ORIGINAL PAPER

NEUROMONITORING THE BRANCHES OF THE RECURRENT NERVE DURING THYROIDECTOMY

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Abstract

The lesions of the laryngeal nerves are the most severe long term complications after thyroidectomy. Visual identification of the recurrent laryngeal nerve during thyroid surgery has been recommended in many studies as the golden standard of RLN treatment. The non recurrent laryngeal nerve should always be taken into consideration in order to avoid accidental injury during thyroid surgery. Laryngeal recurrent nerve can be difficult to identify because of rare anatomical variants, extra laryngeal branches, or in complicated thyroid operations, such as voluminous goiter or thyroid cancer. Intraoperative nerve monitoring is secure for the patient, easy to use and useful in showing the integrity of laryngeal recurrent nerve, both during and after surgery. The Departament of Surgery, Valcea Country Hospital, from January 2014 to April 2015, developed a prospective study which enrolled 123 patients who underwent thyroid interventions with neuromonitoring and all had been treated by the same surgeon. The signal obtained from RLN localization, 215 nerves (96%), from a total of 222 , show a clear and reliable EMG response. 7 nerves (3%) were not received through EMG signal. In 3 cases involving 5 RLN there was a false negative result caused by electrode malposition and in 2 cases the RLN was injured during surgery. Clinical evolution of the procedure and more extended studies are needed to show if intraoperative monitoring decreases the rate of recurrent laryngeal nerves iatrogenic injury.

Keywords*: intraoperative nerve monitoring, recurrent laryngeal nerve, electromyography*

Introduction

Preservation, both anatomic and functional, of the recurrent laryngeal nerve (RLN) is the golden standard during thyroid surgery. Visual identification of RLN has decreased the incidence of injury from 5% to 1%. However, iatrogenic lesions of the laryngeal nerves are one of the most severe complications post thyroidectomy [1]. This is one of the most frequent causes of medicolegal litigation after thyroid surgery (50%). 90% of these pertain to RLN injury. In the end, in only one of three cases the judgement is in favour of the accused [2].

Various risk factors of RLN injury have been identified during total thyroidectomy, voluminous goiter and thyroid cancer. Also, an important risk factor is a surgeon with less experience [3].

Inside the larynx, the nerve usually divides in branches. Page [4] and Casella [5] show a single

branch in 91% of cases and two branches in 19% of cases, contrary to Yalcin who renders evident a single branch in 7.3% of cases and two branches in 85% of cases.

The Zuckerkandl Tubercle (TZ), the Berry ligament and the inferior thyroid artery are the most important landmarks for RLN dissection [7].

An embryological rest, which is the most important landmark for dissection, TZ is present in 60% to 90% of adult glands [8]. This is often placed in the medium third of the thyroid lobe (82%), but it can be evident in the inferior part (12%) or the superior one (5%) [9]. In more than 90% of the cases the nerves pass beneath the TZ [10].

RLN can be coated by an extension of conjunctive tissue at the level of the Berry ligament, this being the place where injuries occur the most [7].

Relationships between RLN and inferior thyroid artery have a great variability. RLN or its branches can cross the inferior thyroid artery anteriorly, posteriorly or among its branches [7]. Sometimes the recurrent laryngeal nerve may be non recurrent. It is an abnormality which suggests an embryological disorder [11].

When there is evidence based on medicine, surgeons search for a new adjunct designed to allow better identification of nerves at risk and also to reduce complications. The first use of technology was published in 1965 [2]. Davis and Eisele introduced the laryngeal electrode [6]. The electrode is applied on endotracheal tubes and gives intraoperative information about vocal folds function. Since 2000, the implication of commercial firms in the development of laryngeal electrode has spread the intraoperative nerve monitoring (IONM) technique all over the world [12].

Neuromonitoring uses low intensity stimulation current to stimulate RLN. IONM offers possibility to detect injuries before they become severe. A laryngeal electrode is applied in contact with vocal folds. Movements of the laryngeal muscle are determined by the current produced by the stimulating probe. Acoustic and luminous signal on the electrostimulation panel confirms the nerve integrity. Electromyographic signal (EMG) is received by the laryngeal electrod attached to the endotracheal tube [1].

Objectives - To evaluate the role of intraoperative neuromonitoring of RLN during thyroidectomy.

Material and methods

The Departament of Surgery, Valcea County Hospital, from January 2014 to April 2015, developed a prospective study which enrolled 123 patients who underwent thyroid interventions with neuromonitoring and all had been treated by the same surgeon. They have started monitoring RLN using a Neurosign 100 device (Figure 1) made by Magstim (U.K.).

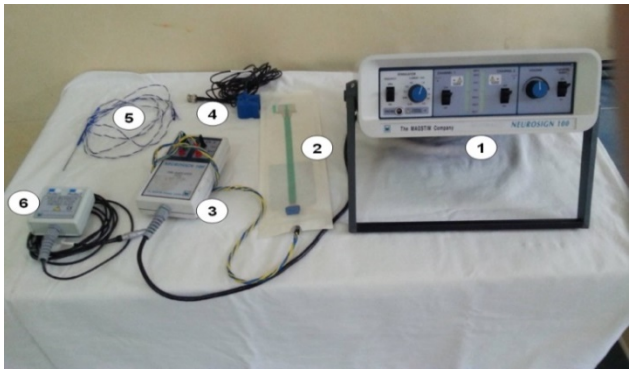

Figure 1 - Neurosign 100 stimulator includes: stimulator module (1), endotracheal electrodes (2), preamplifier (3), mute sensor (4), bipolar concentric stimulator probes (5), stimulator probe pod (6)

8 cases were excluded from the study because the device was unavailable for a short period. Inferior thyroid artery, Berry ligament and TZ were very important landmarks in the RLN localization and identification.

Pelizzo in 1998 was first to report the importance of TZ for the RLN dissection. TZ is especially placed in the medium third of thyroid lobe (82%). It can also be found in the inferior part (12%) or the superior part (5%). Non recurrent laryngeal nerve was a high risk anatomic situation and it was evaluated.

The first step is to attach the laryngeal electrode (Figures 2,3) to the endotracheal tube using the suggestions proposed by the manufacturer. The patient's position must not to be changed after intubation. Laryngeal contraction is obtained only in the absence of the neuromuscular block.

Neuromonitoring supposes three levels of stimulation: vagal stimulation, RLN localization and RLN identification.

After identification, the vagus nerve was stimulated with a 2mA electrical current. The vagus nerve was routinely tested to ensure the normal pathway of the RLN and that the monitoring system was working.

After opening the space between the thyroid gland and carotid sheath, the position of the RLN was localized with a stimulating probe at the tracheoesophageal groove. Initially, the surgical team tried to localize the RLN with an electrical current of 1-2mA. If the RLN localization failed at 2mA, the stimulation current would be increased to 3mA. EMG signal can be determined by shunt stimulus. In this situation, they have to lower the stimulation current to 0.5mA if they want to differentiate a small artery from RLN.

After the RLN was localized and identified, they tested it with a stimulation current with a low intensity for definite confirmation. In the end, the nerve was dissected to the entry of the larynx.

Results

The study enrolled 123 patients with thyroid disease hospitalized in Department of Surgery, Valcea County Hospital during a period of 16 months. 8 cases were expelled from the study. Among the 115 remaining cases they visually identified 222 RLN. In 162 of the 222 cases (72%) TZ was recognizable. 154 patients (95%) had RLN posterior from TZ and lateral from this in 8 cases (5%). Non recurrent laryngeal nerve is an embryological disorder and a rare anomaly, but they found 2 non recurrent laryngeal nerves. The signal obtained from RLN localization, 215 nerves (96%), from a total of 222, show a clear and reliable EMG response. For 7 nerves (3%) there were no received EMG signals.

In 3 cases (2 total thyroidectomies and 1 lobectomy) involving 5 RLN there was a false negative result caused by electrode malposition and in 2 cases the RLN was injured during surgery: in one case deliberately (tumor invasion) and in one case accidentally. In case of RLN extra laryngeal ramification they monitored the branches distinctively. In this case they had to diminish current intensity to avoid shunt stimulus. The EMG amplitude signal was different between the anterior and posterior branch. In the anterior branch the signal amplitude is high and in the posterior branch the EMG signal is very low [12].This means that there are huge differences between branches in terms of conducting the EMG signal. Two grounds are important to mentioned: the motor fibers of RLN or the anterior branch perform the motor fibers for the most important laryngeal muscle [14].

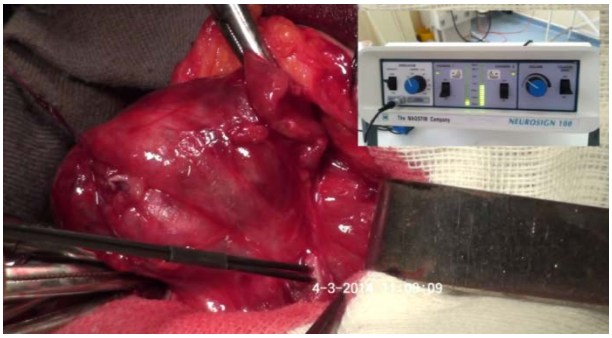

Figure 2 - Recurrent laryngeal nerve

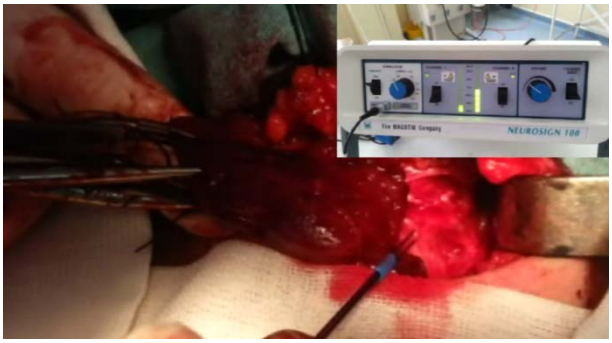

Figure 3 - Recurrent laryngeal nerve (anterior and posterior branches)

Discussions

The authors of a multicenter study have motivated that neuromonitoring reduces the incidence of postoperative paresis [15]. In their study, recognizable TZ proves to be an important landmark for RLN. When they can identify TZ the nerve is almost always beneath it (95%). Unfortunately TZ is not identifiable every time. If TZ is too small, under 5mm and in case of multinodular goiter with nodules placed on the posterior side, it is difficult to distinguish between TZ and a goiter nodule [12].

It is important to notice that by monitoring the branches of RLN they obtain major EMG signal on the anterior one. The surgical meaning is that the anterior branch is carrying the most important motor fibers and they have to pay extra care to the correct identification and preservation of it [12].

These results confirmed that IONM is a good tool for the localization of the RLN and confirmation of its integrity during thyroid operations, especially in difficult cases. By using neuromonitoring during thyroid surgery, RLN injury rarely occurs [12].

Conclusions

IONM is safe for patient, easy to use and useful in showing the integrity of RLN.

Neuromonitoring is useful in difficult cases when the risk of lesion is high.

Recognizable TZ is a reliable landmark for RLN visual identification during thyroidectomy.

More advanced studies are needed to show if intraoperative monitoring decreases the rate of RLN iatrogenic injury.

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