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International consensus

International consensus (ICON) on comprehensive management of the laryngeal nerves risks during thyroid surgery

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ABSTRACT

The laryngeal monitoring of the inferior and superior laryngeal nerves, and the vagus nerve, has advanced for last years, in practice of thyroid and parathyroid surgery. Different methods are used, using direct or indirect laryngeal stimulation and also intermittent or continuous nerve registration. At present time, various recommendations of it in the world use are reported, and availability of the tool used remains a limit in some countries. The aim of this Icon during Ifos 2017 was to share knowledge about laryngeal intraoperative nerve monitoring (LIONM) procedures and to evaluate current practices used to improve the quality of thyroid and parathyroid surgery. Benefits of LIONM were discussed with three experts (Pr G. Randolph from Boston, Pr Henning Dralle from Halle in Germany, Pr Hoon Yub KIM from Seoul). All of them have been actively involved in the development and use of laryngeal nerve monitoring during thyroid and parathyroid surgery.

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1. Introduction

The laryngeal intraoperative laryngeal nerve monitoring (LIONM) has advanced for last years, in the practice of thyroid and parathyroid surgery, improving the outcome of patients undergoing neck surgery [1]. The recurrent laryngeal nerve (RLN), which is located near the thyroid gland, supplies the main motor function to the larynx. Damage to this nerve during surgery can result in a patient losing the ability to speak, to breath and to swallow.

The first condition well-demonstrated of laryngeal nerve preservation is its visualization [2–6]. This is also required for LIONM. Pre- and postoperative laryngoscopy also remains a condition to evaluate preservation of laryngeal nerves [7]. It is very important to ascertain if there is or not laryngeal paralysis and term of paresis following surgery should be excluded in this postoperative evaluation.

To monitor the nerve during surgery can help to avoid damage to the nerve, both the inferior and superior laryngeal nerves, to prevent nerve injury during surgical manipulation, and also to provide a prognosis for postoperative nerve function. However, one study assessed nerve monitoring impact with significantly lower rates of temporary RLN paralysis with LIONM [8], in contrast to others who reported no difference in transient or permanent paralysis of the recurrent laryngeal nerve (RLN) [9–12]. The limit to demonstrate efficacy of LIONM is related to the low incidence of RLN paralysis [4]. IONM decreased the incidence of transient RLN paralysis in repeated thyroid surgery [13–15]. Recently, Bergenfelz et al. [16] reported from a large Scandinavia database, a significant reduction in permanent RLN paralysis with LIONM utilization, but only 33% of postoperative laryngoscopy was performed.

Various LIONM methods have been used, direct electromyography by needle or hook wires placed in cricothyroid or thyroarytenoid muscles to test either the superior or the inferior laryngeal nerves, or the use of adhesive surface electrodes or the electrode itself embedded in the endotracheal tube (ETT) to monitor muscles by stimulation of superior or inferior laryngeal nerves [13], or the vagus nerve. The use of ETT is gaining popularity due to ease of setup for all surgeons, especially for non-otolaryngologists. Furthermore, intermittent (I-LIONM) or continuous nerve registration (C-LIONM) [17–20], with automatic periodic stimulation (APS) electrode on the vagus nerve [21,22], may be recorded, also during endoscopic and robotic surgery [23,24]. The system Inomed

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(Neurosign® 100/400/800; Inomed GmbH, Feningen, Germany) or NIM (NIM2, NIM3; Medtronic Xomed, Jacksonville, Floride, USA) are the most commonly used.

One of the great benefits of LIONM utilization is to perform a staged thyroidectomy when a loss of monitoring signal (LOS) is intraoperatively detected on the first side during planned bilateral thyroidectomy, to avoid risk of contralateral RLN injury and bilateral RLN palsy [25–29]. LOS is defined as decrease of the nerve amplitude unless 100 μV from a baseline amplitude of more than 500 μV after supra-threshold vagus stimulation at 1 to 2 mA Loss of neuromonitoring signal is subdivided into segmental, focal type 1 injury, and global LOS type 2 [26,30–32]. Type 1 reflected more severe nerve damage than global nerve injury. It is interesting to notice that injury on the first laryngeal nerve detected may dramatically increase from 9 [33] to 17% [34] the risk of contralateral laryngeal nerve damage [29].

In addition to intraoperative information in determining surgical strategy in patients undergoing bilateral (para)thyroidectomy, LIONM may also be determinant to predict prognosis of nerve injury.

At present time, recommendations of LIONM is reported, but its current use remains various around the world, partly due to availability of the tool. Recent guidelines from the American Academy of Otolaryngology Head and Neck Surgery recommend IONM use in thyroid surgery to improve voice outcomes [35]. The German Association of Endocrine Surgeons practice guidelines and the International Neural Monitoring Study Group guidelines both support using IONM in all thyroid surgeries [26,36], while the American Head and Neck Society endorses its utilization in thyroid cancer cases, especially in patients with preoperative RLN palsy [37]. In France, the Rapport of the French ORL, expressed that its use is especially recommended in bilateral dissection of RLN, in preoperative RLN paralysis, and in cases of previous thyroid surgery [38,39].

All of experts have been actively involved to LIONM guidelines, during (para)thyroid surgery; we have proposed to share opinions in its use to discuss both current procedures and applications in view of the literature [40]. Six selected questions have been previously addressed to experts (Hoon Yub Kim, HYK; Gregory W. Randolph, GR; Henning Dralle, HD) and exposed.

This reported ICON does not include grade of recommendations, since these are different and precised from different group of experts [13,26,38,39], and this work is an experts' point of view and not a recommendation.

2. Selected questions

- Which system of LIONM do you use during thyroid/parathyroid surgery (electrodes on endotracheal tube, translaryngeal electrodes)?
- Which nerves are systematically recorded by laryngeal LIONM during thyroid/parathyroid surgery? Is there specific method for LIONM during robotic thyroid surgery?
- Is continuous LIONM (C-LIONM) indicated in selected cases?
- How do you confirm loss of signal during LIONM and consequences on surgery?
- In cases of laryngeal IONM not available, do you modify the dissection of the RLN?
- Usefulness of LIONM for prognosis of laryngeal nerve paralysis?

2.1. Which system of LIONM do you use during thyroid/parathyroid surgery (electrodes on endotracheal tube, translaryngeal electrodes)?

HY: I use the EMG electrodes on the endotracheal tubes for LIONM in all my thyroid and parathyroid operations. Mores specifically, the system more used for LIOM in my experience is the NIM 3.0 system from the Medtronic, along with the classic NIM Contact Tube, because the NIM Trivantage tube is not imported to Korea yet.

GR: I think currently virtually all utilizing neural monitoring routinely use electrodes on the endotracheal tube. There are experimental trends laryngeal electrode options but I would say these have not penetrated into the typical neural monitoring surgical venue to any significant extent.

HD: We started with routine use of I-IONM in 1997 by using translaryngeal stich electrodes to the vocal muscles. Since 2002, we are using tube electrodes only as well for I-IONM as since 2011 for continuous vagus stimulation (C-IONM).

2.2. Which nerves are systematically recorded by laryngeal IONM during thyroid/parathyroid surgery? Is there specific method for LIONM during robotic thyroid surgery?

HYK: I always monitor the vagus and the RLN in all types of thyroid and parathyroid operations, including the robotics. In addition, I always try to monitor the external branch of the superior laryngeal nerve as well, however, in some cases, it is difficult to monitor the EMG response of external branch of the superior laryngeal nerve by the system because the sensitive Trivantage tube is not available in the market in Korea.

I have done hundreds of BABA robotic thyroidectomies, and recently more than a hundred of transoral robotic thyroidectomies with I-IONM. You may grasp and use the needle nerve stimulator incorporated into the trocar insertion site by the robotic needle driver. However, I've found that it is more easy and convenient to use the robotic monopolar cauterization hook as the nerve stimulator, which can be easily transformed by simply connecting the NIM system to the hook with simple electric conducting wires.

GR: most typically the vagus, RLN and external branch of the superior laryngeal nerve are monitored-or can be monitored. I would say most commonly data is routinely obtained on the RLN, next most common is vagus and probably least common external branch of the superior laryngeal nerve in terms of what is currently performed.

HD: I have some experience with transaxillary endoscopic thyroidectomy but not with robotic, neither transaxillary nor transoral. During open thyroidectomy, we are using routinely C-IONM by APS electrode. I-IONM is used only in the case of parathyroidectomy (first surgery) for primary hyperprathyroidism. With I-IONM and C-IONM RLN and vagus nerve, EMG's are routinely recorded before and after resection (V1; R1; V2; R2). External branch of the superior laryngeal nerve is recorded only when successful EMG is obtained.

2.3. Is continuous LIONM indicated in selected cases?

HY: I use C-IONM in all my open conventional cases, because I believe it has the great role to make it possible to avoid the traction injury of RLN. However, frankly speaking, I do not use C-IONM in all my series of transoral robotic thyroidectomies, because it really takes extra time and effort for me to put the automatic periodic stimulating (APS) around the vagus nerve in the robotic operations. But it is fortunate and glad to find out that I had not experienced any traction injury case in my recent > 130 consecutive transoral robotic thyroidectomy series, which may be reported to be the advantage of the cephalo-caudal procedure.

GR: continuous monitoring is still, I am afraid, in its infancy, but has great application for the potential prevention of traction injury.

HD: in my departments C-IONM is used in all cases. We do not favour selective C-IONM, because we have learned and published with the International Nerve Monitoring Study Group (INMSG) that instead of direct nerve injuries with LOS Type 1, indirect nerve

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