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MINIREVIEWS

Electrophysiological neuromonitoring of the laryngeal nerves in thyroid and parathyroid surgery: A review

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Abstract

Recurrent laryngeal nerve (RLN) injury is one of the most common complications of thyroid surgery. Injury to the external branch of the superior laryngeal nerve is less obvious and affects the voice variably; however, it can be of great significance to professional voice users. Recent literature has led to an increase in the use of neuromonitoring as an adjunct to visual nerve identification during thyroid surgery. In our review of the literature, we discuss the application, efficacy and safety of neuromonitoring in thyroid surgery. Although intraoperative neuromonitoring (IONM) contributes to the prevention of laryngeal nerves injury, there was no significant difference in the incidence of RLN injury in thyroid surgery when IONM was used compared with visual identification alone. IONM use is recommended in high risk patients; however, there are no clear identification criteria for what constitutes "high risk". There is no clear evidence that IONM decreases the risk of laryngeal nerve injury in thyroid surgery. However, continuous IONM provides a promising tool that can prevent imminent nerve traction injury by detecting decreased amplitude combined with increased latency.

Key words: Neuromonitoring; Superior laryngeal nerve; Recurrent laryngeal nerve; Thyroid surgery

Core tip: As recurrent laryngeal nerve injury is one of the most common causes of medicolegal litigation after thyroid and parathyroid surgery, securing the nerve is an increasing demand in these surgeries. Although visual identification has been used as the gold standard and had been proved to reduce the rate of laryngeal nerves injury, intertwining with inferior thyroid vessels and unusual course of the nerve may be challenging. Neromonitoring has been introduced as a novel technique to help identifying the nerve and prevent misidentification of any cord-like structure as a nerve, the thing that can reduce rate of laryngeal nerves injury.

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INTRODUCTION

Visual identification of the recurrent laryngeal nerve (RLN) is considered the gold standard in the prevention of nerve injury during thyroid surgery[1-3]. Although visual identification of RLN during thyroid surgeries decreases the rate of permanent RLN injury, it remains the most common cause of medicolegal litigations after these surgeries[4].

In addition to the morbidity caused by bilateral vocal cord paresis, monetary settlements to plaintiffs can reach up to millions of dollars[5]. The RLN is at higher risk of injury during thyroidectomy in high risk patients, including patients with substernal goiter, advanced thyroid cancer, or patients undergoing reoperation[6,7].

Intra-operative nerve monitoring (IONM) technologies were first reported to decrease the risk of RLN injury by Shedd and Durham in 1965[8]. Intramuscular vocal cord electrodes were described by Basmajian in 1970[4]. It was proposed that IONM could be useful in nerve identification and prevention of RLN injury in thyroid surgery[2,6,9]. However, IONM was not proven to decrease the rate of permanent RLN palsy[10,11]. Since IONM has been introduced, it has gained popularity, especially in the last decade[12]. It was reported that over recent years, about 65% of otolaryngologists and 53% of general surgeons use IONM in some or all of their cases[13,14].

Additionally, IONM has been reported to be a safe and feasible adjunct to the routine visual identification of the laryngeal nerves[7,15]. Some studies showed that IONM decreases the prevalence of transient RLN injury[6,16,17]. This may be due to its ability to aid in the dissection of the RLN near the Berry's ligament, as it enhances the detection of branched nerves and reduces traction injury of the anterior branches of these nerves[16]. Another study reported that IONM is effective in video-assisted thyroidectomy as it makes surgeons more comfortable[18].

In contrast, studies comparing IONM to the routine visual identification of RLN showed no statistically significant differences in the rate of overall, transient or permanent RLN palsy[10,19-22], but this may simply be due to the low incidence of RLN palsy. It has been reported that at least 39907 nerves at risk for both groups, either IONM or visual identification, are needed to show a significant difference in the nerve injury rate[2].

IONM did not show much improvement with experienced thyroid surgeons, with an RLN injury rate of < 1%[6]. However, it showed a decrease in the incidence of permanent RLN palsy in the hands of low-volume surgeons[2]. Studies have also recommended the use of IONM in patients whose laryngeal nerves are at higher risk of injury[7,21]. A single study analyzed the performance of IONM in repeat thyroid surgeries and found that it did not reduce the incidence of RLN injury in these patients[23].

Sari *et al*[24] showed that IONM decreases operative time when compared to visualization alone by shortening the time needed to identify the RLN. However, a systematic review reported no difference in operative time when IONM was used compared to visual identification alone[22].

It was reported that IONM can prognosticate the postoperative status of the RLN as an intact non-reduced monitoring signal at the end of the operation. This is consistent with a negative predictive value higher than 97%[2,6]. However, with loss of signal, the positive predictive value was reported to be as low as 33%-37.8%[2,6]. It is recommended that contralateral surgery be avoided if loss of signal is encountered in the first lobe resection[6].

Though IONM is considered a safe procedure, it carries some limitations. It is difficult to determine whether the change in EMG amplitude is due to nerve injury or loss of contact between vocal cords and recording electrodes. In addition, EMG signal can also be affected by anesthesia and manipulation of trachea.

Intermittent IONM assessment of nerve integrity is limited to the short interval of direct stimulation. Hence, RLN palsy is usually detected after it has occurred. It is also limited to testing the part of the nerve distal to the point of nerve stimulation, thus it can easily miss proximal nerve injury, or injury in the gap between 2 stimulations.

Continuous IONM was introduced as a superior modality that can avoid periodic short timed stimulation and more accurately detect proximal injuries. A clip is placed over the vagus nerve and stimulates it periodically at short intervals. This allows it to recognize any lesion along the RLN or external branch of the superior laryngeal nerve (EBSLN), even the most proximal[25]. By providing vital intraoperative information about impending RLN injury caused by suture compressing the nerve or traction, continuous IONM allows surgeons to take measures to reverse the adverse condition and save the nerve. Traditional stimulator probes should still be used in conjunction with the continuous IONM system as it helps in mapping the nerves.

Supporters of IONM claim that its use helps to protect the RLN and EBSLN by detecting them before visualization, providing information about nerve function during surgery, and by detecting anatomical variants that are at higher risk of injury[3]. However, some disadvantages include possible technical failures such as electrode displacement, and a high rate of false positive results leading to unnecessary staging in bilateral surgeries[3].

CONCLUSION

IONM has some advantages over visual identification

alone. Most injured nerves appear intact by visual inspection, but IONM provides a more accurate prediction of postoperative neural function. In addition, IONM helps avoid bilateral RLN injury by staging the operation if a nerve injury is encountered in the initial side of a bilateral operation. Continuous IONM is a promising improvement over traditional monitoring as it can give timely information about nerve status which may reverse impending nerve injury. Additionally, it can detect proximal nerve injury which might be missed by intermittent IONM of the RLN. Although some studies showed that IONM decreases the rate of RLN palsy, most of the studies reported no statistically significant difference between it and visual identification regarding laryngeal nerves injury. Due to the low incidence of permanent RLN palsy, more controlled studies with larger populations are warranted to provide a better assessment of this technique in preventing laryngeal nerve injury.

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