Objective: To study the feasibility of using laryngeal mask anesthesia (LMA) with bronchoscopic evaluation of recurrent laryngeal nerve (RLN) integrity when stimulated.

Design: Single-institution prospective case series.

Setting: A single, mid-Atlantic region academic medical center.

Patients: Twenty-seven adult volunteers.

Interventions: Laryngeal mask anesthesia for thyroid surgery, monitored by flexible laryngoscopy and nerve integrity testing.

Main Outcome Measures: Success rates for LMA use in thyroid surgery, bronchoscopic visualization of laryngeal glottis, and documentation of RLN integrity following surgery.

Results: We report our experience on 27 consecutive cases in which LMA with RLN stimulation was used for thyroid surgery. Twenty-five of 27 patients underwent successful LMA and visual documentation of RLN integrity by bronchoscopic inspection of nerve stimulation.

Conclusions: Direct visualization of vocal cords using a fiberoptic bronchoscope via an LMA provides a safe and feasible method of laryngeal assessment following thyroid dissection. Continuous real-time video monitoring may be the next step in development of this technique as a patient safety measure for thyroid and parathyroid surgery.

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Thyroid surgery is performed for thyroid cancer, goiter, autoimmune thyroid disease, and dominant solitary nodules, and the surgical options include total, subtotal, lobectomy, or partial lobectomy. A possible complication of thyroid surgery is injury to the recurrent laryngeal nerve (RLN) resulting in postoperative vocal cord dysfunction, typically manifesting as hoarseness. In the setting of total thyroidectomy, bilateral RLN paralysis is possible. This could manifest as acute postoperative stridor and present an airway emergency. The use of a nerve stimulator and/or electromyography monitoring may help to prevent RLN damage by both identifying the RLN intraoperatively and confirming that the nerve was not damaged at the conclusion of the case prior to closing the surgical wound.

The nerve stimulator stimulates the RLN and results in adduction of the vocal cord. A potential problem with this technique is assessing adequate cord function. Alternative ways of assessing the response to RLN stimulation include palpating the larynx, monitored vocal cord contraction by an indwelling electrode (ie, on an endotracheal tube), or direct visualization of the vocal cord response to RLN stimulation.

The laryngeal mask airway (LMA) has been used extensively in thyroid surgery in some centers and offers a number of advantages to the patient, such as the avoidance of muscle relaxants and relaxant reversal, decreased hemodynamic response to intubation and extubation, and possibly a decreased incidence of postoperative odynophagia. Its use may increase because there is greater pressure to perform these procedures as outpatient surgery. Direct visualization of the cords, using a fiberoptic bronchoscope via an LMA, provides a method of laryngeal assessment during and following thyroid dissection.

The technique of direct cord visualization via the LMA has been described by others, and we wished to confirm the feasibility of this approach at our institution.

METHODS

A human subject protocol was designed and approved by the Penn State Milton S. Hershey...
Medical Center (Hershey, Pa) institutional review board. After we obtained written informed consent from them, 27 adult volunteers were included in the study. Inclusion criteria for the study consisted of age of 18 to 75 years, thyroid surgery to be performed by a single surgeon (B.C.S.), with no specific contraindication for the use of the LMA. Typical contraindications for use of the LMA are morbid obesity (>2.5 × ideal body weight), an unplanned surgical procedure without adequate fasting (full stomach), high risk for gastric regurgitation (eg, hiatal hernia, history of regurgitation, heartburn, or ileus), abnormal airway anatomy or disease, anticipated difficult ventilation, or any other contraindication to LMA placement (eg, low pulmonary compliance or elevated pulmonary resistance).

Attending anesthesiologists were not limited to the authors and included all attending faculty comfortable with LMA usage in our institution. Patients received premedication with benzodiazepine hydrochloride. After arrival in the operating room, patients were monitored with a noninvasive blood pressure cuff, pulse oximetry, and an electrocardiogram. Following preoxygenation, an appropriate weight-based dose of intravenous propofol and fentanyl citrate were used at the anesthesiologist’s discretion. After induction, an appropriately sized disposable LMA (based on ideal body weight and the anesthesiologist’s discretion) was placed and inflated, and the patient was allowed to breath spontaneously. No muscle relaxants were used.

After placement of the LMA, a bronchoscope adaptor was attached between the anesthesia machine circuit and the LMA. This facilitates the introduction of the bronchoscope without interruption of the continuous ventilation and delivery of anesthesia. The fiberoptic bronroscope was then passed via the bronchoscope adaptor through the LMA to confirm proper LMA placement and visualization of the vocal cords. Anesthesia was maintained with inhaled sevoflurane and intravenous fentanyl.

The surgical procedure was then completed as planned. When the surgeon was ready to stimulate the RLN (0.5 mA), the fiberoptic bronchoscope was reintroduced and the anesthesiology provider would report any movements observed. The fiberoptic view was also displayed on a video monitor and recorded on a DVD disc. At the conclusion of the surgery, the inhaled sevoflurane was discontinued and the LMA was removed when the patient regained consciousness. If analgesia was inadequate, the dosage of the fentanyl was adjusted at this point.

**RESULTS**

In 25 of 27 cases, the use of the LMA resulted in uncomplicated observation of vocal cord movement (Figure). Seventeen cases were hemithyroidectomies, and 10 were total thyroidectomies. In 1 case, the LMA failed to provide an adequate seal after placement, and the anesthesiologist elected to remove the device and replace it with a standard endotracheal tube. In the second case, at the conclusion of the surgery, the battery-powered nerve stimulator failed to work properly, and a replacement stimulator was not readily available. This patient had no clinical evidence of vocal cord dysfunction postoperatively.

In 6 cases, a transient phenomenon was observed. As the surgical team dissected the thyroid tissue adhering
to the trachea, the tension applied to the thyroid tissue resulted in a slight rotation of the larynx. The result was a partial closure of the laryngeal introitus (documented on video), which produced a sound similar to a laryngospasm and that spontaneously resolved when the tension was released. Most patients tolerated this event without difficulty; however, in 2 cases a request was made to the surgical team to release tension so that the patient could ventilate better. The surgery then continued with less retraction on the larynx. There were no cases of postoperative vocal fold dysfunction noted by clinical and/or endoscopic examination. None of these cases required intubation.

Recurrent laryngeal nerve monitoring during thyroid surgery is a controversial subject. Many surgeons, with arguments similar to those for unmonitored parotid surgery, reason that visual identification and meticulous dissection coupled with extensive experience are all that are needed to dissect these motor nerves safely.6 Proponents of routine monitoring advocate its use to localize difficult-to-find nerves, prevent inadvertent injury, and confirm nerve function following the procedure, and they see the issue as one of patient safety. Certainly its use to prevent injury is intuitive, yet many studies have failed to demonstrate this result.6-10 Many surgeons who do not monitor the RLN routinely will reserve monitoring for cases of reoperation or of unusual anatomy.7 Anatomic challenges in thyroid surgery cannot always be anticipated, however.

Conventional RLN monitoring consists of a needle electrode placement into the cricoarytenoid muscle (direct needle placement, endoscopic hook, or special endotracheal tube) and a stimulator electrode contact with the nerve. An alternative or adjunct to electromyography is open palpation of the arytenoids during RLN stimulation, which can be done during thyroid dissection for identification and/or at the conclusion of the resection to ensure nerve integrity.1

An endoscopic visual assessment of laryngeal function during procedures that involve the RLN is an alternative to these methods. In the study described herein, we used the technique described by others (Table), although we developed them de novo without using them as references.3-5,11,12 Issues that surround this approach include the following: (1) Can thyroid/parathyroid surgery be performed safely with an LMA? (2) Can the vocal folds be visualized through the LMA? And (3), can stimulation of the RLN be visualized and confirmed? The LMA experience is much smaller than that reported for electromyographic monitoring with an endotracheal tube; however, to date, no cases of a false-negative outcome (a cord that was stimulated and was paretic postoperatively) have been reported. It is still premature to state that this technique provides complete protection. The procedure we describe could be used for intermittent verification of nerve integrity or surveillance during an entire procedure.

What have not been mentioned in previous reports are the anesthetic complications associated with this technique. Our experience shows that specific airway problems occur in addition to the other well-known problems with LMA usage, such as malpositioning, aspiration risk, and dislodgement. Our incidence of laryngeal rotation causing stridor (pseudolaryngospasm) was approximately 25%, but this will vary according to specific patient anatomy and surgical technique. To our knowledge, our study is the first report of this technique. We managed this particular complication by requesting the surgeon to relax on laryngeal rotation briefly and then to resume surgery while minimizing laryngeal rotation. It is possible that in some patients significant traction may be required, and this complication, where unavoidable, can be managed.

In conclusion, in adult patients, the LMA is an alternative to the endotracheal tube in providing general anesthesia for thyroid and parathyroid surgery. However, it must be recognized that laryngeal manipulation may compromise the patient’s airway in a considerable number of cases. Fortunately, the complication can be easily managed. We plan further studies to explore the use of a modified LMA with an indwelling fiberoptic to continuously monitor intraoperative laryngeal movement during thyroid surgery.

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Correspondence: Brendan C. Stack, Jr, MD, Department of Otolaryngology–Head and Neck Surgery, #310 W Markham St, No. 543, Little Rock, AR 72205 (bstack@uams.edu).

Author Contributions: Dr Pott had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study

Table. Review of Literature on Laryngeal Mask Airway/Bronchoscopic Technique for Thyroid/Parathyroid Surgery

<table>
<thead>
<tr>
<th>Study</th>
<th>Subjects, No.</th>
<th>Unique Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current study</td>
<td>27</td>
<td>96% Success rate; 3.7% required intubation, no RLN and injuries detected</td>
</tr>
<tr>
<td>Hillermann et al, 2003</td>
<td>30</td>
<td>Both RLN and SLN stimulated; 3 cases of RLN palsy</td>
</tr>
<tr>
<td>Eltzschig et al, 2002</td>
<td>327</td>
<td>95% Success rate; 1 case required intubation, 2 cases of pneumothorax, 0.03% RLN palsy</td>
</tr>
<tr>
<td>Schueller and Ellison, 2002</td>
<td>8</td>
<td>No RLN injuries detected</td>
</tr>
<tr>
<td>Shah et al, 2001; Hobbiger et al, 1995; Palazzo et al, 2000; Greatorex and Denny, 1991</td>
<td>144</td>
<td>42.7% Success rate for technique; no RLN injuries detected</td>
</tr>
<tr>
<td>Hobbiger et al, 1996; Greatorex and Denny, 1991</td>
<td>97</td>
<td>50% Success rate for technique; no RLN injuries detected</td>
</tr>
</tbody>
</table>

Abbreviations: RLN, recurrent laryngeal nerve; SLN, superior laryngeal nerve.
concept and design: Pott, Swick, and Stack. Acquisition of data: Pott and Swick. Analysis and interpretation of data: Pott, Swick, and Stack. Drafting of the manuscript: Pott, Swick, and Stack. Critical revision of the manuscript for important intellectual content: Pott and Stack. Administrative, technical, and material support: Stack. Study supervision: Stack.

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REFERENCES