

# A Prospective Evaluation of Recurrent Laryngeal Nerve Paralysis During Thyroidectomy

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**Hypothesis:** Recurrent laryngeal nerve paralysis after thyroidectomy can be unrecognized without routine laryngoscopy, and patients have a good potential for recovery during follow-up.

**Design:** A prospective evaluation of vocal cord function before and after thyroidectomy. Periodic vocal cord assessment was performed until recovery of cord function. Persistent cord palsy for longer than 12 months after the operation was regarded as permanent.

**Setting:** A university hospital with about 150 thyroid operations performed by 1 surgical team per year.

**Patients:** From January 1, 1995, to April 30, 1998, 500 consecutive patients (84 males and 416 females) with documented normal cord function at the ipsilateral side of the thyroidectomy were studied.

**Main Outcome Measures:** Vocal cord paralysis after thyroidectomy.

**Results:** There were 213 unilateral and 287 bilateral pro-

cedures, with 787 nerves at risk of injury. Thirty-three patients (6.6%) developed postoperative unilateral cord paralysis, and 5 (1.0%) had recognizable nerve damage during the operations. Complete recovery of vocal cord function was documented in 26 (93%) of 28 patients. The incidence of temporary and permanent cord palsy was 5.2% and 1.4% (3.3% and 0.9% of nerves at risk), respectively. Among factors analyzed, surgery for malignant neoplasm and recurrent substernal goiter was associated with an increased risk of permanent nerve palsy. Primary operations for benign goiter were associated with a 5.3% and 0.3% incidence (3.4% and 0.2% of nerves at risk) of transient and permanent nerve palsy, respectively.

**Conclusions:** Unrecognized recurrent laryngeal nerve palsy occurred after thyroidectomy. Thyroid surgery for malignant neoplasms and recurrent substernal goiter was associated with an increased risk of permanent recurrent nerve damage. Postoperative vocal cord dysfunction recovered in most patients without documented nerve damage.

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**R**ECURRENT laryngeal nerve damage is a well-recognized morbidity after thyroidectomy and has been involved in most claims concerning complications of thyroid surgery.<sup>1</sup> The reported incidence of permanent nerve palsy varies widely from 0% to 5.8% of patients after thyroid operations.<sup>2-18</sup> However, the incidence of permanent recurrent nerve paralysis could be as high as 13% and 30% of patients during thyroid cancer operations and secondary thyroidectomy, respectively.<sup>4</sup> It was suggested that complications after thyroid surgery were often underestimated because of reporting preference.<sup>5</sup> Routine examination of the vocal cords perioperatively to document recurrent nerve damage was usually incomplete,<sup>7,8,14</sup> and the reported incidence of nerve injury may be somewhat underestimated.

The incidence of nerve palsy was not usually reported according to the underlying disease, nerve at risk, or both, and comparison of treatment results was difficult. In addition, many reports<sup>2,3,7</sup> were retrospective and included operations performed by many surgeons and extended during a long duration. The present prospective study documents the incidence of postoperative vocal cord palsy after thyroidectomy performed by 1 surgical team during a relatively short period, evaluates its recovery potential, and identifies potential risk factors for the development of permanent paralysis.

## RESULTS

The operative procedure included unilateral lobectomy in 172, total or near total thyroidectomy in 156, bilateral subtotal thyroidectomy in 91, completion total thy-

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## PATIENTS AND METHODS

From January 1, 1995, to April 30, 1998, 501 consecutive patients underwent thyroidectomy for treatment of various thyroid diseases by a single surgeon (C.-Y.L.) or by surgical residents operating with supervision. One patient with preoperative unilateral cord paralysis secondary to malignant involvement of recurrent nerve was excluded from the analysis. There were 84 males and 416 females in the study (age range, 12-88 years; median age, 43 years). Routine identification of the recurrent laryngeal nerve was performed during all operative procedures. Indirect or flexible laryngoscopy was performed 48 hours before and was repeated within 2 weeks after the operations for all patients by trained endoscopists and otorhinolaryngologists. Suspected nerve damage was documented during the operation. Postoperative voice disturbance was graded according to 4 grades: nil, mild, moderate, and significant.

*Postoperative cord palsy* was defined as the presence of an immobile vocal cord or the decreased movement of the vocal cord during phonation. Patients with recurrent nerve palsy underwent speech therapy and were followed up by an otorhinolaryngologist (P.-W.Y.) with a periodic vocal cord examination until full recovery was documented. Recurrent nerve palsy was regarded as permanent if it persisted for more than 1 year after the operation. The incidence of postoperative transient and permanent cord palsy was calculated in relation to the number of patients and the number of nerves at risk of damage. Potential risk factors for recurrent nerve paralysis, including the underlying pathological characteristics, the weight of the gland resected, the extent of resection, surgery for substernal goiter, thyroid reoperations, surgery for recurrent substernal goiter, operating time, and estimated blood loss, were examined. Comparisons were based on the number of patients developing cord palsy rather than on the number of nerves at risk, except for comparison between lobectomy and subtotal resection. Statistical analysis was performed using the  $\chi^2$  or Fisher exact test (categorical variables) and the *t* test (continuous variables).  $P < .05$  was regarded as statistically significant.

roidectomy by unilateral lobectomy in 41, and ipsilateral lobectomy with contralateral subtotal thyroidectomy in 40 patients. Thyroid reoperations and surgery for retrosternal goiter were performed in 9.8% and 13.0% of the patients, respectively. Reoperations were performed in 12 patients (2.4%) with recurrent substernal goiter. Total and subtotal lobectomies were performed in 565 and 222 lobes, respectively, accounting for 787 nerves at risk of injury. Preoperative vocal cord palsy was noted at the side of the previous lobectomy in 1 patient who underwent completion total thyroidectomy. Postoperative unilateral cord palsy was documented in 33 patients (6.6%) during vocal cord examination, and voice disturbance was graded as nil ( $n = 3$ ), mild ( $n = 9$ ), moderate ( $n = 11$ ), or significant ( $n = 10$ ) on discharge from

**Table 1. Incidence of Recurrent Nerve Paralysis According to the Underlying Pathological Characteristics**

Pathological Characteristic	No. of Patients	No. of Nerves at Risk	No. (%) of Operations*	No. (%) of Nerves at Risk*
Hyperplasia				
Nodular	270	401	10 (3.7)/3 (1.1)	10 (2.5)/3 (0.7)
Diffuse	90	180	8 (8.9)/0 (0)	8 (4.4)/0 (0)
Carcinoma				
Papillary	50	95	3 (6.0)/3 (6.0)	3 (3.2)/3 (3.2)
Follicular	20	33	1 (5.0)/0 (0)	1 (3.0)/0 (0)
Follicular adenoma	56	57	3 (5.4)/0 (0)	3 (5.3)/0 (0)
Thyroiditis	8	10	1 (12.5)/0 (0)	1 (10.0)/0 (0)
Others†	6	11	0 (0)/1 (16.7)	0 (0)/1 (9.1)
<b>Total</b>	<b>500</b>	<b>787</b>	<b>26 (5.2)/7 (1.4)</b>	<b>26 (3.3)/7 (0.9)</b>

\*Data are given as transient/permanent.

†Others included anaplastic carcinoma in 3, thyroid lymphoma in 2, and metastasis in 1 patient.

**Table 2. Incidence of Recurrent Nerve Paralysis According to the Type of Thyroidectomy**

Type of Thyroidectomy	No. of Patients	No. of Nerves at Risk	No. (%) of Operations*	No. (%) of Nerves at Risk*
Unilateral lobectomy	172	172	4 (2.3)/2 (1.2)	4 (2.3)/2 (1.2)
Total	156	312	10 (6.4)/4 (2.6)	10 (3.2)/4 (1.3)
Bilateral subtotal	91	182	8 (8.8)/1 (1.1)	8 (4.4)/1 (0.5)
Completion total	41	41	3 (7.3)/0 (0)	3 (7.3)/0 (0)
Lobectomy and contralateral subtotal	40	80	1 (2.5)/0 (0)	1 (1.3)/0 (0)
<b>Total</b>	<b>500</b>	<b>787</b>	<b>26 (5.2)/7 (1.4)</b>	<b>26 (3.3)/7 (0.9)</b>

\*Data are given as transient/permanent.

the hospital. During a median period of 3 months (range, 1-9 months), 26 (79%) of these 33 patients had recovery of vocal cord function with preceding improvement in phonation. The incidence of transient and permanent recurrent nerve palsy was 5.2% and 1.4% (3.3% and 0.9% of nerves at risk), respectively. The incidences of nerve palsy with respect to the number of patients and the number of nerves at risk are shown in **Table 1** and **Table 2** according to the underlying pathological characteristics and types of thyroidectomy, respectively. Patients who underwent a primary operation for benign thyroid conditions had transient and permanent palsy rates of 5.3% (3.4% of nerves at risk) and 0.3% (0.2% of nerves at risk), respectively. There was no difference in the incidence of transient or permanent nerve palsy for patients who underwent lobectomy or subtotal resection ( $P > .05$ ).

**Table 3** shows the details of 7 patients with permanent cord palsy. Nerve damage was documented in 5 patients, including inadvertent transection ( $n = 3$ ) and intentional sacrifice ( $n = 2$ ), while 2 patients had extensive dissection of recurrent nerve from peritumor adhesion. Of the patients who had unexpected unilateral recurrent nerve palsy ( $n = 28$ ), the recovery potential was 93%. Of the factors analyzed, surgery for a malignant neo-

**Table 3. Details of 7 Patients With Permanent Nerve Palsy\***

Patient No./ Sex/Age, y	Pathological Characteristics	Type of Thyroidectomy	Operative Findings	Side	Hoarseness	Follow-up, mo
1/M/67	PTC	Total	Tumor adhesion	L	Significant	25
2/M/47	PTC	Total	Tumor encasement	R	Significant	29
3/F/63	PTC	Total	Tumor encasement	R	Moderate	40
4/F/69	ATC	Total	Tumor adhesion	R	Moderate	7 (Death)
5/M/48	Nodular hyperplasia	Unilateral lobectomy	Nonrecurrent nerve damage	R	Nil	24
6/F/45	Nodular hyperplasia	Bilateral subtotal†	Nerve damage	R	Moderate	33
7/F/77	Nodular hyperplasia	Unilateral lobectomy†	Nerve damage	L	Moderate	31

\*PTC indicates papillary thyroid carcinoma; ATC, anaplastic thyroid carcinoma.

†Recurrent substernal goiter.

plasm (4 of 76 patients) was associated with a higher risk of permanent recurrent nerve palsy compared with an operation for benign diseases (3 of 424 patients) ( $P = .01$ ). Surgery for recurrent substernal goiter was associated with a higher risk of permanent nerve palsy compared with surgery for other goiter (2 of 12 vs 5 of 488 patients;  $P = .01$ ). The weight of the thyroid lobe resected, reoperative thyroid surgery, surgery for substernal goiter, and surgery for thyrotoxicosis were not associated with an increased risk of transient or permanent nerve palsy. A longer operative time (156 vs 114 minutes;  $P = .007$ ) and an increase in estimated blood loss (246 vs 97 mL;  $P = .01$ ) were noted for patients who developed postoperative permanent cord palsy. Of those patients who developed postoperative cord paralysis ( $n = 33$ ), surgery for the malignant neoplasm and for recurrent substernal goiter was associated with a statistically significant ( $P = .04$  for both) increased risk of permanent nerve palsy. Four (50%) of the 8 patients who underwent thyroid cancer operations developed permanent cord palsy compared with 3 (12%) of the 25 patients who underwent thyroidectomy for benign thyroid diseases. The postoperative cord palsy in 2 patients (100%) who underwent thyroidectomy for recurrent substernal goiter became permanent compared with 5 (16%) of 31 patients who underwent thyroidectomy for other conditions.

#### COMMENT

Recurrent nerve injury, with its associated voice disturbance, is a disabling complication of thyroid surgery. Reported recurrent nerve palsy rates vary widely depending on definition, patient selection, surgeons' patient volume, types of thyroidectomy, and the underlying disease.<sup>2,3</sup> The calculation based on nerves at risk seems to be a more logical method for comparison between various reported series.<sup>2,3,7</sup> It was suggested that complications after thyroid surgery were often underreported partly because of the reporting methods and partly based on the tendency to identify success and to ignore failure.<sup>5</sup> Reports<sup>2,3,7</sup> on nerve palsy were frequently retrospective and involved multiple surgeons with different surgical techniques during a long period. Our prospective study of 500 consecutive patients by 1 surgical team showed that the permanent nerve palsy rates of 1.4% based on the number of patients and 0.9% based on the number of nerves at risk compared favorably with those of other reported

series.<sup>2-16</sup> The identification of postoperative recurrent nerve injury based on clinical symptoms without routine vocal cord examination is not reliable for documenting the incidence of recurrent nerve injury.<sup>5,8,15</sup> Postoperative voice change without an associated recurrent nerve lesion may be the result of superior laryngeal nerve damage or intubation alone,<sup>19</sup> whereas the rare asymptomatic injury may be clinically missed.<sup>8</sup> One third of our patients had minimal voice hoarseness during the postoperative period despite the presence of unilateral cord palsy. As a result, the reported incidence of nerve injury may be somewhat underestimated without routine vocal cord examination. In addition, complication rates are affected considerably by the extent of surgical experience.<sup>18</sup> Our surgical team included 1 surgeon (C.-Y.L.) with years of experience specializing in thyroid surgery. By analyzing the surgical results prospectively during a relatively short period using a standard technique, we attempt to identify potential risk factors associated with a specific complication. Thyroidectomy was performed with excellent results by experienced surgeons from various major endocrine centers with a high patient volume.<sup>7-16</sup> A recurrent nerve paralysis rate of less than 2.5% was reported for patients who underwent more extensive thyroid operations for benign<sup>12-14</sup> and malignant<sup>5,8,11</sup> thyroid conditions and during thyroid reoperations.<sup>15,16</sup> Despite the numerous reports of safety during more extensive thyroid operations and reinterventions by experienced surgeons, thyroid cancer operations and secondary thyroidectomy were associated with a higher complication rate and an increased risk of recurrent nerve injury.<sup>2-4,17</sup>

An impressively low incidence of recurrent nerve palsy was consistently reported in series with thyroidectomy predominantly for benign disease.<sup>4,7,14,18</sup> Our permanent palsy rates of 0.9% based on the number of patients and 0.7% based on the number of nerves at risk during surgery for benign thyroid diseases were consistent with the 0.3% to 1% incidence of nerve palsy as reported based on the number of patients.<sup>4,7,14,18</sup> However, the recurrent nerve is more vulnerable to damage during secondary thyroidectomy, with a reported incidence of 3.8% to 20% of patients.<sup>2-4,14</sup> Jatzko et al<sup>4</sup> showed that the incidence of recurrent nerve palsy increased from 0% during primary operations for benign goiter to 7.5% for recurrent goiter. An incidence of 25% palsy was noted during thyroidectomy for recurrent goiter without rou-

tine identification of recurrent nerve.<sup>4</sup> Reeve et al<sup>12</sup> reported no permanent nerve palsy in 115 primary total thyroidectomies, whereas the rate of permanent nerve palsy increased to 3.1% after secondary thyroidectomy for multinodular goiter in 258 patients. Our 4% (2 of 49 patients) incidence of permanent nerve paralysis (3.5% of nerves at risk) after secondary thyroidectomy is comparable with that of others<sup>15-17</sup> but was significantly increased compared with that for primary operations. The incidence was even higher when the secondary thyroidectomy was performed for substernal goiter (16.7%). These results emphasize the need to provide the best possible therapy at the initial operation, when it can be performed with the least risk.<sup>15-17</sup>

Since the article published by Lahey<sup>20</sup> in 1938, there remains controversy about the need for routine identification of recurrent nerve during thyroidectomy, but cumulative reports<sup>3,4,21</sup> support this surgical approach. In patients undergoing total lobectomy, it has been reported that the permanent palsy rate increased from 3.8% to 7% when the nerve was not exposed or identified.<sup>3</sup> An English-language only literature review of more than 12 000 documented thyroid resections has reported rates of the order of 1.2% or 5.2% of permanent nerve palsies depending on whether the nerve was exposed during surgery.<sup>4</sup> There should be few, if any, instances in which the recurrent nerve cannot be identified.<sup>21</sup> Inadvertent nerve damage could be easily recognized during the operation with routine identification of recurrent nerve.

Postoperative recurrent nerve palsy has the potential for recovery, with a recovery rate ranging from 50% to 88%.<sup>2-4,18</sup> Our overall recovery rate of 79% was comparable with others. However, when inadvertent nerve injury recognized intraoperatively was excluded, the recovery potential for unsuspected nerve paralysis was nearly complete, except during thyroid cancer operations, in which the nerve was dissected from peritumor adhesion. Our policy for surgical treatment of a well-differentiated thyroid carcinoma is to preserve cord function by dissection of the recurrent nerve from the adjacent tumor unless in the presence of preoperative cord dysfunction or any definite evidence of nerve encasement by the tumor intraoperatively. Contrary to others, the nerve was sometimes reported as invaded by tumor or sacrificed and was not calculated as postoperative nerve palsy.<sup>11</sup> This may partly attribute to the lower incidence of recurrent nerve damage during thyroid cancer operations in some reports. The nonrecurrent recurrent laryngeal nerve on the right side of the neck is always a threat to inadvertent injury because of its rare occurrence.<sup>21</sup>

Unrecognized recurrent laryngeal nerve palsy can occur after thyroidectomy, and this complication may be

underestimated without the use of routine laryngoscopy. With routine identification of recurrent nerve during thyroidectomy, postoperative cord palsy has a nearly complete recovery potential unless in the presence of recognized nerve damage or after extensive dissection from malignant tumors. Thyroid surgery for malignant neoplasms and recurrent substernal goiter was associated with an increased risk of permanent recurrent nerve damage.

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