td>
<td>50</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>Porhomayon</td>
<td>31</td>
<td>174</td>
<td>43</td>
<td>207</td>
</tr>
<tr>
<td>Quinn</td>
<td>25</td>
<td>157</td>
<td>12</td>
<td>157</td>
</tr>
<tr>
<td>Swann</td>
<td>16</td>
<td>50</td>
<td>11</td>
<td>50</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>690</td>
<td>725</td>
<td>68.0%</td>
<td>1.69 [0.76, 3.75]</td>
</tr>
<tr>
<td>Total events</td>
<td>204</td>
<td></td>
<td>145</td>
<td></td>
</tr>
<tr>
<td>Pediatric</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dokrød</td>
<td>36</td>
<td>69</td>
<td>37</td>
<td>62</td>
</tr>
<tr>
<td>Gul</td>
<td>4</td>
<td>40</td>
<td>4</td>
<td>40</td>
</tr>
<tr>
<td>Gulati</td>
<td>6</td>
<td>40</td>
<td>7</td>
<td>40</td>
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<tr>
<td>Klockgether-Radke</td>
<td>38</td>
<td>50</td>
<td>24</td>
<td>50</td>
</tr>
<tr>
<td>Patel</td>
<td>1</td>
<td>30</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>229</td>
<td>222</td>
<td>32.0%</td>
<td>1.30 [0.61, 2.76]</td>
</tr>
<tr>
<td>Total events</td>
<td>85</td>
<td></td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>919</td>
<td>947</td>
<td>100.0%</td>
<td>1.56 [0.87, 2.79]</td>
</tr>
<tr>
<td>Total events</td>
<td>289</td>
<td></td>
<td>217</td>
<td></td>
</tr>
</tbody>
</table>
| Heterogeneity: Tau² = 0.92; Chi² = 69.58, df = 16 (P < 0.00001); I² = 81% Test for overall effect: Z = 1.48 (P = 0.14) Test for subgroup differences: Chi² = 0.22, df = 1 (P = 0.64), I² = 0% The graph favors ETT with less PONV.

but failed to show sufficient independent significance to be included in the final models. But we continue to see investigators including PONV as a variable outcome difference between LMA and ETT. Two prospective randomized control trials (RCT) by Holhreidner reported statistically significant reduction of PONV with the use of Pro-Seal LMA. A recent meta-analysis of RCTs in 2010 by Yu looked at the risk of airway complications between the LMA and ETT. Since the primary goal of Yu study was to look at the airway complications, he failed to show statistical significance in the incidence of PONV between the two devices. Additionally, pediatric studies were excluded due to differences in airway anatomy between adult and children.
statistically significant reduction in PONV with LMA. Of note, the studies by Holthreider\(^7\) were conducted with Pro-Seal LMA and universal oro-pharyngeal tube placement with gastric decompression. Therefore gastric decompression may have a role in preventing PONV.

The study by Joshi, Swann, Dokro and Cork\(^{15,20,21}\) indicated higher PONV with the use of ETT. One hypothesis leading to the difference in the incidence of PONV between the airway devices may be related to greater stimulation with the use of ETT requiring higher doses of anesthetics and opioids\(^3\) when compared to the LMA group\(^6\). Opioids and volatile anesthetics have also a role in the development of PONV with a dose dependent effect on the development of PONV. Alteration in barometric pressure was demonstrated by Nader et al\(^{22}\) when LMA was used in comparison to ETT. Although the authors of that article did not demonstrate a statistically significant difference in PONV between the ETT and LMA, they showed a higher trend of PONV in the LMA group. This study was underpowered and additional trials are necessary to address this hypothesis.

**Limitations**

Due to nature of meta-analysis, results were analyzed from wide variety of RCTs with differing anesthetic techniques, types of surgery, anesthesiologist experience, various types of LMA, and time when outcome was measurement. Heterogeneity was high due to different anesthetic techniques\(^{23}\), type of surgeries and heterogeneous population. However, with RCT there was standardization of anesthetic techniques between two groups to minimize confounding factors. Those without standardization between two groups were excluded from the trial. Despite standardization of anesthetic techniques, there were differences in duration of anesthesia and intra-operative opioid usage. There were statistically significant differences
in patient selection as well as type of procedure within some of the RCTs. Additionally; patient characteristics relevant to the risk of PONV was not always reported.

Consistent with previously performed meta-analysis\(^9\) studying the same outcome, we were able to identify only a limited number of studies addressing the influence of airway device on PONV. Furthermore, many of the RCTs had small sample sizes limiting reliability in concluding the incidence PONV between the two groups. Furthermore, two large retrospective studies\(^{24,25}\) were identified, but were not included in the final analysis due to high degree of variability in anesthetic techniques.

**Conclusion**

Further research and additional randomized controlled trials are needed to precisely identify the influence of airway device on PONV. These trials should provide essential information for the design, conduct, and presentation of these studies. When comparing group, comparability should be based on well-proven risk factors. And lastly, interpretation of results should take into account the study hypothesis, sources of potential bias or imprecision, and the difficulties associated with multiplicity of analysis and outcome.
References


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**Initial bolus**
Inject 1 ampoule Tramal® 100 mg i.v. or i.m. slowly over 2-3 minutes

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- **Infusion**
- **PCA**
- **Injection**

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Inject 2 ampoules Tramal® each 100 mg in 500mL of infusion solution. Infusion rate 12-24 mg Tramal®/h (10-20 ul/min or 30-60u/h). Subsequent increments of 20 mg with a lock-out time of 5 minutes. Usual dose 30 mg or 100 mg 14 hourly up to a total daily dose of 400 mg except in special circumstances which might merit daily dose up to 600 mg. Further treatment with Tramal® balles on demand.

**STEP III**
Follow-up
- 50 mg 1-2 capsules every 4-6 hours
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An intra-operative loading dose of Tramal® will reduce PONV rates

*If needed further doses of 50 mg up to a total of 200mg (incl. the initial bolus) may be given within the first 60 min.

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**Predictable and complete reversal**
- 98% of BRIDION patients recovered to a TOF* ratio of 0.9 from reappearance of T₂ within 5 minutes²
- 97% of BRIDION patients recovered to a TOF* ratio of 0.9 from 1 to 2 PTCs † within 5 minutes³

**Rapid reversal**
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- BRIDION rapidly reversed patients from 1 to 2 PTCs † in 2.7 minutes³

BRIDION is indicated for the reversal of neuromuscular blockade induced by rocuronium or vecuronium. In children and adolescents (aged 2-17 years), BRIDION is only recommended for routine reversal of moderate rocuronium-induced neuromuscular blockade.

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If neuromuscular blockade is required within 24 hours of BRIDION administration, a nonresidual neuromuscular blocking agent should be used instead of rocuronium or vecuronium. The most commonly reported adverse reactions were dysgeusia (metal or bitter taste) and anesthetic complications (movement, coughing, grimacing, or sucking on the endotracheal tube). In patients treated with BRIDION, a few cases of awareness were reported. The relation to BRIDION was uncertain. In a few individuals, allergic-like reactions (i.e., flushing, erythematous rash) following BRIDION were reported. Clinicians should be prepared for the possibility of allergic reactions and take the necessary precautions. In a trial of patients with a history of pulmonary complications, bronchospasm was reported in 2 patients and a causal relationship could not be fully excluded.

Volunteer studies have demonstrated a slight (17%-22%) and transient (<30 minutes) prolongation of the prothrombin time/activated partial thromboplastin time (PT/aPTT) with BRIDION; however, clinical studies have demonstrated no clinically relevant effect on peri- or postoperative bleeding complications with BRIDION alone or in combination with anticoagulants. As BRIDION has demonstrated an in vitro pharmacodynamic interaction with anticoagulants, caution should be exercised in patients on anticoagulation for a pre-existing or concomitant condition. This pharmacodynamic interaction is not clinically relevant for patients receiving routine postoperative prophylactic anticoagulation. Although formal interaction studies have not been conducted, no drug interactions were observed in clinical trials. Preclinical data suggest that clinically significant drug interactions are unlikely with the possible exceptions of toremifene, fusidic acid, and hormonal contraceptives.

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* Train-of-four
† Post tetanic count
‡ Second twitch


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