INTRODUCTION

Recurrent laryngeal nerve paralysis is the most common and serious complication after thyroid cancer surgery. The objective of this study was to report the advantages of the vein wrapping technique for nerve reconstruction in patients with thyroid cancer invading the recurrent laryngeal nerve and its effects on postoperative phonatory function. The subjects were three patients who underwent resection of the recurrent laryngeal nerve during surgical extirpation of papillary thyroid cancer. Free ansa cervicalis nerve graft or direct neurorrhaphy with a vein wrapping technique was used to facilitate nerve regeneration, protect the anastomosed nerve site mechanically, and prevent neuroma formation. One-year postoperative laryngoscopic examination revealed good vocal cord mobility. Maximum phonation time (19.5 ± 0.3 sec) was longer than a previously-reported value in conventional reconstruction patients (18.8 ± 6.6 sec). The present phonation efficiency index (7.88 ± 0.78) was higher than that previously calculated in conventional reconstruction (7.59 ± 2.82). The mean value of the Voice Handicap Index-10 was 6, which was within the normal range. This study demonstrates improvement in phonation indices measured 1 year after recurrent laryngeal nerve reconstruction. Our results confirm that the vein wrapping technique has theoretical advantages and could be favored over conventional reconstruction techniques for inervenate nerve injuries.

Keywords: Recurrent laryngeal nerve / Thyroid neoplasms / Nerve regeneration / Phonation / Vocal cords
anastomosed without tension. However, if the defect is too long for direct neurorrhaphy, a free nerve graft taken from the transverse cervical nerve, supraclavicular nerve or ansa cervicalis nerve is used to fill the defect.

Secure nerve anastomosis is the most important in successful nerve reconstruction [5]. In particular, there are two anastomosis sites when free nerve grafts are applied, so proper technique is needed. Several techniques for enhancement of nerve recovery after nerve anastomosis have been developed. Feasible approaches include tubulization with biological or synthetic materials as graft conduits and the epineural sleeve technique [5-8].

In our study, defects of the severed recurrent laryngeal nerve were anastomosed directly or filled with a free ansa cervicalis nerve graft immediately after extirpation of thyroid cancer. We designed a special vein wrapping technique to enhance nerve recovery. We report here the advantages of the vein wrapping technique for nerve reconstruction in patients with thyroid cancer invading the recurrent laryngeal nerve and its effects on postoperative phonatory function.

**IDEA**

The subjects were three patients (all female, mean age 51 years; range, 44 to 59 years) with advanced thyroid cancer who underwent resection of the recurrent laryngeal nerve during surgical extirpation of the thyroid cancer in February and March, 2010. All patients were diagnosed with papillary thyroid cancer by means of histological examination of specimens (Table 1). There were two cases in which a free ansa cervicalis nerve graft was used to reconstruct the recurrent laryngeal nerve after tumor extirpation. They were too long to permit direct neurorrhaphy (3 cm long nerve defect in patient 1 and 4 cm long in patient 3). Upon exploration, the left ansa cervicalis nerve was intact, so that the nerve was harvested as a 4-cm-long segment. Free nerve grafting on the proximal end was done with #9-0 nylon using the epineural suture technique. The left anterior jugular vein was harvested and wrapped around the anastomosis site (Fig. 1A). In case of patient 2, a 1-cm-long right recurrent laryngeal nerve defect due to tumor extirpation was noted. Direct neurorrhaphy was performed with #9-0 nylon using the epineural suture technique because the defect was short. The right anterior jugular vein was harvested and wrapped around the anastomosis site (Fig. 1B).

To assess vocal cord function, laryngoscopic examinations were performed periodically after the operation (short-term follow-up at 3 months after the operation and long-term follow-up 1 year postoperatively). Also, the maximum phonation time (MPT) and phonation efficiency index (PEI) determined 1 year postoperatively were used to objectively evaluate the outcome. MPT is the length of sustained phonation of the vowel “a” at the loudness of a usual conversational voice after maximum inspiration in a sitting position [9]. The ratio of MPT and vital capacity (VC; sec/L)-which should indicate vocal cord function by converting a unit volume of exhaled air to certain duration of phonation—was calculated. Thus, this value is called the PEI [9]. For the evaluation of the patient’s subjective concerns, we applied the Voice Handicap Index-10 (VHI-10), adapted from Rosen et al. [10]; 2004 obtained 1 year after the operation. The

| Table 1. Patient data |
|-----------------------|
| **Characteristics**    | **Patient 1** | **Patient 2** | **Patient 3** |
| Sex                   | F             | F             | F             |
| Age (yr)              | 50            | 44            | 59            |
| Tumor pathology       | PTC           | PTC           | PTC           |
| Lymph node metastasis | (-)           | (+) at 3/66   | (+) at 5/45   |
| Distant metastasis    | (-)           | (-)           | (-)           |
| Nerve defect length (cm)| 3            | 1             | 4             |

PTC, papillary thyroid cancer.

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![Fig. 1. Illustration of the vein wrapping technique](image)
VHI-10 comprises 10 questions from the original 30 questions of the VHI [11].

Laryngoscopic examination conducted as a short-term follow-up at 3 months after the operation showed that the vocal cords on that side were fixed in the median, but had good tension during phonation and that the gaps between the cords were narrow during phonation [9]. Although patient 3 did not participate in the long-term follow-up, the other two patients who did showed a better vocal cord mobility at 1 year than at 3 months postoperatively (Fig. 2). MPT and PEI at 1 year postoperatively was 19.5 ± 0.3 sec and 7.88 ± 0.78 sec, respectively. The mean value of VHI-10 was 6 (Table 2). There were no major complications such as infection, hematoma, or recurrence of cancer.

**DISCUSSION**

The recurrent laryngeal nerve is an essential nerve for phonation and psychosocial interaction [12]. Therefore, when the recur-
Veins potentially available for nerve wrapping are easily acc
gered by nerve trauma in the surrounding tissues [13].

inflammatory cascade and neurotrophic factor production trig-
ing technique can be done with the goal of isolating it from the
neuromas [13]. To prevent neuroma formation, the vein wrap-
s and may grow aberrantly, forming dense nerve tangles called
proximally regenerating axons sprout into the surrounding tis-
to the transected nerve ends [5]. The second advantage relates to
the mechanical protection of the anastomosed nerve site. A me-
chanical chamber could prevent protrusion of fascicles out from
the suture line and sprouting axons can be well-aligned within
the chamber [5]. The third advantage concerns prevention of
neuroma formation. When nerve transection injury occurs,
proximally regenerating axons sprout into the surrounding tis-
sue and may grow aberrantly, forming dense nerve tangles called
neuromas [13]. To prevent neuroma formation, the vein wrap-
ing technique can be done with the goal of isolating it from the
inflammatory cascade and neurotrophic factor production trig-
ered by nerve trauma in the surrounding tissues [13].

Veins potentially available for nerve wrapping are easily ac-
cessible and available in the same operative field. Veins can be
easily dilated with fine surgical forceps to adapt the lumen to the
nerve size and can thus be used to treat large nerves [13]. Al-
though successful wrapping with numerous synthetic materials
(such as silicon and collagen conduits) has been reported, veins
have the advantage of being obtainable at no cost and are easily
available. Furthermore, this technique does not cause any risk of
venous thrombosis [13].

In the postoperative course, recurrent laryngeal nerve and
vocal cord function can be examined by a variety of means:
self assessment of voice, nerve stimulation, cricothyroid palpa-
tion, or the use of proper equipment for direct visualization. A
direct laryngoscopy can be used to check vocal cord mobility;
however, it is not by itself sufficient to evaluate the recovery of
vocal cord function, as the reinnervated cords are usually fixed
in the median [4]. For more exact evaluation of the recovery of
the voice quantitatively, the MPT and PEI were measured. In
this study, subjective assessment was performed on all patients post-
operatively by the VHI-10 [11]. Self assessment also provides
different information about voice function, so the VHI-10 can
be useful to evaluate the vocal cord function.

We had few patients and no control group, so our results were
compared with the data from a previous study [9]. Patients with
thyroid cancer underwent reconstruction of the recurrent laryn-
geal nerve. The recurrent laryngeal nerve was reconstructed with
several conventional techniques such as direct neurorrhaphy,
free nerve graft, ansa cervicalis nerve-recurrent laryngeal nerve
anastomosis, and vagus nerve-recurrent laryngeal nerve anasto-
mosis without the vein wrapping technique [9].

Our study showed that 1 year postoperatively, the patients
displayed longer MPT (19.5 ± 0.3 sec) than the previously-re-
ported [9] conventional reconstruction group (18.8 ± 6.6 sec).
Also, the present patients displayed a higher PEI (7.88 ± 0.78)
than the previous patients (7.59 ± 2.82) [9]. A very recent study
reported that a VHI-10 score > 7 should be considered abnor-
mal. In our study, the mean value of the VHI-10 was 6, so it was
within the normal range.

This series is limited by the drawbacks of a retrospective design
and few study cases. Furthermore, there was no control group,
thereby exposing this series to selection bias. However, this study
used a similar design and similar patient groups to a prior study
so that the results could be compared [9].

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