Risk factors for transient vocal cord palsy after thyroidectomy

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Background: Transient recurrent laryngeal nerve palsy affects to 5–10 per cent of patients after extracapsular thyroidectomy. This prospective study assessed the impact of surgical injury and extralaryngeal branching of the inferior laryngeal nerve (ILN) on vocal cord dysfunction (VCD).

Methods: Total thyroidectomy or lobectomy was performed in 188 patients, with 302 ILNs at risk. The anatomy of the ILN and degree of injury to the nerve, based on the Laryngeal Nerve Injury Score (LNIS), were recorded. Fibreoptic laryngoscopy was performed a mean(s.d.) of 10±6(4·1) days after thyroidectomy.

Results: Some 37·4 per cent of ILNs showed extralaryngeal branching. In all, 10·9 per cent of patients developed VCD; 4·3 per cent had paresis and 6·6 per cent paralysis. All paretic and all but one paralytic cords recovered fully after 61(17) days. VCD was more frequently associated with branched than non-branched ILNs (15·8 versus 8·1 per cent; P = 0·022). Injuries were more common in branched nerves (mean(s.e.m.) total LNIS 0·94(0·08) versus 0·51(0·05); P < 0·001). Branched nerves were more likely to be associated with VCD (odds ratio 2·2 (95 per cent confidence interval 1·1 to 4·5)).

Conclusion: Branched ILNs suffer more surgical injuries and are twice as likely to be associated with VCD.

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Introduction

Vocal cord palsy is a dreaded complication of thyroidectomy. Its clinical consequences may be severe and, in any case, it produces a disturbing postoperative hoarseness that can become permanent. It is also one of the more frequent reasons for malpractice claims after thyroidectomy¹.

Since Lahey² proposed the routine identification of the inferior or recurrent laryngeal nerve (ILN) to avoid its injury during thyroidectomy, unintentional division of the nerve causing permanent vocal cord paralysis has become uncommon in experienced hands³,⁴. The prevalence of permanent damage to the ILN after careful dissection is below 2 per cent in most series published during the past decade³,⁴.

Transient ILN palsy, however, still represents a common complication of thyroidectomy after an extracapsular resection (lobectomy or total thyroidectomy), when dissection of the distal portion of the ILN (in close contact with Berry’s ligament) is carried out. The exact pathogenesis of transient ILN palsy is unknown. It can be the result of direct injury (mechanic or electric) to the ILN without severing it. Other factors, such as stretching, perineural devascularization or compression by a haematoma, have also been identified as potential causes of ILN palsy.

The few comprehensive prospective studies of the prevalence of transient ILN palsy after initial thyroidectomy have reported numbers of both patients and nerves at risk⁵,⁶. These studies have stressed the importance of assessing vocal cord status within 2 weeks after thyroidectomy. Transient and permanent vocal cord dysfunction may produce the same symptoms (dysphonia, risk of aspiration, dyspnoea and sometimes stridor) shortly after thyroidectomy, and the unpredictable outcome is of concern to both the patient and surgeon.

Although technical factors during surgery are involved in the pathogenesis of transient ILN palsy, anatomical variations of the ILN may increase its vulnerability. In particular, the authors have hypothesized that extralaryngeal
branching of the ILN may be a risk factor for postoperative ILN palsy. This prospective study determined the prevalence of transient ILN palsy after thyroidectomy, and examined the relationship between intraoperative trauma and the potential vulnerability of the ILN depending on its bifurcation and its anatomical relation with the inferior thyroid artery (ITA).

**Methods**

This observational clinical study was carried out at a single endocrine surgery unit. From March 2004 to March 2006, all patients who had lobectomy or total thyroidectomy were considered for the study. Patients scheduled for subtotal thyroidectomy (almost exclusively those with Graves–Basedow disease) were not considered eligible. Patients with a history of ipsilateral thyroid surgery, vocal cord palsy or intentional resection of the ILN owing to its total entrapment by a thyroid carcinoma were excluded. Informed consent was obtained from each patient before entry into the study. Immediately after thyroidectomy, the operating surgeon recorded demographic details, the indication for thyroidectomy and operative data.

**Surgical technique**

The same surgical team operated on all patients, using a standardized surgical technique. Briefly, after taking a conventional midline approach to the thyroid gland and limited division of the sternothyroid muscle cranial insertion, careful dissection of the upper pole was carried out, taking care to avoid any low external branch of the superior laryngeal nerve but without intentional dissection to find it. The lateral aspect of the thyroid was exposed after division of the middle thyroid vein. The lower-pole vessels were clipped or ligated and the inferior parathyroid gland identified when possible. The ITA was identified and the search for the ILN owing to its total entrapment by a thyroid carcinoma were excluded. The frequently identified ansa galeni and the extralaryngeal branches leaving the ILN for the oesophagus or trachea were not taken into account. A diagram of the course of the ILN was drawn over a template (Fig. 1).

Immediately after the procedure the surgeon completed the patient data file, with details of identification of the ILN; the number of branches entering the larynx; where appropriate, the distance from the branching to the entry point and the relationship with the first branch of the ITA; and the relative position of both structures (ILN and ITA). The frequently identified ansa galeni and the extralaryngeal branches leaving the ILN for the oesophagus or trachea were not taken into account. A diagram of the course of the ILN was drawn over a template (Fig. 1).

The degree and mechanism of any potential injury to each identified branch of the ILN were recorded prospectively using the Laryngeal Nerve Injury Score (LNIS; range 0 to 3), giving one point for each type of injury: placing a ligature or a clip at less than 5 mm from the ILN, monopolar cautery used at less than 10 mm, or extensive dissection or stretching of the nerve. For every patient, a LNIS was recorded for each identified extralaryngeal branch of the ILN. Thyroid volume was estimated from ultrasonographic measurements using the ellipsoid approximation and the new correction factor recommended by the World Health Organization7.

**Registration of operative data**

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**Postoperative findings**

Patients were seen in the outpatient clinic by the surgical team a mean(s.d.) of 10·6(4) days after surgery. An independent and blinded ear, nose and throat specialist (J.F.) performed a clinical voice assessment and fibreoptic laryngoscopy in a separate outpatient clinic. The patient was discharged if vocal cord function was normal. When vocal cord palsy was identified, a weekly follow-up was carried out initially for 8 weeks, and then every 3–4 weeks until recovery was achieved; the dysfunction was considered permanent if it persisted after 6 months. Assessment of the rate of vocal palsy was based on the number of nerves at risk. Vocal cord function was diagnosed as either normal, paretic (hypomotility without paramedian paralysis) or paralysis (not moving and paramedian position). In the analysis, paretic and paralytic vocal cords were grouped together as vocal cord dysfunction (VCD).

**Statistical analysis**

The main outcome variable was VCD (either paresis or paralysis). Previous unpublished data in the multicentre Spanish National Thyroidectomy Outcomes Study showed a prevalence of transient ILN paralysis of 3 per cent (unpublished data). It was estimated that, with mandatory and early laryngoscopy, the prevalence of paresis would be
Transient vocal cord palsy after thyroidectomy

Identification of superior laryngeal nerve

Right side

- YES
- NO

Left side

- YES
- NO

Right recurrent nerve

- Anterior
- Posterior
- Crossing

Branches

- 1
- 2
- 3
- >3

Distance from cricoid

1.5 cm

Left recurrent nerve

- Anterior
- Posterior
- Crossing

Branches

- 1
- 2
- 3
- >3

Distance from cricoid

1 cm

LNIS

- Ligature near
- Electrocautery
- Manipulation

Laryngoscopy

- Normal
- Paralysis
- Paresia

Data were analysed at three levels, with respect to patients, nerves and ILN branches. The analysis was focused on the association of VCD with the presence and number of branches, ILN length, the position of the ILN in relation to the ITA, and the LNIS. The normality of the distribution of quantitative variables was assessed by means of the Kolmogorov–Smirnov test. Results were expressed as arithmetic mean(s.d.) unless specified otherwise. For quantitative variables, two-tailed Student’s t test for non-paired data was used to assess the significance.
of differences in means between two groups and ANOVA for three or more groups. Contingency tables of qualitative data were assessed using $\chi^2$ or Fisher’s exact test when appropriate. In all analyses, $P < 0.050$ was accepted as statistically significant. FileMaker version 7.5 (FileMaker, Mountain View, California, USA) was used as database manager. StatView version 5.0.1 (SAS Institute, Cary, North Carolina, USA) was used for statistical analysis.

**Results**

A total of 222 patients underwent thyroidectomy involving dissection of one or both ILNs. Patients operated on for recurrent benign goitre (eight), those who had a Dunhill procedure (six) and those reoperated on shortly after the initial thyroidectomy owing to haemorrhage (two) were not included in the study. Two patients in whom the ILN was entrapped by a poorly differentiated carcinoma were also excluded, as were five patients who had a parathyroidectomy associated with the thyroidectomy. Of the remaining 199 patients, six did not have fibreoptic laryngoscopy within the first 2 weeks and five were lost to follow-up, leaving 188 patients who completed the study protocol fully. There were 23 men (12.2 per cent) and 165 women (87.8 per cent), of mean(s.d.) age 53(16) years, with a total of 302 nerves at risk. Indications for surgery were multinodular goitre in 98 patients (three with Plummer disease), a benign thyroid nodule in 58 (five cysts, four toxic adenomas and 49 non-toxic nodules), thyroid cancer in 31 and Graves–Basedow disease in one. Total thyroidectomy was performed in 114 patients (60.6 per cent) and a lobectomy in 74 (39.4 per cent).

**Anatomy of the inferior laryngeal nerve and extralaryngeal branching**

Two extralaryngeal branches of the ILN were identified in 97 nerves (32.1 per cent) and three branches in 16 (5.3 per cent), giving an overall prevalence of extralaryngeal branching of 37.4 per cent. There were no significant differences in the prevalence of branching between the left and right sides (Table 1), or between men and women (39.0 versus 36.4 per cent; $P = 0.595$). There was one right non-branched non-recurrent ILN.

The mean distance between the point of branching and the entrance of the ILN into the larynx was 21.5(1.3) (range 3–50) mm, with no significant difference between sides. The ILN crossed anterior to all branches of the ITA in 55 instances (18.2 per cent), posterior to all branches in 106

<table>
<thead>
<tr>
<th>No. of branches</th>
<th>Right side</th>
<th>Left side</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>95 (62.9)</td>
<td>94 (62.2)</td>
<td>189 (62.6)</td>
</tr>
<tr>
<td>2</td>
<td>52 (34.4)</td>
<td>45 (29.8)</td>
<td>97 (32.1)</td>
</tr>
<tr>
<td>3</td>
<td>4 (2.6)</td>
<td>12 (7.9)</td>
<td>16 (5.3)</td>
</tr>
<tr>
<td>Total</td>
<td>151 (100)</td>
<td>151 (100)</td>
<td>302 (100)</td>
</tr>
</tbody>
</table>

Values in parentheses are percentages. $\chi^2 = 4.5$, 2 d.f., $P = 0.105$.

![Fig. 2 Distribution of nerves by Laryngeal Nerve Injury Score (LNIS)](image)

(35.1 per cent) and snaked within the ITA branches in the remaining 141 (46.7 per cent), with a clear predominance for the anterior course on the right side (27.8 versus 11.5 per cent; $P = 0.001$). The external branch of the superior laryngeal nerve was identified in a third of patients, with no difference between right and left sides (34.1 versus 30.7 per cent).

**Laryngeal Nerve Injury Score**

LNIS values did not have a normal distribution ($P < 0.001$, Kolmogorov–Smirnov test) and are all presented as mean(s.e.m.). The cumulated LNIS was 0.63(0.05). Almost half of the nerves (147, 48.7 per cent) suffered some kind of injury during dissection (Fig. 2), with a similar rate of injury on both sides. The commonest type of injury was caused by stretching/manipulation (61.9 per cent of all injuries), followed by close electric coagulation (36.1 per cent) and placement of a clip or ligature near the ILN (27.2 per cent).

**Vocal cord dysfunction**

The first fibreoptic laryngoscopy showed a dysfunctional vocal cord in 33 patients (10.9 per cent of all nerves at risk), 13 (4.3 per cent) diagnosed as paresis and 20 (6.6 per cent) as paralysis. Dysphonia was recorded in 20.4 per cent of
Transient vocal cord palsy after thyroidectomy

Factors influencing vocal cord dysfunction

Branching
VCD was almost twice as common in patients with branched nerves than in those with non-branched nerves (15·8 versus 8·1 per cent; \( P = 0.022 \)). The branches of dysfunctional nerves were significantly longer than those of functioning nerves (29·4(10·4) versus 19·1(9·8) mm; \( P = 0.003 \)). Branched nerves had twice the risk of being associated with VCD than non-branched nerves (odds ratio 2.2 (95 per cent confidence interval (c.i.) 1.1 to 4.5)).

Position relative to the inferior thyroid artery
The position of the nerve in relation to the ITA did not influence the rate of VCD (anterior, 14 per cent; posterior, 14·7 per cent; crossing, 9·1 per cent; \( P = 529 \)).

Injury as measured by Laryngeal Nerve Injury Score
Dysfunctional nerves had a higher total (1·01(0·10) versus 0·56(0·12); \( P < 0.001 \)), maximum (1·04(0·11) versus 0·59(0·04); \( P < 0.001 \)) and mean (0·73(0·08) versus 0·40(0·03); \( P = 0.004 \)) LNIS than functioning nerves. The proportion associated with VCD was three times higher for LNIS 2/3 than for LNIS 0/1 (Fig. 4). These differences

Table 2 Laryngeal Nerve Injury Score for each position of the inferior laryngeal nerve relative to the inferior thyroid artery

<table>
<thead>
<tr>
<th>Position of the nerve</th>
<th>n</th>
<th>LNIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>55</td>
<td>0·45(0·09)</td>
</tr>
<tr>
<td>Intertwined</td>
<td>117</td>
<td>0·84(0·08)</td>
</tr>
<tr>
<td>Posterior</td>
<td>105</td>
<td>0·59(0·07)</td>
</tr>
<tr>
<td>Total</td>
<td>277</td>
<td></td>
</tr>
</tbody>
</table>

Values are mean(s.e.m). LNIS, Laryngeal Nerve Injury Score. \( P = 0.046 \) (ANOVA).

Relationship between inferior laryngeal nerve branching and injury score

Branched ILNs suffered more than twice the number of injuries as their non-branched counterparts (total LNIS 0·94(0·08) versus 0·51(0·05); \( P < 0.001 \)). However, among branched nerves the distribution of injuries to the ILN was not evenly distributed among their branches; the anterior branch had a significantly higher LNIS than the posterior one(s) (0·54(0·04) versus 0·23(0·04) versus 0·06(0·06); \( P < 0.001 \)) (Fig. 5).

Comparison of total LNIS values for nerves lying anterior, posterior or between the branches of the ITA showing that nerves crossing the branches of the ITA received a greater number of injuries (Table 2).

Fig. 3 Relationship between inferior laryngeal nerve branching and Laryngeal Nerve Injury Score (LNIS). Values are mean(s.e.m.). * \( P < 0.001 \) (two-tailed Student’s t test)

Fig. 4 Vocal cord dysfunction in relation to Laryngeal Nerve Injury Score (LNIS)
Table 3 Prevalence of vocal cord dysfunction after thyroidectomy according to diagnosis, malignancy and thyroid status

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Normal vocal cord function (n = 268)</th>
<th>Vocal cord dysfunction (n = 33)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multinodular goitre</td>
<td>168 (88.9)</td>
<td>21 (11.1)</td>
<td>0.838*</td>
</tr>
<tr>
<td>Thyroid nodule</td>
<td>99 (89.2)</td>
<td>12 (10.8)</td>
<td>0.421*</td>
</tr>
<tr>
<td>Diffuse hyperplasia</td>
<td>1 (100)</td>
<td>0 (0)</td>
<td>0.509†</td>
</tr>
<tr>
<td>Malignancy status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thyroid cancer (all)</td>
<td>38 (93)</td>
<td>3 (7)</td>
<td></td>
</tr>
<tr>
<td>Benign conditions</td>
<td>230 (88.5)</td>
<td>30 (11.5)</td>
<td></td>
</tr>
<tr>
<td>Thyroid status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyperthyroidism</td>
<td>7 (88)</td>
<td>1 (12)</td>
<td></td>
</tr>
<tr>
<td>Euthyroidism</td>
<td>261 (89.1)</td>
<td>32 (10.9)</td>
<td></td>
</tr>
</tbody>
</table>

Values in parentheses are percentages. *χ² test; †Fisher’s exact test.

diminished when only non-branched nerves were analysed, because the LNIS of dysfunctional nerves was only marginally greater than that of intact nerves (0.57(0.23) versus 0.46(0.05); P = 0.408). Overall, the odds ratio for developing VCD for injury graded LNIS 2–3 compared with 1–2 was 6·1 (95 per cent c.i. 2·8 to 13·2). No specific type of injury was associated with a greater likelihood of VCD.

Diagnosis, thyroid status and thyroid volume

VCD was not associated with any specific diagnostic group, thyroidectomy for cancer, or the presence of hyperthyroidism (either toxic adenoma, Graves–Basedow or Plummer disease) (Table 3). Data for estimation of thyroid volume were available for 168 patients. There was no difference between the estimated volume of thyroid lobes ipsilateral to dysfunctional cords and those ipsilateral to normal cords (mean(s.e.m.) 59.8(16.1) versus 59.1(5.1) ml; P = 0.922).

Discussion

In this series transient VCD was common after thyroidectomy. Fibreoptic laryngoscopy carried out shortly after thyroidectomy revealed that 10·9 per cent of vocal cords were dysfunctional, but all but one eventually recovered. The prevalence of definitive vocal cord palsy was 0·3 per cent of nerves at risk and 0·5 per cent of patients. Both figures lie within the range of published values.6,9,10 Hyperthyroidism has been identified previously as a risk factor for recurrent nerve injury and temporary vocal cord palsy11, but not in this series, probably because only a small number of patients had the condition. In retrospective series, the rate of transient vocal cord palsy has varied between 2·3 and 2·9 per cent in patients with benign conditions, and between 12·8 and 15·4 per cent after treatment of thyroid cancer5,6,12.

Any delay in assessing the vocal cords is of relevance as almost two-thirds of dysfunctional cords recover during the first 4 weeks after thyroidectomy.4,5,6,13 As in every careful study of voice changes after thyroidectomy, there was a poor association between dysphonia and VCD, suggesting that factors other than laryngeal nerve injury appear to alter the voice after thyroidectomy13.

The LNIS results from the addition of dichotomous data, based on the surgeon’s perception of the number and type of injuries inflicted on the ILN. LNIS values for dysfunctional nerves were consistently greater than scores for those with normal function. The LNIS may become a simple tool with which to gauge the amount of mechanical insult to the nerve, but external validation is mandatory first to assess its value and reproducibility. As a practical intraoperative application, an injury to a nerve graded LNIS 1 ought to trigger an ultrasound mode to avoid progressing to LNIS 2 or 3. The awareness of having injured the ILN on one side up to LNIS 2 or 3 could be a reason to proceed with extreme caution in order to avoid any mechanical stress to the contralateral nerve.

The incidence of extralaryngeal branching of the ILN in this series is almost identical to rates published in other surgical series14–17, but reports of anatomical dissection are different18,19, probably owing to the deep dissection into the inferior pharyngeal constrictor muscle and inclusion of the ansa galeni as an extralaryngeal branch. The relationship between these extralaryngeal branches and the constant and well described extralaryngeal branches of the ILN, which serve the thyroarytenoid and posterior cricoarytenoid muscles, is not clear19.

From the perspective of the thyroid surgeon, approximately a third of ILNs branch into two or three rami before reaching the cricothyroid joint, with no significant differences between the right and left sides. Branching of the ILN was shown to be related to the incidence of transient vocal cord palsy after thyroidectomy in the present study; this anatomical variant was associated with a twofold increased prevalence of VCD after thyroidectomy. The length of the branch also appeared to be related to the risk of VCD. The thinner anterior branch had to cope with a similar or greater amount of manipulation/mobilization stress than its single-trunk counterpart (Fig. 3) and, being more vulnerable, was associated with a higher proportion of dysfunctional cords.

The greater vulnerability of a branched ILN and the importance of preserving every branch of the ILN...
has been recognized previously. The belief of some surgeons that injury to one branch of a nerve can be compensated by the other branch is by no means supported by the present clinical findings. Greater awareness of the increased vulnerability of branched nerves, together with the increased availability of intraoperative monitoring of the ILN, should help further to reduce the rate of postoperative VCD.

In summary, this paper has confirmed the hypothesis that extralaryngeal ramification of the ILN constitutes a risk factor for postoperative VCD, and specifically for transient vocal fold palsy. There are clearly technical factors associated with this type of lesion, specifically affecting the more vulnerable branched nerves.

Acknowledgements

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