Editorial

The pros and cons to real-time nerve monitoring during recurrent laryngeal nerve dissection: an analysis of the data from a series of thyroidectomy patients

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Liu *et al*. published a novel and provocative article in *Kaohsiung Journal of Medical Sciences* entitled "*Exclusive real-time monitoring during recurrent laryngeal nerve dissection in conventional monitored thyroidectomy*", that examines the benefits of intraoperative nerve monitoring during thyroidectomy with a new potential to continuously monitor the recurrent laryngeal nerve (RLN) with minimal risk. The article sheds light on the advancements in nerve monitoring as an adjunct technology to the gold standard of anatomic identification of the RLN. It demonstrates how this technology can be an aid in real-time dissection of the RLN and ultimately vocal fold function outcomes. Continuous intraoperative neuromonitoring (CIONM) of the RLN during thyroid surgery allows the surgeon to assess impending neurophysiologic injury to the nerve by measuring amplitude and latency changes which may be able to predict impending vocal fold weakness without evidence of RLN injury anatomically (1). The authors however suggest that even with the application of this technique, RLN injuries still occur. RLN injury most often occurs during dissection and goes unrecognized until post-op because there is no obvious anatomic injury. Results of multiple studies suggest that the RLN is at high risk for this type of injury during dissection (1,2) and therefore continuous RLN monitoring may improve a surgeon's vocal fold functional outcomes with more real-time, continuous monitoring.

Conventional use of intermittent IONM as an adjunct technology can help thyroid surgeons track neurophysiologic changes of the RLN and elucidate mechanisms of injury that would not otherwise be interpreted anatomically. The negative predictive value of this technology is high while the positive predictive value low (3), leaving the technology with limitations and risks. According to the authors, assessment of functional integrity of the RLN is limited by the timing and intervals of direct RLN stimulation, as well as the site of stimulation. If stimulation of the RLN is done only intermittently, a change in function may not be detected until a loss of signal (LOS) rendering it too late to change the course of RLN function intra-op and immediately post-op. Continuous vagal nerve monitoring (C-IONM) has been used as a means to monitor for the earliest signs of RLN injury, but has been reported to cause complications related to the dissection of the vagus nerve, circumferential placement of the electrode around the vagus nerve, traction injury to the vagus nerve, and unpopularity with its feasibility (4,5).

This study evaluated the potential for continuous RLN monitoring by monitoring the most proximal portion of the exposed RLN in the surgical field in 208 nerves at risk. This study strictly followed standardized IONM procedures, reinforcing the protocol by which the International Neural Monitoring Group (INMG) created in order to relevantly follow the amplitudes of stimulation along the course of the RLN (6). Amplitude changes were monitored and consistent with the INMG, a greater than 50% drop in the EMG signal was considered a significant reduction. This signal

reduction of 50% or greater is consistent with other studies that have evaluated both IONM and C-IONM (2,3,6). The advantage of this technology from the conventional IONM is demonstrated by the authors with the use of 'surgical standby' when there was a drop in amplitude by 50%, and a subsequent regain in amplitude over a prescribed course of 10 minutes. The average 'standby' time was just over 6 minutes which did not add significant intraoperative time with this technology. A previous experiment by the same group demonstrated a nearly full recovery in EMG amplitude after 10 min when the RLN was exposed to stress. Therefore, return of amplitude over the course of 10 min was the endpoint for a significant return.

The value of the 10-minute standby as the endpoint for a significant return in amplitude is debatable because there is no other timeframe or data point for comparison. The authors of this study relied upon the return of EMG potential or amplitude to pre-dissection value without a LOS that they defined as amplitude <100 mV with suprathreshold stimulus. The time point for significant return is a novel concept in this study. Previous studies have demonstrated the relationship between pre- and post-dissection evoked potentials and the gradient between the two that may signify post-operative vocal cord weakness (7). There is no gold standard for a certain time-point for significant return so this is a suggestion based upon correlation.

The incidence of vocal fold palsy is also study specific. The authors also cite an incidence of temporary and permanent palsy rates of 0.96% and 0%, respectively. It is important to consider what the temporary rates of palsy would have been if the authors did not alter management based upon the intraoperative amplitudes assuming no false positives. It may have been equal or close to the rates as described. The significance of these rates is hard to verify without a control group. There were 18 cases that suffered a progressive decline in amplitude, all >50%, but there is no delineation of which nerves suffered a greater drop in amplitude and if a greater drop required potentially more time (or not) to recover. The authors mention only one case in which there was a greater than 50% drop during RLN dissection with no recovery after the standby, related to thermal injury. The nerve recovered two months post-operatively. There was no complete LOS post-dissection. The lack of permanent vocal cord palsy assumes that the use of intraoperative nerve monitoring changes the rate of vocal cord palsy. The lack of false positives in this study should be challenged with repeat studies and reproducible results in order to confirm the suggested low rates of palsy. There are no complications encountered during the study as it related to permanent vocal fold palsy and/or intraoperative complication to the patient or inconvenience to the surgeon. Continuous IONM was easy to perform in each patient.

The intraoperative results of this study were correlated with laryngoscopy post-operatively. It is also worth mentioning that each patient underwent preoperative laryngoscopy, a significant component of using IONM intraoperatively. According to the International Neural Monitoring Group, preoperative laryngoscopy is a crucial baseline that must be obtained when employing the use of intraoperative nerve monitoring, in order to interpret amplitude changes and the effects on post-operative vocal cord mobility (8). Multiple guidelines have only recently acknowledged the importance of preoperative laryngoscopy as a gold standard in baseline examination of thyroid surgical candidates (9-11), but practice paradigms have not matched this among all thyroid surgeons. It is important to highlight the importance of the baseline and post-operative direct visualization of the true vocal cords as a significant step in any thyroid surgery if we are to truly evaluate functional outcomes.

The authors in this study exemplify how modifications in nerve monitoring technique may pave the way to achieve better possible outcomes for thyroid surgeons and their patients. Exclusive, continuous real-time monitoring of the RLN appears to be a feasible alternative to continuous vagal nerve monitoring. It also comes without the risks inherent and documented with continuous vagal monitoring (4). The authors discuss how this method is able to detect an adverse signal change early during the RLN dissection and allows the surgeon to change the course of the dissection immediately without further injury to the nerve and often with a recovery of signal. The main inconvenience to the technique is the necessity of an assistant to hold the probe throughout the case, thereby causing possible interference with dissection. While this study had no complications related to interference with dissection, this is a potential complication. In future studies, it may be worthwhile to consider the creation and placement of an electrode on the most proximal portion of the exposed RLN in the surgical field to avoid this inconvenience. While the results from this study appear promising the positive predictive value of this technique and of nerve monitoring in general is still not well understood and further evaluation of false positives and why they occur is necessary in order to refine the

technology and to determine the value of continuous nerve monitoring in thyroid surgery.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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