Effects of Topical Lidocaine on Successful Extubation Time Among Patients Undergoing Elective Carotid Endarterectomies

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Little research has been done on the effects that topical intratracheal anesthesia have on the length of time required to successfully extubate patients after surgical interventions. This retrospective case-control study, using a convenience sample (n = 100 patients), explored the effects of using topical lidocaine laryngotracheal anesthesia injected into the adult trachea before insertion of the endotracheal tube on patients undergoing surgical treatment for blockage of the carotid artery. Both descriptive and inferential analyses were performed to evaluate differences among all variables. Multiple linear regression was also performed while adjusting for the confounding factors (age, gender, and smoking status).

Results revealed that the use of lidocaine laryngotracheal anesthesia during induction of anesthesia prolonged the mean times for postoperative removal of the endotracheal tube by nearly 2 minutes. Extended time for removal of endotracheal tubes may lead to increased costs to the healthcare institution and to the patient, which in turn may lead to dissatisfaction within healthcare teams and possibly to patient discontent with care provided.

Keywords: Anesthesia, emergence phenomenon, extubation, lidocaine, topical anesthesia.

Review of Literature

During emergence from anesthesia coughing and bucking are common occurrences when endotracheal tubes are used. Severe coughing associated with emergence can delay readiness for extubation and can increase the risk of laryngospasm or bronchospasm. Crerar and colleagues found that coughing after tracheal extubation occurred in 38% to 96% of patients and that the use of intracuff alkalinized lidocaine significantly decreased coughing and other emergence events associated with endotracheal tube placement.

Sore throat or dysphagia can lead to delayed discharge from the postanesthesia care unit and can predispose the patient to the risk of pulmonary aspiration. Although coughing is the most common side effect seen, sore throat is the most common complaint heard from patients who have undergone endotracheal intubation. In a randomized, controlled clinical study (n = 25 for each group), Estebe et al explored the use of alkalinized lidocaine via intracuff administration for prevention of postoperative side effects including sore throat. They found a significant decrease in sore throats associated with the use of alkalinized intracuff lidocaine compared to the standard use of air for cuff inflation.

Sumathi et al identified betamethasone gel applied to the tracheal tube before insertion as superior to lidocaine gel for prevention of sore throat; however, extubation times were not compared. Navarro and colleagues explored the effects of different intratracheal anesthesia techniques using lidocaine for prevention of adverse airway effects. However, little research has been done to determine whether LTA lidocaine affects the length of time from the end of surgery until successful extubation. Carotid artery endarterectomy is a surgical procedure after which it is desirable to rapidly extubate the patient's trachea and assess neurologic status, breathing, and speech.

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racheal intubation for general anesthesia exposes the surgical patient to a variety of potentially adverse airway events that can occur in the postoperative period. Examples of such adverse effects include sore throat, dysphagia, severe coughing, laryngospasm, and pulmonary aspiration. These complications may lead to extreme patient discomfort and dissatisfaction with their care, and in some instances, to injury. Some of the side effects of endotracheal intubation are caused by local irritation and inflammation of the airway. A number of tools and interventions have been developed to assist the anesthetist with prevention of airway irritability leading to these side effects. One common method is the intratracheal administration of the animo amide local anesthetic lidocaine during induction of anesthesia to allow for topical anesthesia of the trachea. Lidocaine is commonly given intratracheally via laryngotracheal anesthesia (LTA 360 kit, Hospira, Inc, Forest Lake, Illinois).

Previous studies have investigated the effects of different intratracheal anesthesia techniques using lidocaine for prevention of adverse airway effects. However, little research has been done to determine whether LTA lidocaine affects the length of time from the end of surgery until successful extubation. Carotid artery endarterectomy is a surgical procedure after which it is desirable to rapidly extubate the patient's trachea and assess neurologic status, breathing, and speech.
amined the efficacy of intracuff alkalized lidocaine in prevention of high intracuff pressures and postoperative sore throat related to tracheal lesions caused by endotracheal tube placement. They found that the use of intracuff lidocaine reduced cuff pressures thus limiting tracheal lesions and lessening the incidence of sore throat, hoarseness, and coughing after extubation. The results of this research highlight the effectiveness of intratracheal lidocaine for prevention of sore throat but again fail to show a significant difference in time to extubation.

Bronchospasm and laryngospasm also represent significant events that can occur with both intubation and extubation of patients who require endotracheal tube placement. Both laryngospasm and bronchospasm lead to substantial airway constriction and can be life-threatening. Intratraheally administered topical lidocaine is considered a routine treatment option when spasm on tracheal extubation is expected.

A randomized, controlled study by Kao and colleagues examined the effects of lidocaine applied to tracheal smooth muscle of rats in an attempt to measure the ability of lidocaine to prevent constriction when stimulated. They found that lidocaine significantly reduced contraction of the rat tracheal smooth muscle at low doses and that lidocaine relaxed the muscle more quickly at higher dosages. These findings strengthen the belief that lidocaine is effective in prevention of laryngospasm and bronchospasm during both intubation and extubation and suggest that this mechanism may be operational in humans.

The use of the lidocaine for prevention of side effects associated with the use of endotracheal tubes is a commonly applied intervention in anesthesia practice. However, the use of lidocaine is a noticeably nonstandardized treatment regimen, as seen by its multiple routes and methods of administration. Furthermore, the effects of lidocaine on times to extubation have been studied very little.

Turnaround times within the operating theater are important benchmarks of efficiency. Delays in extubation and subsequent transfer to the postanesthesia recovery unit can affect productivity standards set forth by healthcare institutions and can lead to prolonged patient stays within the postanesthesia care unit. The present study therefore attempted to test the following hypothesis: Intratraheally administered topical lidocaine will reduce times to successful extubation of patients undergoing general endotracheal anesthesia for carotid endarterectomy. Identifying the effects of LTA lidocaine on the time required to successfully extube patients is important in measuring the efficacy of this intervention in benefiting both patients and healthcare organizations in improving postoperative outcomes. We attempted to identify statistically significant and clinically significant evidence that LTA lidocaine administered during induction of general anesthesia altered times to extubation in patients who underwent carotid endarterectomy surgeries.

Materials and Methods

This research employed a retrospective case-control study design analyzing existing medical records of 100 adult patients having American Society of Anesthesiologists (ASA) physical status classification II to IV who underwent elective carotid endarterectomies at Charleston Area Medical Center, Charleston, West Virginia, from January 2007 to January 2010. All of the patients studied were older than 18 years. None of the patients studied underwent emergent surgery. The study received institutional review board approval.

Subjects entered into the treatment group (LTA) consisted of a convenience sample of 50 patients who underwent tracheal intubation with the administration of LTA lidocaine using LTA 360 kits containing 4 mL of 4% lidocaine totaling 160 mg. Control subjects included 50 similar patients who underwent tracheal intubation but did not receive intratracheal lidocaine. The groups were matched by age and gender. The carotid endarterectomy procedure was chosen because of the frequent use of lidocaine LTA. Expeditious emergence and extubation allowed prompt postoperative evaluation of bleeding, airway obstruction, and neurologic status. Exclusion criteria for this study included ASA physical status classification I and V, severe chronic obstructive pulmonary disease, neurologic and skeletal muscle disorders, emergent surgery and diagnosed allergy to lidocaine. Patients requiring reexploration of the carotid endarterectomy due to failed neurologic examination, bleeding, or other complications were also excluded. Initially, 1,186 patient records were obtained for review, but only 100 patients were selected and included for the study after screening of the aforementioned selection criteria.

The single dependent variable studied was mean time to successful tracheal extubation in the operating room. This time was measured in minutes from surgery stop time until the charted time of extubation. These data were easily extracted from the anesthesia record of each patient. The independent variables consisted of whether or not an LTA 360 kit was used, ASA physical status, length of surgical procedure (in minutes), and whether or not intraoperative fentanyl was given. The following demographic variables were also collected from the preanesthetic evaluations and included in the analysis: age in years, gender, weight in kilograms, height in centimeters, body mass index (BMI), and current smoking status (yes or no). Demographic and treatment variables were examined to identify factors that significantly affected extubation times. Stepwise multiple regression analysis was used to compare mean extubation times between groups and to identify other meaningful factors that contributed to such differences.
All statistical analyses were performed using the SPSS software package (version 18.0, SPSS Inc, Chicago, Illinois). We compared patients who received LTA lidocaine anesthesia before intubation (treatment group) with those patients who did not receive LTA lidocaine anesthesia (control group). The confounding factors age, gender, BMI, and smoking status were controlled in the regression analysis. The level of significance was set at a value of $P < .05$.

### Results

Table 1 displays demographic characteristics of the treatment and control groups. The unpaired Student $t$ test was used to compare means between the 2 groups. No statistical differences were identified between the study groups in terms of BMI, age, weight, height, fentanyl dose, or procedure length. However, a statistically significant difference in mean extubation time was found between the groups. The LTA group required 9.96 minutes for extubation, whereas the control group required 7.98 minutes ($P < .04$).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total (n = 100)</th>
<th>LTA group (n = 50)</th>
<th>Non-LTA group (n = 50)</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y; mean ± SD)</td>
<td>69.2 (± 10.05)</td>
<td>70.5 (± 9.14)</td>
<td>68.0 (± 10.83)</td>
<td>.21</td>
</tr>
<tr>
<td>Gender (% of total sample)</td>
<td></td>
<td></td>
<td></td>
<td>.50</td>
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<tr>
<td>Male</td>
<td>47</td>
<td>24</td>
<td>23</td>
<td></td>
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<tr>
<td>Female</td>
<td>53</td>
<td>26</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²; mean ± SD)</td>
<td>28.96 (± 6.57)</td>
<td>29.43 (± 7.22)</td>
<td>28.49 (± 5.87)</td>
<td>.48</td>
</tr>
<tr>
<td>Mean extubation time (min)</td>
<td>8.97</td>
<td>9.96</td>
<td>7.98</td>
<td>.04*</td>
</tr>
<tr>
<td>Fentanyl (µg)</td>
<td>225.75</td>
<td>217</td>
<td>234.5</td>
<td>.38</td>
</tr>
<tr>
<td>Procedure length (min)</td>
<td>100.97 (± 29.07)</td>
<td>105.48 (± 29.82)</td>
<td>96.46 (± 27.87)</td>
<td>.12</td>
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<td>ASA class III (% of total sample)</td>
<td>49</td>
<td>21</td>
<td>28</td>
<td>.98</td>
</tr>
<tr>
<td>ASA class IV (% of total sample)</td>
<td>51</td>
<td>29</td>
<td>22</td>
<td>.98</td>
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<tr>
<td>Smoking history (%)</td>
<td>37</td>
<td>18</td>
<td>19</td>
<td>.50</td>
</tr>
</tbody>
</table>

Table 1. Characteristics of Sample

Abbreviations: LTA, laryngotracheal anesthesia; BMI, body mass index.

* Significant at $P < .05$.

### Discussion

The results of this study reveal several significant implications for anesthesia practice. We found that the use of lidocaine LTA 360 kits with induction of anesthesia prolonged mean extubation times by nearly 2 minutes. The reasons for this are not clear, but may have occurred because the patients were not able to perceive the stimulating effects of the tracheal tubes because of the topical anesthesia provided by lidocaine.

The prolonged extubation times for the LTA group were surprising given the fact that the purpose for using LTA was to prevent emergence side effects that delay extubation, such as coughing, tachycardia, hypertension, and oxygen desaturation.8 This finding differs from that of Gonzalez et al,18 who found no differences in extubation times between patients who were given topical lidocaine versus those who received nothing. Three plausible explanations for these differences are: (1) Gonzalez et al used 2% topical lidocaine rather than 4%, (2) they administered the lidocaine through laryngotracheal instillation of topical anesthesia tubes (LITA, Sheridan Catheter Corp, Argyle, New York) rather than through LTA 360 kits, and (3) they measured extubation times differently, beginning at the time of reversal of neuromuscular blockade, rather than at the end of the operation. Decreasing time to extubation may benefit the
anesthesia care team in a number of ways. Long turnover times frustrate anesthesia providers and surgeons waiting to provide patient care, may reduce professional satisfaction, and may reduce surgical workload if surgeons have a choice of facilities at which to do their cases. In addition, the perception of prolonged turnover times by surgeons, anesthesiologists, Certified Registered Nurse Anesthetists (CRNAs), and administrators can result in substantial organizational costs resulting from multiple meetings and assessments of workflow.19,20

Another important aspect of our findings is that an increase in extubation time may lead to both an increase in anesthesia billing units and increased length of stay within the operating room. With the current push in healthcare to contain costs, use of LTA lidocaine appears to contradict that premise and could increase costs to both the hospitals and patients.16 Dexter et al21 studied the effects of emergence and extubation times after general anesthesia. They found that faster emergence times and omission of phase 1 postanesthesia unit care resulted in decreased labor costs. Surprisingly, we found that the administration of fentanyl had no significant effect on mean extubation times. This is contrary to popular belief in anesthesia practice, since fentanyl is known to be a powerful opioid analgesic with significant depressive effects to the respiratory system. While the present study found no significant effect of fentanyl on extubation times, it failed to compare magnitude of doses. It is likely that larger fentanyl dosages would lead to increased extubation times. This limitation reduces the generalizability of our study.

An additional finding in the present study is that none of the other variables examined exhibited significant effects on extubation times. Conventional wisdom in anesthesia practice is that factors such as larger body weight and cigarette smoking contribute to emergence side effects due to prolonged drug clearance and respiratory system comorbidities. Again, this analysis provides empirical evidence that, under the conditions studied, neither of the aforementioned variables resulted in statistically significance differences.

While this research does provide evidence of an increase in extubation times associated with LTA use, the following study limitations should be noted. The t-test comparison between groups failed to show a statistical significance in BMI between study groups. This research did not take into consideration differences in BMI between patients labeled as obese or normal weight (as defined by the Centers for Disease Control and Prevention guidelines) therefore eliminating the possibility of closely analyzing the effects of LTA use among normal weight versus obese patients. Obese and morbidly obese patients have higher adipose tissue masses and might require higher dosages of lidocaine and other anesthetics in order to obtain their pharmacological effects due to their lipophilic properties. Furthermore, geriatric patients exhibit higher proportions of adipose tissue as compared to younger adults, thus allowing differences in therapeutic dosages of medications between patients of different ages. This could limit the results of the present study, since the mean age of all subjects was 69.2 years.

Another potentially confounding variable in the present study is the synergistic effect that volatile anesthetics exert in conjunction with intratracheally administered lidocaine. Inhalational anesthetics possess analgesic and reflex suppressing properties that could act synergistically with topical lidocaine and thus prolong the local anesthetic action of the lidocaine. This could lead to increased loss of sensation within the airway and lead to prolonged extubation times in surgical procedures. This study did not examine the end-tidal concentrations

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds ratio</th>
<th>Confidence interval</th>
<th>t</th>
<th>P</th>
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<tr>
<td>Constant</td>
<td>7.98</td>
<td>1.00</td>
<td>11.753</td>
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<tr>
<td>LTA use</td>
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<td>0.968</td>
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<td>Fentanyl use</td>
<td>0.89</td>
<td>0.987</td>
<td>0.889</td>
<td>.38</td>
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<td>BMI</td>
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<td>0.995</td>
<td>−0.218</td>
<td>.93</td>
</tr>
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<td>ASA class III</td>
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<td>−0.025</td>
<td>.98</td>
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<tr>
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<td>0.98</td>
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<td>.98</td>
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<tr>
<td>Gender</td>
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<td>1.00</td>
<td>1.574</td>
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</tr>
<tr>
<td>Age</td>
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<td>0.984</td>
<td>−0.05</td>
<td>.96</td>
</tr>
<tr>
<td>Current smoking status</td>
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<td>1.00</td>
<td>−0.512</td>
<td>.61</td>
</tr>
<tr>
<td>Procedure length</td>
<td>0.034</td>
<td>0.976</td>
<td>0.341</td>
<td>.73</td>
</tr>
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</table>

Table 2. Results of Stepwise Multivariate Linear Regression Analysis for Extubation Times

Abbreviations: LTA, laryngotracheal anesthesia; BMI, body mass index.

<sup>a</sup> P < .05 between groups.
of the inhalational agents used; however, we believe that routine practice patterns of a variety of anesthesia providers add to the external validity of the study. The retrospective nature of this study certainly also limits its generalizability. Patients who underwent carotid endarterectomy were selected for the study because they required fully awake extubations to allow immediate neurological assessment in the operating room. However, the subjectivity of the determination of wakefulness was not controlled. A prospective, randomized study that includes strict protocols regarding induction, maintenance, and emergence would more precisely evaluate the effect of LTA lidocaine on extubation time.

One important study limitation is the inability to include other confounding factors in the analysis including, among others, practitioners’ experiences and skills, induction agents used, other drugs given, and patients’ comorbidities. These confounding factors can play a role in influencing our findings. In addition to those, this research used a convenience sampling method for identification of the sample of patients that we studied. Convenience sampling methods could introduce sampling bias thus limiting the results of the study. Other prospective studies with a large sample size are needed to verify our finding. In the process of matching case subjects to control subjects, we used only age and gender. We acknowledge that there are other factors that may affect the patient’s likelihood to have airway issues. Thus, caution is necessary when interpreting the findings of this study.

The use of additional intravenous medications for maintenance of anesthesia is an additional potential limitation of this study. Hocker et al24 compared the use of remifentanil with both propofol and sevoflurane to compare emergence and recovery times between patients undergoing surgeries lasting greater than 3.5 hours. Results indicated that the use of remifentanil with propofol resulted in shorter extubation times than did remifentanil and sevoflurane anesthesia.24 Our study showed that use of fentanyl had no significant effects on time to extubation but failed to examine other medications as variables.

It is well known that there are many methods and uses of lidocaine for the prevention of emergence side effects regarding tracheal intubation and subsequent extubation. Although the literature provides evidence of the ability of lidocaine to reduce side effects, prolonged extubation times were rarely considered as adverse outcomes. Andrzejowski and Francis25 compared the intratracheal administration of either lidocaine or saline immediately before extubation and found no differences between groups in prevention of emergence side effects or times to extubation. A similar study by Altintas et al26 compared the use of intracuff lidocaine versus intracuff saline to examine differences in prevention of emergence phenom-


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