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Voice tuning with new instruments for type II thyroplasty in the treatment of adductor spasmodic dysphonia

Tetsuji Sanuki *, Eiji Yumoto, Yutaka Toya, Yoshihiko Kumai

Department of Otolaryngology-Head & Neck Surgery, Graduate School of Medicine, Kumamoto University, Kumamoto, Japan

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ABSTRACT

Objective: Adductor spasmodic dysphonia is a rare voice disorder characterized by strained and strangled voice quality with intermittent phonatory breaks and adductory vocal fold spasms. Type II thyroplasty differs from previous treatments in that this surgery does not involve any surgical intervention into the laryngeal muscle, nerve or vocal folds. Type II thyroplasty intervenes in the thyroid cartilage, which is unrelated to the lesion. This procedure, conducted with the aim of achieving lateralization of the vocal folds, requires utmost surgical caution due to the extreme delicacy of the surgical site, critically sensitive adjustment, and difficult procedures to maintain the incised cartilages at a correct position.

During surgery, the correct separation of the incised cartilage edges with voice monitoring is the most important factor determining surgical success and patient satisfaction.

Methods: We designed new surgical instruments: a thyroid cartilage elevator for undermining the thyroid cartilage, and spacer devices to gauge width while performing voice monitoring. These devices were designed to prevent surgical complications, and to aid in selecting the optimal size of titanium bridges while temporally maintaining a separation during voice monitoring.

Results: We designed new surgical instruments, including a thyroid cartilage elevator and spacer devices. Precise surgical procedures and performing voice tuning during surgery with the optimal separation width of the thyroid cartilage are key points for surgical success.

Conclusion: We introduce the technique of voice tuning using these surgical tools in order to achieve a better outcome with minimal surgical complications.

1. Introduction

"Adductor spasmodic dysphonia" (AdSD) is an idiopathic focal dystonia characterized by a strained-strangled voice quality, effortful speech production, and frequent voice breaks occurring secondary to adductor muscle spasms with consequent vocal fold hyperadduction [1]. Current treatments for SD consist primarily of botulinum toxin injections. Although injections can relieve symptoms and improve the quality of life [2,3], the approach has notable limitations. First, injections must be repeated approximately every 4 months [4]. Second, effectiveness can vary significantly with injection site and dose, as well as over time. Third, in some studies patients have reported a suboptimal voice 60% of the time [5,6]. Thus, there is a continuing need for alternative therapies.

Type II thyroplasty differs from previous treatments [7–13] in that this surgery does not involve any surgical intervention with regard to the laryngeal muscle, nerve, or vocal folds. Type II thyroplasty intervenes in the thyroid cartilage, which is

* Corresponding author at: Department of Otolaryngology-Head & Neck Surgery, Graduate School of Medicine, Kumamoto University, Honjo, Kumamoto 860-8556, Japan. Tel.: +81 96 373 5255; fax: +81 96 373 5256.
E-mail address: otostl0319@fc.kuh.kumamoto-u.ac.jp (T. Sanuki).

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unrelated to the lesion. This procedure, conducted with the aim of achieving lateralization of the vocal folds, requires the utmost surgical caution due to the extreme delicacy of the surgical site, critically sensitive adjustment, and difficult procedures to maintain the incised cartilages in the correct position [14]. There are reports of surgical complications, such as friable cartilages [15,16], perforation of the upper anterior commissure, and distorted vocal folds with extensive subperichondrial undermining around the anterior commissure [17].

During surgery, the correct separation of the incised cartilage edges with voice monitoring is the most important factor in determining surgical success and patient satisfaction. In 2004, Chan et al. [15] reported poor outcomes of type II thyroplasty. This was due largely to the fact that they performed the surgery under general anesthesia without voice monitoring.

We designed new surgical instruments: a thyroid cartilage elevator for undermining the thyroid cartilage, and spacer devices to gauge the width while performing voice monitoring. These devices were designed to prevent surgical complications, and to aid in selecting the optimal size of titanium bridges, while temporarily maintaining a separation during voice monitoring. In this paper, we introduce the technique of voice tuning using these surgical tools to achieve a better outcome with minimal surgical complications.

2. Surgical technique and discussion

2.1. Essential points in surgical technique for type II thyroplasty

Under local anesthesia, a horizontal skin incision, about 3–4 cm in length, is made at a level a little lower than the midpoint of the thyroid cartilage. The median vertical strip of the thyroid cartilage is exposed from well above the notch down to the cricothyroid membrane. The thyroid cartilage is incised at the midline, leaving the underlying soft tissue intact.

2.1.1. Separation between the thyroid cartilage and the inner perichondrium

Fine instruments are required for the separation and undermining of the incised thyroid cartilage. The separation is made just along the backside of the cartilage. Cartilage-perichondrial separation using the new thyroid cartilage elevator (Fig. 1) is also performed laterally, from the median incision within the area to hold the titanium bridge [18]. Two titanium bridges are now used for firm and permanent fixation of the thyroid cartilage at both the upper and lower corner. The thyroid cartilage elevator has a scale on the tip for indicating the distance to undermine, usually about 2 mm from the midline at the lower portion. Similarly, the upper portion is also undermined to hold the bridge (Fig. 2). The middle part of the incised thyroid cartilage, the anterior commissure is undermined minimally, or if possible, left untouched. Undermining is not performed widely around the anterior commissure to prevent detachment of the vocal folds from the anterior commissure, resulting in the lowering of the vocal pitch [17].

2.1.2. Determining the optimal width of separation of the incised cartilage edges

There are spacer devices (Fig. 3) of various widths and two depths, designed to temporarily maintain the exact length of separation at the lower and upper parts of the incised thyroid cartilage, and to assist in holding the cartilage to select the optimal size titanium bridges (video). While asking the patient to produce vocal sounds, such as vowel /a/, or any words that the patient has problems pronouncing, such as ‘‘ohayo gozaimasu’’ (meaning: good morning), the separation width

Table 1
A summary of results.

Pt. No.	Gender	Age	Pre-Op.							3 month Post-Op.						
			F0	Flow	G	R	B	A	S	F0	Flow	G	R	B	A	S
1	F	29	245	226	1	0	0	0	1	243	131	0	0	0	0	0
2	M	39	138	141	2	0	0	0	2	166	416	1	0	0	0	1
3	M	36	118	145	2	0	0	0	2	164	147	1	0	0	0	1
4	F	29	262	175	2	0	1	0	2	264	96	1	0	0	0	1
5	F	58	232	84	2	0	0	0	2	264	88	0	0	0	0	0
6	F	24	246	136	2	0	0	0	2	264	179	1	0	0	0	0
7	M	27	117	102	3	0	0	0	3	121	100	1	0	0	0	1
8	F	76	245	309	2	0	0	0	2	254	292	0	0	0	0	0
9	F	46	209	400	3	0	1	0	2	254	100	1	0	1	0	0
10	F	47	241	70	2	1	0	0	2	248	61	0	0	0	0	0
11	F	45	218	180	2	0	0	0	2	250	140	0	0	0	0	0
12	F	34	213	222	1	0	0	0	1	210	95	0	0	0	0	0
13	F	39	252	68	2	0	0	0	2	269	62	0	0	0	0	0
14	M	43	111	101	2	0	0	0	2	148	233	1	0	1	0	0
15	F	50	253	61	2	0	0	0	2	292	122	1	0	0	0	1
16	F	28	221	71	1	0	0	0	1	253	154	0	0	0	0	0
17	F	32	232	151	1	0	0	0	1	219	130	0	0	0	0	0
18	F	44	196	74	2	0	0	0	1	187	132	0	0	0	0	0
19	F	49	199	68	3	0	0	0	2	219	119	1	0	0	0	1
20	M	47	182	93	2	1	0	0	2	175	145	0	0	0	0	0
	Ave.		206	144	2.0	0.1	0.1	0.0	1.8	223	147	0.5	0.0	0.1	0.0	0.3

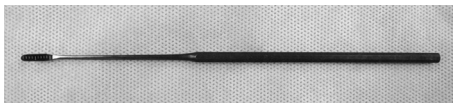

Fig. 1. The thyroid cartilage elevator. The thyroid cartilage elevator has an angle and a scale on the tip indicating the distance to be undermined.

is adjusted to the optimal point where the voice can easily be produced without any strangulation sensation being experienced by the patient. Too wide a separation can make the voice breathy and weak. At the moment when the glottis on phonation is adequately widened, the patient always realizes the difference in the ease of voice production. The spacer devices may be identical, or they may be different sizes at the upper and lower portions of the thyroid cartilage, depending on voice improvement. An adequate width of separation ranges from 2 to 6 mm, most commonly 3–4 mm.

2.1.3. Installation of the selected titanium bridges and fixation by sutures

After confirming the space created under the thyroid cartilage to hold the bridge, selected bridges of the same sizes as the spacer devices are carefully bent with pliers to comply with the curvature of the thyroid cartilage, and are gently set holding the cartilage, one side after the other, with the help of an assistant surgeon. The edges of the incised cartilage should not be damaged, which would cause narrowing of the intended width and reduce the effect of the surgery. The bridges are fixed to the cartilage with four 4–0 nylon sutures, passing through the hole or holding them using a suture surrounding the bridge.

2.2. The benefits of new surgical instruments

Ethical approval for this study was obtained from the Institutional Review Board of Kumamoto University Hospital.

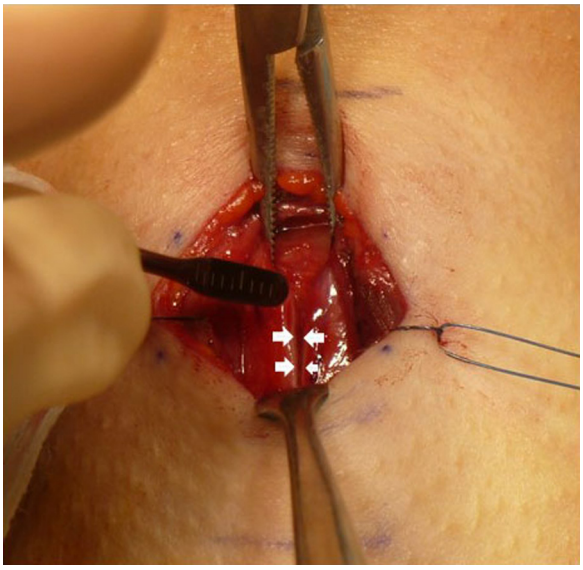

Fig. 2. The thyroid cartilage elevator and curved-tip hemostatic forceps. These are used to undermine laterally from the median incision within the area to hold the titanium bridges apart, usually about 2 mm. White arrows: the incised edges of thyroid cartilage.

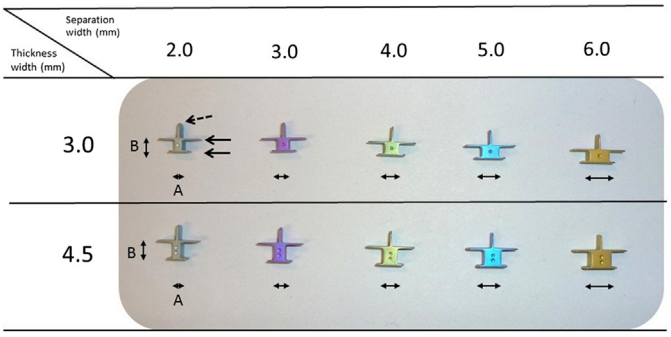

Fig. 3. Spacer devices. The devices have an assist handle (dotted-line arrow) and a short bilateral receptor (solid-line arrows) to grasp the cartilage edges, because the devices are used to temporarily maintain the correct separation while deciding on the optimal width of separation of the incised cartilage edges. The spacers have five different separation widths (A = 2.0–6.0 mm) with five different colors, the same as the titanium bridges (double-lined arrow), and are able to accommodate the different cartilage thicknesses of male and female patients (B = 3.0 and 4.5 mm).

We attempted to use the surgical instruments for type II thyroplasty in 20 cases of AdSD.

(1) The thyroid cartilage elevator makes it easier to undermine the incised edges of the thyroid cartilage because the elevator has a flat, angled tip to fit precisely. During the cartilage-perichondrial undermining around the anterior commissure, the elevator indicates the distance to precisely undermine the cartilage perichondrium around the anterior commissure. There were no surgical complications, such as friable cartilage or lowering of the vocal pitch in this study.
(2) While asking the patient to produce vocal sounds, such as the vowel/a/and other words, the separation width of the incised thyroid cartilage is adjusted to the optimal point where the voice can be produced easily without any strangulation sensation being experienced by the patient. However, holding the incised thyroid cartilage with a pair of curved-tip hemostatic forceps results in an unstable phonation because the surgeon holds the forceps during phonation. The spacer devices are the same size as the corresponding titanium bridges. The devices are used to temporarily maintain the correct separation while determining the optimal width of separation of the incised cartilage edges. Several sizes of the devices are tried repeatedly until patients are satisfied with their voice change during surgery. Spacers of two thicknesses were prepared to accommodate differences in male and female thyroid cartilage thickness. Spacers accommodating a cartilage thickness of 3.0 mm are generally used for female patients, while spacers accommodating a cartilage thickness of 4.5 mm are used for male patients.
(3) Table 1 shows a summary of results. After surgery, GRBAS scale showed significant improvement in overall grade and sustain grade. There is no lowering pitch after surgery.

3. Conclusions

We designed new surgical instruments, including a thyroid cartilage elevator and spacer devices. Precise surgical

procedures and performing voice tuning during surgery with the optimal separation width of the thyroid cartilage are key points for surgical success. Using these tools and techniques in the treatment of 20 AdSD patients (from 2011 to 2013) resulted in superior patient satisfaction with no complications.

Conflict of interest

There is no conflict of interest to be disclosed with any companies.

Acknowledgment

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.anl.2015.12.015.

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