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ORIGINAL RESEARCH

Prevalence and patterns of intraoperative nerve monitoring for thyroidectomy

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OBJECTIVE: To estimate the patterns of use of intraoperative recurrent laryngeal nerve (RLN)-monitoring devices during thyroid surgery by otolaryngologists in the United States.

METHODS: A questionnaire was mailed to 1685 randomly selected otolaryngologists, representing approximately half of all otolaryngologists currently practicing in the United States. Topics covered included training history and current practice setting, use and characteristics of use of RLN monitoring during thyroid surgery, as well as history of RLN injury and/or subsequent lawsuits. χ^2 test was used to examine associations between monitor usage and dependent variables, and odds ratios calculated by logistic regression were used to refine the magnitude of these associations.

RESULTS: A total of 685 (40.7%) of questionnaires were returned, and 81 percent (555) of respondents reported performing thyroidectomy. Of those, only 28.6 percent (159) reported using intraoperative monitoring for all cases. Respondents were 3.14 times more likely to currently use intraoperative monitoring if they used it during their training. Surgeons currently using intraoperative RLN monitoring during thyroidectomy were 41 percent less likely to report a history of permanent RLN injury. Further information about surgeon background and rationale for decisions regarding RLN monitor usage are discussed.

CONCLUSIONS: Presently, the majority of otolaryngologists in the United States do not report regular usage of RLN monitoring in their practices. Surgeon background and training, more so than surgical volume, significantly influenced the use of intraoperative RLN monitoring.

Transient or permanent recurrent laryngeal nerve (RLN) injury is a well-known complication of thyroid and parathyroid surgery. Consequences may include aspiration, hoarseness, or even airway compromise. The reported incidence of permanent RLN injury resulting from thyroid gland surgery ranges from 0.5 percent to 5 percent of cases.[1-4] Failure to identify the RLN may result in inadvertent trauma, whether from division or laceration, traction, pressure, suction, crush, or cautery injury.[5] With the advent of intraoperative nerve monitoring, additional means of reducing the risks of RLN injury are available. By employing an RLN monitor during thyroid gland surgery, the surgeon may reduce the risks of misidentification and/or inadvertent injury to the nerve.

Intraoperative nerve monitoring has two main indications in head and neck surgery: facial nerve monitoring in parotid surgery and RLN monitoring in thyroid/parathyroid surgery. Patterns of use for facial nerve monitoring in the United States has been well-described.[6] The use of nerve monitoring in surgery of the head and neck has been examined in the United Kingdom. Although the use of nerve monitoring for mastoid, parotid, and thyroid surgeries among surgeons in the United Kingdom has been examined, there is no literature that reports the prevalence of RLN monitoring during thyroid gland surgery by otolaryngologists in the United States.[7] We surveyed a representative group of otolaryngologists who were members of the American Academy of Otolaryngology–Head and Neck Surgery (AAO-HNS) in an attempt to characterize the patterns of use of RLN monitoring. The underlying premise of this survey was not to establish standards of care, but rather to determine the trends in the usage of RLN monitoring among otolaryngologists in the US.

MATERIALS AND METHODS

A questionnaire modeled on evaluation of the pattern of use of facial nerve monitoring in parotid surgery by Lowry

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et al[6] was revised to inquire about the use of RLN monitoring during thyroid surgery. The survey was designed to record information related to level of training, current practice setting, use of RLN monitoring for thyroid surgery in both training and current practice, as well as reported history of RLN injury and/or subsequent lawsuits. In addition, participants were questioned about specific reasons for or against the use of an RLN monitor during thyroid/parathyroid surgery (Appendix 1). Approximately one half of all active members (N = 1685) of the AAO-HNS were selected to receive this mailed questionnaire. Institutional review board approval was not needed for this study, as neither direct patient involvement nor human experimentation was required.

Data were assembled with the use of Microsoft Access (Microsoft Corp, Redmond, WA), and results were analyzed with the use of the Stata Statistical Software Program (StataCorp LP, College Station, TX). Associations between independent variables and RLN-monitoring and -dependent variables were examined by the χ^2 test. Logistic regression was used to determine the magnitude of these associations.

RESULTS

A total of 1685 anonymous surveys were mailed to randomly selected members of the AAO-HNS. A total of 685 surveys were returned, for a response rate of 40.7 percent. Of the otolaryngologists who responded, 570 (83.2%) were general otolaryngologists or surgeons of other subspecialties without additional training in head and neck surgery, while 115 (16.8%) were fellowship trained in head and neck surgery. Of the respondents, 26.6 percent (n = 182) did not report performing thyroid surgery in their current practice; this response is likely a function of the number of participants in the survey who practice other subspecialties within the AAO-HNS. Respondents who were fellowship trained in head and neck surgery were 4.2 times more likely to perform thyroid surgery (odds ratio [OR] 4.24, $P < 0.000$) than other otolaryngologists. The majority of respondents performing thyroid surgery report performing less than 25 procedures per year. The respondents not performing thyroid surgery were excluded from analysis of the use of RLN monitoring in current practice.

Survey results revealed an even distribution of the year of training completion: from the 1970s to 2000s. With regard to practice setting, 15.5 percent of survey participants were currently in an academic setting, while 84.5 percent were in a private/health maintenance organization setting. There were no significant associations found between the type of practice and performance of thyroid surgery, although fellowship-trained surgeons were more likely to be in an academic setting. Practice setting and fellowship training were not significantly associated with nerve injury.

Only 13 percent of respondents reported using RLN monitoring during their training. However, 44.9 percent reported using a monitor in their current practice; 23 percent responded that they use it in every case. Respondents were three times more likely to use the monitor in practice if they used it in training (OR 3.14, $P < 0.000$). In addition, the use of the monitor in training was significantly associated with the likelihood of performing thyroid surgery in practice ($P < 0.000$). Fellowship-trained surgeons were no more likely to have used the monitor in training or to use it in practice. Almost all respondents reported using the Xomed endotracheal tube with a nerve integrity monitor (NIM, Medtronic Xomed, Inc., Jacksonville, FL) if they did use monitoring. Other methods for intraoperative nerve monitoring were reported by 3 percent (N = 5) of respondents and included placing a needle via the thyrocricoid space into the true vocal cord or direct visualization of the glottis by fiberoptic laryngoscopy while stimulating the RLN.

Of the thyroid surgeons surveyed, 41.6 percent (N = 231) reported experiencing a case of permanent RLN injury in their practice. Of those, 20.1 percent (N = 48) reported having used a monitoring device during the case of interest. However, respondents were 41 percent less likely to report a history of permanent nerve injury if they used the monitor in their current practice (OR 0.59, $P = 0.001$).

Four (0.72%) respondents to the survey were involved in a lawsuit as a result of RLN injury. Intraoperative nerve monitoring was not used in any of these cases. No association with the number of thyroid/parathyroid surgeries and the likelihood of lawsuit was observed. Interestingly, none of the individuals involved reported a change in their use of the monitor as a result of the lawsuit case.

Opinions varied widely among respondents as to the rationale for or against the use of intraoperative RLN monitoring during thyroid/parathyroid surgery. Sixty-three percent of respondents were gracious enough to provide written comments. Rationales for and against intraoperative RLN monitoring are listed in Tables 1 and 2. Most respondents cited more than one reason for their stance on intraoperative RLN monitoring.

DISCUSSION

Continuous intraoperative RLN monitoring during thyroid and parathyroid surgery remains a controversial issue. The basic technique involves a skin surface electrode used to make electromyography (EMG) recordings, which have an audible alarm to alert the surgeon if nerve stimulation has occurred. Nerve monitoring of the facial nerve during otologic surgery and during parotid surgery is becoming more and more common. In a comparable study of US surgeons performing parotid operations, it was revealed that 60 percent used intraoperative monitoring some or all of the time.[6]

There are several modalities in which the RLN can be monitored intraoperatively: 1) direct laryngoscopy or fiber optic laryngoscopy while probing the RLN with a nerve stimulator, 2) EMG observation of the arytenoids muscle

Table 1
Most common reasons stated by survey respondents who do not use RLN monitor

Reasons stated for NOT using RLN monitor (n = 251 respondents; some had multiple comments)	N (% of respondents who commented)
Rely on anatomy	63 (25%)
Not needed	63 (25%)
Too many false positives/unreliable	51 (20%)
Not available	29 (12%)
Cost	28 (11%)
Not used in training; never tried	19 (8%)
Do not think it helps	17 (7%)
Use only a nerve stimulator	9 (4%)
ET tube difficult; anesthesia resists use	9 (4%)
Gives surgeon false sense of security	8 (3%)
Do not feel it will prevent injury	7 (3%)
Have success without it	7 (3%)
Do not believe it is standard of care	2 (1%)
Consider its use dangerous	1 (<1%)

RLN, recurrent laryngeal nerve; *ET,* endotracheal tube.
Note: Some respondents cited more than one reason; therefore, percentages add up to greater than 100%.

function, 3) palpation of the arytenoids while stimulating the RLN with a nerve stimulator, or 4) electrophysical monitoring of the RLN using an endotracheal tube with integrated surface electrodes to record true vocal cord movement.[8-10] Our results suggest that almost all surgeons who used RLN monitoring used the Medtronic Xomed EMG endotracheal tube with a Neurosign or NIM nerve monitor. This technique allows for monitoring of both the RLN and the superior laryngeal nerve as it senses a change in the baseline electrical activity of the glottic musculature. Only 2 perceut of respondents (n = 3 of 147) stated that they used other monitoring techniques. This was also true for those surgeons who had tried RLN monitoring but had decided not to use it in their current practice. The three responders who did not use the Xomed endotracheal tube used direct visualization of the larynx via fiberoptic laryngoscopy.

Intraoperative RLN monitoring was introduced almost 30 years ago.[8] However, results of this survey suggest that the majority of otolaryngologists do not currently use this adjunct for thyroid surgery.[5] Sixty percent of our respondents report using RLN monitoring rarely or never. A recent postal survey of otolaryngologists in the United Kingdom revealed that only 23.7 percent routinely use RLN monitoring in all cases. This percentage increased to 35 percent in revision thyroid surgery.[7] Although few would argue that the best means of preventing damage to the RLN during thyroid surgery is intimate knowledge of the anatomy and meticulous surgical technique, even the most experienced surgeons report RLN nerve injury in the range of 0.5 to 5 percent.[3] Most current approaches to thyroid surgery emphasize preservation of the RLN, with recent studies advocating the importance of intraoperative nerve identification

Table 2
Most common reasons stated by survey respondents who do use RLN monitor

Reasons stated for using an RLN monitor (n = 97 respondents; some gave multiple comments)	N (% of respondents who commented)
Improves safety of the procedure	33 (34%)
Helpful in revision surgery/large goiters	32 (33%)
Medical-legal protection	21 (22%)
It is available; no reason not to use it	21 (22%)
It provides additional help in surgery	15 (15%)
Believe it to be the standard of care	12 (12%)
To confirm nerve once it is found	7 (7%)
Increases surgeon comfort	7 (7%)
It is helpful when operating with residents	6 (6%)
Decreases surgical time	6 (6%)
For patient comfort/reassurance	1 (1%)

RLN, recurrent laryngeal nerve.
Note: Some respondents cited more than one reason; therefore, percentages add up to greater than 100%.

and protection rather than avoidance.[5] The most striking evidence to support this is a review by Hermann et al[11] of 16,443 patients undergoing thyroidectomy. With nerve exposure ranging from mere identification to complete exposure, there was a lower RLN injury rate with increasing level of dissection. In a multi-institutional prospective study, Dralle et al[12] examined almost 30,000 RLNs at risk during thyroid surgery and found no significant difference in the rate of injury to the RLN when comparing intraoperative identification vs identification with continuous nerve monitoring.

Intraoperative nerve monitoring can be viewed as an additional tool to confirm identification of the RLN, thereby allowing proactive protection of the nerve. It is by no means a substitute for careful and appropriate dissection during surgery. Benefits of intraoperative RLN monitoring may include immediate feedback of mechanically evoked potentials to prompt the surgeon to modify the technique or location of the dissection, verification of nerve location once identified, verification of nerve integrity at the end of the procedure to help in decision making (ie, the extent of dissection on the contralateral side) as well as a guide when anatomy is distorted by malignancy or reoperation.[13] To date, no controlled prospective trials show that there is a reduced rate of injury to the RLN with intraoperative nerve monitoring. This was, in fact, a reason cited by several of our survey respondents for not using RLN monitoring.

It is interesting to note that, while only 44 percent of respondents used intraoperative RLN monitoring during thyroid/parathyroid surgery, greater than 60 percent of respondents to similar surveys reported using nerve monitoring during parotid surgery.[6] Why one nerve at surgical risk is preferentially monitored more so than another cannot be determined from these data. Whether this finding is a function of global surgical preference, perceived standards of care, or survey bias is unclear. One limitation of our study was the relatively small number of practicing otolaryngologists who responded. Our study design surveyed 50 percent of AAO-HNS member otolaryngologists with a 41 percent response rate; therefore, about 20 percent of the targeted group weighed in with responses. Because of this percentage, a responder bias may have been present.

Although RLN injury from thyroid surgery can be a devastating complication, it occurs with relative infrequency. This low number of adverse outcomes, especially in the hands of experienced surgeons, makes it difficult to show a statistically significant difference in injury rates by technique, even with a controlled prospective clinical trial. To demonstrate a reduction in the rate of RLN injury from 2 percent to 1 percent with intraoperative monitoring, a study group of about 1000 lobes would be required.[8] A recent retrospective review by Witt[14] was performed to compare rates of RLN injury with and without the use of an RLN monitor. Of 136 cases reviewed, monitored RLNs had a temporary injury rate of 2.8 percent and a permanent injury rate of 0.9 percent. In unmonitored RLNs, these rates were 4.8 percent and 2.4 percent, respectively; neither rate reached statistical significance, but showed a clear trend. Brennan and Shuller[15] performed a prospective analysis of continuous intraoperative nerve monitoring, which showed a 1 percent incidence of temporary RLN injury and a zero percent incidence of permanent injury with a total of 96 nerves at risk in patients undergoing thyroid and parathyroid surgeries. While these rates of RLN injury are lower than those in most published series, it is difficult to determine whether these findings are a function of the nerve monitor or the level of experience of the surgeon.

Concerns cited by many respondents were that intraoperative RLN monitoring was the "standard of care." Those who used monitoring felt as though monitoring was, in fact, the standard of care for their community and that not monitoring could have medical-legal consequences. Conversely, some respondents who did not routinely use RLN monitoring in the operating room stated that it is not considered the standard of care and that its use was the surgeon's preference. Standard of care is legally defined as how another comparable surgeon would administer care to the patient if the circumstances were similar. As this definition is subject to interpretation, it would seem that intraoperative RLN monitoring is not the standard of care, given that a minority of surgeons nationwide employ this technique.

CONCLUSIONS

This study was undertaken to evaluate the patterns of use of intraoperative RLN monitoring by US otolaryngologists during thyroid/parathyroid surgery. Compared with prior surveys of nerve monitoring in parotid surgery, use of nerve monitoring in thyroid/parathyroid surgery is more than half as prevalent. Although we believe we have sampled a representative population of US otolaryngologists, response bias implicit to a survey of this nature may elicit responses from those who feel most passionately about this issue. The absolute role or necessity of intraoperative RLN monitoring in head and neck endocrine surgery has yet to be established. The results of this survey suggest that, while intraoperative RLN monitoring is another tool that can be used by the surgeon during thyroid/parathyroid surgery, it is by no means considered the standard of care and certainly by no means replaces a thorough knowledge of anatomy or meticulous surgical technique in performing these procedures.

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