Intraoperative laryngeal nerve monitoring during thyroidectomy and parathyroidectomy: A prospective study

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KEYWORDS
Thyroid; Electromyography; Recurrent laryngeal nerve palsy; Nerve stimulation; Vocal fold

Summary
Objectives: The aim of this study was to stimulate the recurrent laryngeal nerve during thyroidectomy or parathyroidectomy and to record the muscle responses in an attempt to predict postoperative vocal fold mobility.

Patients and methods: Intraoperative recurrent laryngeal nerve monitoring during general anaesthesia was performed by using an electrode-bearing endotracheal tube (nerve integrity monitor EMG endotracheal tube [Medtronic Xomed, Jacksonville, Flo, USA]). Two hundred and fifteen recurrent laryngeal nerves from 141 patients undergoing total thyroidectomy (n = 74), hemithyroidectomy (n = 63), or parathyroidectomy (n = 4) were prospectively monitored. In each case, the muscle potential was recorded after stimulation of the recurrent laryngeal nerve by a monopolar probe.

Results: The nerve stimulation threshold before and after dissection that induced a muscle response of at least 100 μV ranged from 0.1 to 0.85 mA (mean 0.4 mA). The supramaximal stimulation intensity was defined as 1 mA. The amplitude of muscle response varied considerably from one patient to another, but the similarity of the muscle response at supramaximal intensity between pre- and postdissection and between postdissection at the proximal and distal exposed portions of the nerve was correlated with normal postoperative vocal fold function. Inversely, alteration of the muscle response indicated a considerable risk of recurrent laryngeal nerve palsy, but was not predictive of whether or not this lesion would be permanent.

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Introduction

Recurrent laryngeal nerve palsy is a serious complication of thyroid and parathyroid surgery with a published frequency ranging from 0.4 to 3.9% for transient nerve palsy, and up to 3.6% for permanent nerve palsy [1–4].

The consequences of recurrent laryngeal nerve palsy range from impaired quality of the voice in the case of a unilateral lesion to a risk of acute respiratory distress in the case of bilateral lesions, that may possibly require tracheotomy, arytenoidectomy or posterior cordectomy, with a risk of life-threatening respiratory complications.

Recurrent laryngeal nerve section, always responsible for permanent nerve palsy, is a very rare event (0.4% of operations) [5]. The other mechanisms of nerve damage include partial section, stretching, ligation, electrical and/or thermal trauma, ischaemia, but also oedema, inflammation and minor nerve trauma caused by manipulation of the operative specimen. The nerve usually appears macroscopically intact, but remains non-functional at the end of the operation (3.3 to 5.3% of operations) with a 95% chance of recovery. Traction of the anterior limb of a rapidly dividing recurrent laryngeal nerve (30% of cases) 1 to 2 cm proximal to its entry into the larynx is the most frequent mechanism of laryngeal nerve injury (28% of cases of palsy) according to Snyder et al. [5].

Identified risk factors are cancer, particularly cancer justifying an extensive surgical procedure with lymph node dissection along the recurrent laryngeal nerve, very large inflammatory goitre, late redo surgery, reoperations for bleeding complications, history of neck irradiation, anatomical variants of the nerve (non-recurrent right inferior laryngeal nerve), absence of identification of this variant [6] and limited operator experience [7].

Since the work by Lahey, there is now a general consensus that the best way of protecting the recurrent laryngeal nerve is to visually identify this nerve [1,7]. It would therefore be reasonable to suppose that any technique that facilitates or confirms identification of the nerve should decrease the incidence of recurrent laryngeal nerve injury.

Various methods of recurrent laryngeal nerve monitoring can be used; in every case, the nerve is stimulated directly or via the vagus nerve and the resulting muscle response is recorded.

We report the electrophysiological results of a prospective study of non invasive monitoring of 215 recurrent laryngeal nerves, in which recording electrodes were fixed directly onto the endotracheal tube and positioned in contact with the vocal folds.

Patients and methods

Patients

From January 2008 to December 2009, 141 patients (121 women and 20 men, with a mean age of 47 years; range: 18 to 85 years) underwent thyroidectomy (total thyroidectomy in 74 cases, lobectomy in 63 cases) and parathyroidectomy for adenoma (four cases) with continuous recurrent laryngeal nerve monitoring.

Thyroid disease mostly consisted of single benign nodules (35%) and multinodular goitre (29%), but also cases of papillary carcinoma (13%), toxic nodules (7%), Graves’ diseases (11%) and two cases of thyroiditis (Table 1).  

Monitoring

The NIM-RESPONSE monitoring system was used (Medtronic Xomed, Jacksonville, Flo, USA).

The electromyography intubation tube was a PVC endotracheal tube with a low-pressure cuff, equipped with two pairs of 3 cm long recording electrodes, positioned in contact with the vocal folds (Fig. 1). Two types of probes (Medtronic Xomed, Jacksonville, Flo, USA) were used: EMG Flex (each channel records the left and right recurrent laryngeal nerves) and Reinforced EMG (each channel records the homolateral recurrent laryngeal nerve). The endotracheal tube was placed under general anaesthesia to ensure that the electrodes were in contact with the vocal folds. Correct positioning of the electrodes was confirmed visually and electrically after placing a block under the shoulders.

Recording electrodes were connected to a monitor (integrity monitoring system) that continuously recorded the activity of the intrinsic muscles of the larynx, comprising an electrical generator allowing direct stimulation of the recurrent laryngeal nerve and/or vagus nerve by means of a 0.5 mm Prass monopolar stimulation electrode (Medtronic Xomed, Jacksonville, Flo, USA). The vocal fold recording electrodes were connected to channels 1 and 2 of the system, the earth electrode (green) and anode (white).

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Histopathological diagnosis.</th>
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<tr>
<td>Diagnosis</td>
<td>n</td>
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<tr>
<td>Papillary carcinoma</td>
<td>18</td>
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<tr>
<td>Benign nodule</td>
<td>49</td>
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<tr>
<td>Multinodular goitre</td>
<td>42</td>
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<tr>
<td>Graves’ disease</td>
<td>16</td>
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<tr>
<td>Parathyroid adenoma</td>
<td>4</td>
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<tr>
<td>Toxic nodule</td>
<td>10</td>
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<tr>
<td>Thyroiditis</td>
<td>2</td>
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</table>

n: number of patients; total: 141, 121 women, 20 men.
Thyroidectomy and laryngeal nerve monitoring

were placed in the shoulder muscles (deltoid) on each side, respectively, and the stimulation electrode was connected to the cathode. Electrode impedance was systematically verified after intubation, and during and at the end of the operation if necessary. The impedance of each electrode had to be less than 5 kOhm and the impedance difference between positive and negative electrodes of each channel ideally had to be as close as possible to zero and always less than or equal to 1 kOhm.

The electrical stimulator delivered a variable intensity current, ranging, in our study, from 0.1 to 2.5 mA; the stimulus lasted 100 μs at a frequency of four stimuli per second. A limit of detection of 100 μV was chosen to avoid interference of basal muscle tone and breathing with the responses.

General anaesthesia and surgery

Muscle relaxants were contraindicated during anaesthesia, apart from very short-acting muscle relaxants that were able to be used during anaesthetic induction, to avoid interference with electromyography during the surgical procedure. Thyroidectomy or parathyroidectomy was performed according to classical techniques with systematic visual identification of the recurrent laryngeal nerve [8].

Electrophysiological parameters recorded

After identifying the recurrent laryngeal nerve, the nerve was stimulated and the amplitude of the muscle response was recorded. The supramaximal stimulation value was determined by electrical stimulations of 0.5, 1.0, 1.5, 2.0 and 2.5 mA on 32 recurrent laryngeal nerves (19 patients). In the other patients, the recurrent laryngeal nerve was stimulated at the supramaximal value of 1 mA, and the stimulation threshold was then investigated by gradually decreasing the intensity of stimulation. The muscle amplitude recorded corresponded to the highest response to the four stimuli.

These supramaximal and threshold stimuli were repeated at the end of the operation at the distal and proximal extremities of the exposed nerve and the muscle responses were recorded.

Clinical data

Preoperative direct or indirect laryngoscopy was systematically performed in each patient to assess vocal fold mobility. All patients had normal preoperative vocal fold mobility.

Postoperative vocal fold mobility was analysed 1 week after the operation and then 2, 4, or even 6 months postoperatively in the presence of an abnormality.

Statistical analysis

The results are expressed as the mean ± standard error of the mean (s.e.m.). One-way analysis of variance (Anova) was used to compare the various groups. A P value of less than 0.05 was considered to be significant.

Results

Determination of the supramaximal stimulation intensity

Thirty-two recurrent laryngeal nerves (19 patients) were stimulated at various intensities (0.5, 1.0, 1.5, 2.0 and 2.5 mA); none of these patients presented any signs of recurrent laryngeal nerve palsy. The muscle response presented a stable amplitude (Anova, not significant) on both the predissection recordings (873 μV ± 103.4 at 0.5 mA, 1030 μV ± 115.2 at 1.0 mA, 1025 μV ± 112.5 at 1.5 mA, 1045 μV ± 119.5 at 2.0 mA and 978 μV ± 107.0 at 2.5 mA) and the postdissection recordings at the proximal extremity (838 μV ± 105.2 at 0.5 mA, 894 μV ± 98.3 at 1.0 mA, 906 μV ± 100.9 at 1.5 mA, 920 μV ± 99.5 at 2.0 mA and 942 μV ± 102.6 at 2.5 mA) and at the distal extremity (876 μV ± 103.7 at 0.5 mA, 914 μV ± 109.4 at 1.0 mA, 959 μV ± 104.7 at 1.5 mA, 971 μV ± 107.1 at 2.0 mA and 978 μV ± 107.0 at 2.5 mA) (Fig. 2). The 1.0 mA value was therefore adopted as supramaximal stimulation intensity.

Stimulation thresholds

In patients without postoperative recurrent laryngeal nerve palsy, the mean stimulation threshold was similar before dissection and at the end of the surgical procedure at the distal and proximal extremities of the exposed nerve (Table 2). The predissection stimulation threshold ranged from 0.15 to 0.85 mA and the postdissection stimulation threshold ranged from 0.15 to 0.80 mA at the proximal extremity and 0.10 to 0.80 mA at the distal extremity.
Muscle responses

Muscle responses to predissection stimulation and postdissection stimulation at the proximal and distal extremities ranged from 100 to 2962 μV, 100 to 2087 μV and 100 to 2102 μV at the threshold stimulation, and from 100 to 3224 μV, 100 to 2796 μV and 100 to 2906 μV at supramaximal stimulation (Table 3).

Cases of recurrent laryngeal nerve palsy

Six patients (4.3%), all operated by total thyroidectomy, presented postoperative unilateral impaired vocal fold mobility, which was permanent in one case (0.7%) and transient in five cases (3.5%), resolving in less than 4 months.

The patient with permanent recurrent laryngeal nerve palsy suffered from Graves’ disease in which the marked hypertrophy of the gland caused deep displacement of the recurrent laryngeal nerves. No muscle response was observed on the paralysed side after postdissection stimulation of the proximal and distal extremities at less than 1 mA and a low amplitude muscle response was observed after supramaximal stimulation. Postoperative vocal fold mobility was normal on the contralateral side, as stimulation thresholds were less than the mean value indicated in Table 2 and muscle responses to supramaximal stimulation were greater than the mean reported in Table 3.

In the five cases of transient recurrent laryngeal nerve palsy (four cases of multinodular goitre and one case of thyroiditis), the recurrent laryngeal nerves appeared to be visually intact.

In the first patient with thyroiditis, the distal stimulation threshold was not modified, while the stimulation threshold at the proximal extremity was undetectable. No muscle response was observed at supramaximal stimulation at 1 mA at the proximal extremity of the exposed nerve and the distal response was similar to that measured on the contralateral side. This patient recovered normal vocal fold mobility in less than 2 months.

In the second patient (multinodular goitre), the distal stimulation threshold was not modified, while the stimulation threshold at the proximal extremity was increased. The muscle response to supramaximal stimulation at 1 mA was decreased at the proximal extremity of the exposed nerve and the distal response was similar to that measured on the contralateral side. This patient recovered normal laryngeal function in less than 2 months.

In the third patient, the recurrent laryngeal nerve was distended by a very large lower pole nodule measuring 5 cm in diameter. Immediately following identification of the nerve, it responded positively to stimulation and the signal then suddenly disappeared during dissection. Functional recovery was observed in this patient in less than 2 weeks.

In the fourth patient, haemostasis performed by bipolar electrocoagulation close to the nerve following lobectomy induced loss of the electrical response at the proximal extremity of the exposed nerve with persistence of a muscle response and a normal threshold at the distal extremity. This patient recovered in less than 2 months.

**Table 2** Stimulation thresholds.

<table>
<thead>
<tr>
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<th>Predissection</th>
<th>Proximal postdissection</th>
<th>Distal postdissection</th>
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<tbody>
<tr>
<td>Mean ± s.e.m (n)</td>
<td>0.36 ± 0.01 (163)</td>
<td>0.38 ± 0.009 (198)</td>
<td>0.36 ± 0.009 (194)</td>
</tr>
<tr>
<td>Median</td>
<td>0.30</td>
<td>0.40</td>
<td>0.35</td>
</tr>
<tr>
<td>[min—max]</td>
<td>0.15—0.85</td>
<td>0.15—0.80</td>
<td>[0.10—0.80]</td>
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</table>

Stimulation thresholds (mA) on identification of the nerve (predissection) and postdissection at the proximal and distal extremities of the nerve in patients with normal immediate postoperative laryngeal mobility. s.e.m.: standard error of the mean; min—max: minimum and maximum values; n: number of nerves recorded.

**Table 3** Muscle responses.

<table>
<thead>
<tr>
<th></th>
<th>Predissection</th>
<th>Proximal postdissection</th>
<th>Distal postdissection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± s.e.m (n)</td>
<td>555 ± 41.9 (154)</td>
<td>509 ± 31.5 (191)</td>
<td>521 ± 31.5 (186)</td>
</tr>
<tr>
<td>Median</td>
<td>366</td>
<td>348</td>
<td>388.5</td>
</tr>
<tr>
<td>[min—max]</td>
<td>[100—2962]</td>
<td>[100—2087]</td>
<td>[100—2102]</td>
</tr>
<tr>
<td>Mean ± s.e.m (n)</td>
<td>910 ± 48.9 (189)</td>
<td>808 ± 43.9 (193)</td>
<td>821 ± 44.2 (190)</td>
</tr>
<tr>
<td>Median</td>
<td>774</td>
<td>649</td>
<td>668.5</td>
</tr>
<tr>
<td>[min—max]</td>
<td>[100—3224]</td>
<td>[100—2796]</td>
<td>[100—2906]</td>
</tr>
</tbody>
</table>

Predissection and distal and proximal postdissection muscle responses (μV) at the threshold and at maximum stimulation in patients with normal immediate postoperative laryngeal mobility. s.e.m.: standard error of the mean; min—max: minimum and maximum values; n: number of nerves recorded.
The fifth and last patient presented a very large goitre, larger than 180 cm³. The left recurrent laryngeal nerve, although clearly visualized, did not respond to any stimulation, while the right recurrent laryngeal nerve gave a positive response with simply an elevation of stimulation thresholds. This patient recovered vocal fold mobility in less than 4 months.

Figure 2  Amplitude of the muscle response (µV) to stimulation of the recurrent laryngeal nerve at intensities of 0.5, 1, 1.5, 2 and 2.5 mA prior to dissection immediately after identification of the nerve (A), postdissection at the proximal extremity (B) and postdissection at the distal extremity (C).

Discussion

Type of monitoring, thresholds, supramaximal intensity

Among the various methods of recurrent laryngeal nerve monitoring reported in the literature, the use of surface electrodes fixed directly to the endotracheal tube can be considered to be similar to that based on the use of monopolar electrodes placed endoscopically in the laryngeal muscles [9], bipolar electrodes placed during surgery through the cricothyroid membrane [10] or surface electrodes placed in contact with post-cricoid muscles [11,12]. Although the muscle potentials recorded with surface electrodes have a lower amplitude [10], similar stimulation thresholds (mean of 0.4 mA in our study) are obtained regardless of the method used [2,11–13]. Systems equipped with surface electrodes directly fixed to the endotracheal tube appear to be easier to use than intramuscular electrodes that are more complicated to insert and that can migrate during the operation, and which may not be correctly implanted in the right place [14] or may even break. The advantages of NIM RESPONSE are its ease of use and its noninvasive nature [14]. Correct positioning of the endotracheal tube did not raise any problems (provided a correct impedance value and good contact between vocal folds and recording electrodes are ensured, with the block in position) and no displacement of the tube was observed during the surgical operation. A continuous visual alarm, represented by an action potential on the monitor screen, and an audio alarm do not directly prevent mechanical injuries to the nerve, but allow detection of such injuries.

The present study clearly shows that the supramaximal stimulation value of 1 mA recruited all recurrent laryngeal nerve fibres and that more intense stimulation is not required. The variability of the stimulation threshold and especially the amplitude of the muscle response can be partly explained by differences of exposure of the nerve to the stimulation electrode from one case to another, as a nerve covered by a small amount of connective tissue requires more intense stimulation and/or induces a lower amplitude response than a more extensively exposed nerve [2]. Supramaximal stimulation also activates a greater number of nerve fibres than threshold stimulation and therefore generates a more intense muscle response. Finally, as emphasised by Hermann et al. [14], marked inter-individual variations are observed.

Value of the parameters recorded

Loss or modification of the electrical signal during the operation is difficult to interpret. All cases of transient or permanent recurrent laryngeal nerve palsy observed in this series presented discordant muscle responses that did not allow prediction of the prognosis either during the operation or immediately postoperatively. Persistence of an action potential indicates that at least part of the nerve is intact, but it does not necessarily guarantee contraction of the cricoarytenoid muscle. Another explanation proposed by Thomsch et al. [15] is that the intensity of stimulation delivered to the nerve is sufficiently high to “jump” the
gap at the site of nerve injury. We can therefore conclude that patients in whom no major alteration of the signal is observed have a reasonably good chance of not experiencing recurrent laryngeal nerve palsy, while loss or alteration of the signal is associated with a substantial risk of nerve palsy but is not predictive of whether this palsy will be transient or permanent, as alteration of this signal can correspond to a transient (conduction block) or more lasting lesion, depending on the mechanism of the injury.

The absence of muscle response to nerve stimulation does not exclude the possibility that the tissue stimulated actually corresponds to the nerve. The surgeon must therefore be aware of falsely reassuring false-negative responses [16], which can correspond to:

- a disconnected electrode;
- displacement of the endotracheal tube during placement of the block under the shoulders and surgical drapes or during the operation (rotation, raising or lowering) or use of an insufficiently large endotracheal tube [17];
- defective stimulator;
- stimulation not in contact with the nerve or at an insufficient stimulation intensity when the nerve is covered by fat or connective tissue;
- a curarized patient;
- transient palsy (conduction block).

False-positives can be observed when stimulation is delivered distal to the nerve injury, when a non-specific electrical signal is confused with an action potential, in the presence of an isolated lesion of the posterior branch of the nerve (innervation of the posterior cricoarytenoid muscle, abductor of the larynx), when electrical stimulation is too intense with diffusion of the electrical current to the nerve or in the case of transtracheal stimulation. Operators must therefore be familiar with the causes of artefacts and surgical manoeuvres responsible for nerve stimulation in order to correctly interpret these events. Globally, the electrophysiological data recorded do not provide any absolute data concerning the functional prognosis of the recurrent laryngeal nerve.

According to Hermann et al. [14], recurrent laryngeal nerve monitoring has a low sensitivity (number of cases with recurrent laryngeal nerve palsy without an electrical response over the number of cases with recurrent laryngeal nerve palsy), i.e. ability to detect paresis and/or paralysis associated with an abnormal response. Inversely, the high specificity (number of cases without recurrent laryngeal nerve palsy with an electrical response over the number of cases without recurrent laryngeal nerve palsy) observed in our study was similar to that reported in the literature [13,19]. Most authors [7,18–21] express their results in terms of positive predictive value (number of cases with loss of electrical response and nerve palsy over the number of cases with loss of electrical response) and this value tends to be fairly low and variable (10 to 90%), while the negative predictive value (number of cases with preserved electrical response and normal vocal fold mobility over the number of cases with preserved electrical response) tends to be high (92 to 100%), in line with our results (PPV = 16.7%, NPV = 100%). In view of the marked variability of responses, the similarity of stimulation thresholds and muscle responses to pre- and postdissection supramaximal stimulation and especially the similarity of postdissection responses at the proximal and distal extremities appear to be more reliable than absolute values to predict normal postoperative vocal fold mobility.

Several authors have reported recurrent laryngeal nerve identification rates of 98 to 100% with the use of nerve monitoring. The system used in the present study clearly facilitated identification and dissection of the nerve up to its site of entry into the cricothyroid membrane. As the best way of sparing the recurrent laryngeal nerve is to visualize the nerve and as intraoperative monitoring constitutes an aid to identification of the nerve, intraoperative recurrent laryngeal nerve monitoring can be considered to decrease the risk of nerve palsy. However, in view of the low incidence of recurrent laryngeal nerve palsy, a randomized study (monitoring versus no monitoring) conducted by a single operator with matching for the various types of thyroid disease, and an extremely large cohort would therefore be necessary to demonstrate a statistically significant benefit of the use of intraoperative monitoring.

While many studies [7,20–23] tend to show that recurrent laryngeal nerve palsy occurs less frequently with monitoring, but without demonstrating a statistically significant difference [24], a multicentre prospective study of 4832 cases of benign thyroid goitre operated with and without monitoring, reported by Thomusch et al. [15], showed that systematic use of intraoperative monitoring decreased the incidence of transient and permanent impaired vocal fold mobility. Similarly, Barczynski et al. [21] demonstrated a significant difference for transient but not permanent recurrent laryngeal nerve palsy with the use of monitoring versus exclusively visual identification, regardless of the type of thyroid disease.

**Indications and limits of monitoring**

The indications for intraoperative recurrent laryngeal nerve monitoring could be considered to be reserved to cases in which identification of the nerve is difficult: redo surgery, surgery after radiotherapy, radical surgery with recurrent laryngeal and cervical lymph node dissection for malignant disease, very large inflammatory goitres, etc. However, there are a number of arguments in support of systematic use of monitoring: the reliability of the system is based on regular use and therefore an essential learning curve [17], the difficulty of nerve identification and anatomical variants are often unpredictable, it facilitates and confirms identification of the recurrent laryngeal nerve and assesses its functional integrity. On the other hand, the investment cost of the monitor, endotracheal tube and the specific stimulation electrode, and the possibility of false-negative or false-positive responses can represent an obstacle to the use of this system.

Two situations may be encountered in the zone of detection of the recurrent laryngeal nerve: either the nerve is rapidly visualized and stimulation confirms this identification, or the nerve is not immediately visualized and any structure that could possibly correspond to the nerve must be stimulated to confirm identification before being preserved or sectioned. The use of intraoperative recurrent laryngeal nerve monitoring does not replace the usual...
surgical dissection procedures designed to identify the nerve. Formal identification of the nerve is based on both visual identification and the electrical response and both of these findings must be concordant [25].

Consequently, an anatomical structure that does not respond to stimulation, but which resembles or could possibly correspond to the nerve must not be sectioned; conversely, a structure that does not resemble the appearance and/or course of the nerve, but which repeatedly responds to stimulation must also not be sacrificed. In the particular case of redo surgery in the zone of the recurrent laryngeal nerve, usually in a context of cancer, in which the recurrent laryngeal nerve is not always easy to identify, it is always useful to confirm normal functioning of the nerve by directly stimulating the vagus nerve which is easily and rapidly identified during neck surgery with little risk of iatrogenic injury. More generally, vagus nerve stimulation validates correct functioning of the monitoring system at the beginning of the operation and provides the most accurate prognosis possible of glottal function at the end of the operation, with no risk of false-positive results.

When a nerve injury is suspected during the operation, the cause of the injury can be determined in order to modify the surgical procedure on the contralateral side. However, a more cautious approach in this setting would consist of deferring the contralateral procedure until the real vocal fold mobility can be determined on the operated side, to avoid any risk of bilateral recurrent laryngeal nerve palsy.

There is no medicolegal requirement to use recurrent laryngeal nerve monitoring during thyroid surgery, especially as there is no statistical evidence that use of this technique decreases the incidence of recurrent laryngeal nerve palsy. There is therefore no reason, at the present time, to recommend reference to this procedure in the informed consent form required by law, jurisprudence and medical ethics, and corresponding to the patient’s legitimate desire to be informed [26]. However, intraoperative information concerning the functional status of the nerve remains particularly relevant in the context of bilateral surgery.

Conclusion

The results of this study show that the use of recurrent laryngeal nerve monitoring during thyroid and parathyroid surgery via an endotracheal tube equipped with electrodes is a simple, noninvasive and effective method. Stimulation thresholds are similar to those reported with the use of intramuscular electrodes. In line with data of the literature, the present study does not formally demonstrate that use of intraoperative recurrent laryngeal nerve monitoring decreases the risk of recurrent laryngeal nerve palsy (less than 0.5% of cases of permanent nerve palsy in this study, versus 0.5% to 3.6% according to published studies). However, monitoring facilitates identification of the recurrent laryngeal nerve and provides information about nerve functioning during and at the end of the operation, thereby allowing adaptation of the surgical strategy when a bilateral procedure is indicated. We believe that the contralateral procedure should be deferred in the case of absence of response or loss of the electrical signal on the side operated first.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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