

Intraoperative recurrent laryngeal nerve monitoring in thyroid surgery

Evaluation of its use in terms of “spending review”



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Alessandro Sanguinetti*, Domenico Parmeggiani**, Roberta Lucchini*, Massimo Monacelli*, Roberta Triola*, Stefano Avenia*, Claudia Conti*, Giovanni Conzo**, Nicola Avenia*

*Endocrine Surgery Department University of Perugia, Italy

**Surgery Department II University of Naples, Italy

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BACKGROUND: Intra Operative Nerve Monitoring (IONM) has been used in head and neck surgery since the 1970s. Its utilization for monitoring and protecting the recurrent laryngeal nerve, however, is a controversial subject. This paper details the use, value, and cost of this technology within a single institution.

METHODS: We conducted a retrospective chart review, analysis of surgery time with and without IONM, analysis of postoperative vocal cord function, and review of the literature

RESULTS: IONM did not reduce the operative time during total thyroidectomies in our experience. Use of IONM increased the cost of each surgery by € 450. IONM did not decrease the number of injured nerves (postoperative paresis).

CONCLUSIONS: IONM has proven to be highly useful in certain circumstances but has not been definitively proven to protect the nerve any more effectively than the gold standard of nerve visualization. In our study, the use of IONM did not reduce the time of thyroid surgery and did increase the cost. While IONM may, in special clinical circumstances such as revision and malignant thyroid surgery, increase the value of the operation, its use for every thyroid surgery does not appear to be cost effective or valuable to the patient.

KEY WORDS: Costs, Intraoperative Nerve Monitoring, Use, Value

Introduction

Thyroid surgery is a technically specific surgery involving highly detailed anatomy. The recurrent laryngeal nerve (RLN) is the most important structure at risk dur-

ing thyroidectomies. The gold standard for protecting the nerve is identifying it through careful dissection before proceeding with the removal of the thyroid gland. In the 1950s, Riddell¹ reported this technique of comparing identification and unidentification of the nerve during thyroidectomies. Since that report, nerve visualization, anatomical knowledge, and surgeons' experience have been the most important tools for protecting the RLN and still serve as the standard of care. The variability in the nerve's course can lead to trouble with identification and increase the risk of injury when surgeons are inexperienced¹⁴ Although the rate of injury to the nerve has been reported to be relatively low – up

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Correspondence to : Alessandro Sanguinetti, MD (e-mail: a.sanguinetti@aospn.it)

to 6% for temporary paresis and up to 2% for paralysis – most believe that these types of injury must be reduced further ². Multiple devices over the years have helped surgeons identify the course of the RLN.

Feinstein ³ first mentioned electromyography (EMG) use in diagnosing disorders of the RLN in 1946. Delgado et al ⁴ were the first to use EMG intra operatively to identify the facial nerve in 1979, but Brennan and colleagues were the first to publish their data on RLN monitoring in 2001 ⁵. Intraoperative nerve monitoring (IONM) has become the most widely used adjunct for identifying the RLN and allows real-time identification and functional assessment of the RLN in the operative field ¹³. The Nerve Integrity Monitor Pulse II tube (Xomed, Jacksonville, FL) is a popular device used to monitor the nerve via EMG ⁶. This technology uses spontaneous and evoked potentials to monitor the functionality of the vocalis muscle and the RLN. Spontaneous EMG allows visualization of spontaneous muscle action potentials (MAPs) from nerves with tonic or background activity and also from mechanical stimuli such as dissection or retraction.

The surgeon can use a probe to send a stimulatory impulse to the nerve stimulating the vocalis muscle; in turn, the surface electrodes on the endotracheal tube pick up if the vocal cord muscles respond to the stimulus. An injured nerve will require a higher stimulus than an intact one, allowing for the detection of early injury ⁶. The use of this technology in thyroid surgery has been a much debated topic for years. No consensus exists regarding IONM's effectiveness in preventing RLN injury. Multiple papers have failed to prove with statistical significance that the use of IONM during thyroid surgery decreases the rate of RLN palsy or paresis ⁷. A large prospective evaluation study ⁸⁻¹¹ showed that IONM helps during revision surgery, but research has not proven IONM use to be more effective than nerve identification alone for protecting the nerve during thyroid surgery. This study assessed whether or not the use of IONM is cost effective in thyroid surgeries. We hypothesized that the use of IONM might decrease operating time enough to cover the cost of the device and/or decrease the overall cost of the surgery.

Methods

This study was conducted with the approval of the Endocrine Surgery Department of Azienda Ospedaliera "Santa Maria" in Terni. Our retrospective chart review compared the duration of total thyroidectomies from a surgical endocrine team with and without the aid of IONM in an effort to determine cost effectiveness. We compared the means and medians of the surgery time with and without implementation of IONM. We also analyzed perioperative vocal cord paresis and paralysis and reviewed the current and past literature.

Results

In the 2012 year 350 total thyroidectomies were performed with potentially 700 nerves at risk. The surgeons used IONM in 105 (30%) of the surgery; in this group the RLN was identified at the tracheo-esophageal groove by the application of a bipolar probe to deliver an electric current that ranged from 0,5 to 1,5 mA at a frequency of 30 Hz. The identity of an intact RLN would be confirmed through a series of audible acoustic signals that were generated by the machine.

The functional nerve integrity once again would be confirmed at the end of the thyroidectomy by the testing of the most proximal exposed portion of the nerve. The absence of a signal that was generated by the stimulator at any precise point along the nerve would be accepted as a positive test. All patients were examined pre and post operatively with routine vocal cord examination at 24 to 48 hours before and within 2 weeks after the surgical after the surgical procedure by otolaryngologist using an indirect or flexible laryngoscope. Any reduction in the vocal cords movement was recorded as postoperative cord palsy.

The average time of a total thyroidectomy was 101 minutes; total thyroidectomies using IONM were on average 2.6 minutes shorter than non-IONM cases (Table I). The use of IONM increased the base price of each case by € 450. Twenty-six of the 700 nerves at risk were injured during surgery (3,7%). With IONM in use, 9 of 210 (4,7%) nerves at risk were injured in a manner that caused temporary paresis. Without IONM, 13 of 490 (2,7%) nerves at risk suffered temporary paresis. Four cases of paralysis occurred when IONM was not used (0,8% of 490 nerves at risk).

Discussion

The use of IONM during thyroid surgery has been and will continue to be a highly debated subject. IONM's use for thyroid surgery as an adjunct for decreasing nerve injury during thyroid lobectomies and total thyroidectomies is questionable, although it has proven valuable

TABLE I

Procedure	N°	Mean	SD	Range
Thyroidectomy without IONM	245	102,3	(27,3)	55-156
Thyroidectomy with IONM	105	99,7	(40,0)	66-202

The average total thyroidectomy using IONM was 2,6 minutes shorter than without using IONM (no statistical significance)

TABLE II

	Cost of devices (€)	Cost of Human Resources (€)	Cost of O.R (€)	Cost of Hospitalization (€)	Total (€)
Thyroidectomy with IONM	450	359,58	736,85	1500	3046,43
Thyroidectomy without IONM		359,58	758,35	1500	2596,43

TABLE III

	Injured Recurrent Laryngeal Nerve	Paralysis	Temporary paresis	%
Thyroidectomy with IONM	9/210		9	4,7
Thyroidectomy without IONM	17/490	4 (0,8%)	13	2,7

in certain circumstances, such as revision thyroid surgery in which anatomical landmarks are obscured. However, IONM has not been definitively proven to decrease the rate of RLN injury any more effectively than nerve visualization alone. In 2004, Dralle assessed thyroidectomy in 3 groups: no RLN identification, visual identification alone, and visual identification plus IONM identification. They concluded that for surgeons performing fewer thyroid operations on average, IONM decreased the number of paralyzed nerves. However, further examination did not show a difference in RLN injury rates. In one of the largest retrospective studies of a single surgeon, Shindo and Chheda⁹ in 2007 showed no statistically significant difference in paresis between visualization alone and IONM plus visualization. Thomusch and colleagues¹⁰ showed in 2004 with 15,403 at-risk nerves that IONM can be effective in assisting surgeons but “did not prevent injuries” and “did not make an unsafe surgeon into a safe surgeon.” IONM is an adjunct that may be helpful, but it should never replace the meticulous technique of the surgeon. In this study, IONM increased the length of length of total thyroidectomies by 2.6 minutes. These numbers are not statistically significant. The cost of each surgery with IONM was € 450 higher than without its use (Table II). The actual cost is probably higher when using the IONM system because a nerve monitor technician must be present in the operating room for every case in which the system is employed.¹⁵ Therefore, the use of IONM increased the total cost of surgeries by at least € 47,250 (€ 450 multiplied by 105 surgeries with IONM) without any definitive increase in value: IONM would have to either increase the safety or decrease the cost of the operation, neither of which IONM did in this analysis. Our rate for temporary paresis and paralysis of 3,7% was on par with the average reported range^{7,12}. When using IONM during the surgery, the rate of temporary paresis was actually 1.2% higher than when not used. An injury to 4 of 490 (0.8%) at-risk nerves resulted in a paralysis;

IONM was not used during that case. The difference in the rate of RLN palsies with or without the use of IONM was not statistically significant. Important limitations of this study include the small number of cases, the retrospective analysis, and the lack of histopathology of the thyroid disease for each case. This last concern led the authors to consider that IONM is definitely valuable in patients with prior cervical exploration/thyroidectomy, malignant pathology, previous head and neck radiation, Hashimoto thyroiditis, and/or unilateral vocal fold paralysis in which thyroidectomy is indicated on the opposite lobe.

Conclusion

The use of the IONM for every thyroid surgery does not prove cost effective or valuable to the patient. We found no statistically significant surgical time decrease using IONM – it actually tended toward increased surgical time during thyroidectomy – and an overall increased cost of surgery. While previous literature has proven distinct advantages in using IONM in revision and malignant thyroid surgery,⁸ we found no record of cost analysis. To our knowledge our data – while limited in power – are the first of their kind.

Riassunto

Il monitoraggio intraoperatorio del Nervo Laringeo Ricorrente è utilizzato nella chirurgia della tiroide sin dagli anni 70. La sua utilità nel monitorare e proteggere il nervo è, tuttavia, argomento ancora controverso. Abbiamo voluto valutare l'utilità ed il costo di tale metodica all'interno della nostra Struttura. I risultati ottenuti non hanno dimostrato diminuzione dei tempi operatori, non hanno dimostrato sensibile riduzione delle lesioni nervose iatrogene, hanno dimostrato un costo aggiun-

tivo di 450 € per ogni intervento. In conclusione possiamo affermare che tale metodica deve essere riservata al trattamento dei gozzi cervico-mediastinici ed alla chirurgia delle recidive e neoplasie tiroidee.

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